# Empirical Profiles of Alcohol and Marijuana Use, Drugged Driving, and Risk Perceptions

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**ABSTRACT. Objective:** The present study sought to inform models of risk for drugged driving through empirically identifying patterns of marijuana use, alcohol use, and related driving behaviors. Perceived dangerousness and consequences of drugged driving were evaluated as putative influences on risk patterns. **Method:** We used latent profile analysis of survey responses from 897 college students to identify patterns of substance use and drugged driving. We tested the hypotheses that low perceived danger and low perceived likelihood of negative consequences of drugged driving would identify individuals with higher-risk patterns. **Results:** Findings from the latent profile analysis indicated that a four-profile model provided the best model fit. Low-level engagers had low rates of substance use and drugged driving. Alcohol-centric engagers had higher rates of alcohol use but low rates of marijuana/simultaneous use and low rates of driving after substance use. Concurrent engagers had higher rates of marijuana and alcohol use, simultaneous use, and related driving behaviors, but marijuana-centric/simultaneous engagers had the highest rates of marijuana use, co-use, and related driving behaviors. Those with higher perceived danger of driving while high were more likely to be in the low-level, alcohol-centric, or concurrent engagers' profiles; individuals with higher perceived likelihood of consequences of driving while high were more likely to be in the low-level engagers group. **Conclusions:** Findings suggested that college students' perceived dangerousness of driving after using marijuana had greater influence on drugged driving behaviors than alcohol-related driving risk perceptions. These results support targeting marijuana-impaired driving risk perceptions in young adult intervention programs. (*J. Stud. Alcohol Drugs, 78,* 889–898, 2017)

MOTOR VEHICLE CRASHES remain the leading cause of death among young adults, and many of these deaths are attributable, in part, to substance-related driving impairments. The latest findings from the Centers for Disease Control and Prevention (CDC) indicate that a quarter of young adults involved in fatal motor vehicle crashes had been drinking alcohol (CDC, 2016), and regional studies estimate between 14.6% and 52.6% of substance-using young adults report driving after marijuana or alcohol use (Beck et al., 2008; Caldeira et al., 2008; Whitehall, et al., 2014). Although the distinctive role of delta-9-tetrahydrocannabinol (THC; the psychoactive compound in marijuana associated with impairment) in motor vehicle crashes is difficult to ascertain (National Institute on Drug Abuse [NIDA], 2017), laboratory driving-simulator studies have demonstrated THC-induced delayed responses to road obstacles and diminished driving performance (Downey et al., 2013; Liguori et al., 1998; Ramaekers et al., 2004). Laboratory studies have suggested that driving under the influence of both alcohol and marijuana produces additional detrimental effects, with low levels of alcohol increasing peak THC blood concentration (Downey et al., 2013; Hartman et al., 2015) and co-administration of both drugs increasing the risk of diminished driving performance (Downey et al., 2013). Given the continued prevalence and potentially fatal consequences of substance-impaired driving behavior, understanding factors underlying drugged driving remains a primary public health concern.

Prevention efforts directed toward reducing drunk driving typically target attitudes such as perceptions of dangerousness and likelihood of consequences (Shults et al., 2001). These attitudes may be related to alcohol and/or marijuana use (Gaher et al., 2007; Logan et al., 2012), driving under the influence of alcohol (Grube & Voas, 1996; Turrisi et al., 1997), and driving while high (Arterberry et al., 2013; Aston et al., 2016; Darke et al., 2004; McCarthy et al., 2007; Swift et al., 2010). One difficulty in understanding risk perceptions is that different studies assess risk in different ways, with some assessing perceived dangerousness, others perceived likelihood of consequences, and others combining the two as global "perceived risk." Differences in assessments are meaningful to the extent that they uniquely predict substance-related risky driving behaviors. Although there has been growing consistency that young-adult marijuana users who perceive driving while high as more dangerous are less likely to engage in this behavior (Arterberry et al., 2013; Aston et al., 2016; McCarthy et al., 2007), perceptions of likelihood of consequences related to driving while high have been less consistent (Arterberry et al., 2013; McCarthy et al., 2007).

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Assessment of single-substance behaviors also limits understanding of how driving after simultaneous use of alcohol and marijuana is influenced by perceived risk of driving while intoxicated, high, or both. When comparing alcohol- and marijuana-related perceptions of drugged driving, driving while high was perceived as less likely to result in negative consequences when compared with driving after drinking (McCarthy et al., 2007). Although people believe that driving while intoxicated is impairing and dangerous (Terry & Wright, 2005), young adults who indicated using marijuana before driving denied that it affected their driving ability and believed that marijuana heightened awareness, heightened concentration, and even improved driving performance (Darke et al., 2004; Lenné et al., 2001; Swift et al., 2010; Terry & Wright, 2005). These discrepancies in drugged driving risk perceptions among young adults may be influenced by confusion regarding the legal consequences of driving while high, changing legislation regarding marijuana, and contradictory findings associated with the role of THC intoxication in crash risk.

Despite the potential risks of driving after simultaneous use of alcohol and marijuana, little is known about whether single-substance risk perceptions are sufficient to predict this behavior or whether risk perceptions for driving after simultaneous use provide unique information. One difficulty in identifying distinctive predictors of driving behaviors is the potential confounding of substance use, e.g., risk factors predicting drinking likely also predict driving while intoxicated (Bingham et al., 2007). A common variable-centered method to account for this potential confound is to covary for substance use, which has a number of potential drawbacks (McCarty & McCarthy, 2017; Miller & Chapman, 2001). This variable-centered approach, although straightforward and easy to implement, is insufficient because it conceptually creates a priori group membership and difficulty in interpreting the substantive changes that occur when groups differ on the covariate.

Contrary to a variable-centered methodology, person-oriented methods use an empirical approach to determine group membership (Bergman & Magnusson, 1997). By examining patterns of attributes that emerge among individuals rather than among variables, the person-oriented method characterizes the multifaceted and complex behavior of that individual.

The present study examined the association of specific drugged-driving risk perceptions with risk groups identified by both substance use behaviors and drugged-driving behaviors. Our sample of young adults in college reflected a demographic with particularly high rates of heavy drinking, marijuana use, or both. We used latent profile analysis (LPA) to identify groups based on patterns of marijuana and alcohol use, simultaneous use of both substances, and related driving behaviors. We then tested the hypothesis that lower perceptions of dangerousness and reduced likelihood of consequences when driving after alcohol, marijuana, or simultaneous use would predict riskier group membership. We (a) explored whether perceived danger outperformed perceived likelihood of consequences when predicting risk profiles and (b) compared the relative influence of risk perceptions related to driving after heavy drinking, after marijuana use, and after both.

## Method

### *Participants and procedure*

Participants were young adults in college recruited from introductory psychology classes at a large, public Midwestern university ($N$ = 966). Those who provided complete data on study variables were included in the analysis ($n$ = 897), with 7.1% removed because of missing values on dependent variables. The majority of the sample was female (54.7%). The sample was 79.5% White, 10.6% Black/African American, 5.7% Asian, 2.2% Hispanic, 0.7% Alaskan Native/American Indian, and 1.3% other race. In addition, the mean age of the sample was 19.01 ($SD$ = 1.88) years. The mean grade-point average was 3.09 ($SD$ = 0.63), with the sample consisting of 76.5% freshmen, 14.4% sophomores, 6.7% juniors, and 2.4% seniors.

Study questions were embedded within a larger online survey. Students who opted to participate provided online informed consent and received partial credit toward meeting a research requirement for their psychology course. As part of the online consent procedure, students were informed that questions may require admitting illegal activity, such as underage drinking. Participation was voluntary, and alternatives to participation to fulfill the course research requirements were offered to students. All questions and procedures were reviewed and approved by the university Institutional Review Board.

### *Measures*

*Demographic information.* Participants were asked to complete information such as gender, age, race/ethnicity, year in school, and grade-point average.

*Alcohol and marijuana use.* Use and co-use behaviors were assessed using Likert-type scales with response options modeled after National Institute on Alcohol Abuse and Alcoholism's (NIAAA's) recommended alcohol use questions (NIAAA, 2003). To assess frequency of marijuana use, participants were asked how often they used in the last 12 months and past month using 11 and 12 response options, respectively.

Response options ranged from *no use* to *every day* (past-year frequency) and *no use* to *more than 6 times per day* (past-month frequency). Marijuana quantity was measured by the question, "In the past month, how much

marijuana (in ounces) did you use in a typical week when you used marijuana?" Eleven response options ranged from *no use* to *more than one ounce in a typical week.* Alcohol frequency/quantity were assessed for the past month by asking participants to report how often and how many drinks they had on a typical day in the past month with 8 and 10 response options, respectively, ranging from *no use* to *every day* (past-month alcohol frequency) and from *no use* to *25 or more drinks* (past-month alcohol quantity). Frequency of heavy episodic drinking (HED) was assessed with an 8-point question stating, "In the past month, how often did you have 5 or more (men) or 4 or more (women) drinks containing alcohol?" with response options ranging from *never* to *every day.* Participants were also asked to report the frequency of past-12-month alcohol and marijuana co-use. This question stated, "During the last 12 months, how often did you use marijuana and drink alcohol on the same occasion?" with 11 response options ranging from *never* to *every day.*

*Driving after alcohol.* Participants were also asked to indicate the frequency with which they engage in driving after HED in the past year. Each participant reported the number of times he or she engaged in driving within 2 hours of HED, after using marijuana, and after both HED and using marijuana. Each question included 11 possible response options ranging from *never* to *every day.* Specifically, the HED question asked, "How many times in the past 12 months have you driven after having 4 or more (women) or 5 or more (men) alcoholic drinks in the past 2 hours?"

*Drugged driving.* To assess for drugged driving behaviors, participants reported the frequency they engage in drugged driving and co-drugged driving. The drugged driving question asked, "How many times in the past 12 months have you driven less than 2 hours after using marijuana?" In addition, the co-drugged driving question asked, "How many times in the past 12 months have you driven after having 4 or more (women) or 5 or more (men) alcohol drinks AND using marijuana in the past 2 hours?"

*Risk perceptions.* To assess perceived dangerousness/likelihood of consequences when driving after alcohol and/or marijuana use, participants were asked to indicate on a 4-point Likert-type scale dangerousness (*not at all dangerous* to *very dangerous*) and likelihood of consequences (*not very likely* to *very likely*). Participants responded to drug-specific questions regarding dangerousness of drugged driving as follows: within 2 hours of HED, within 2 hours of marijuana use, and within 2 hours of HED and marijuana use. To evaluate likelihood of consequences, participants were asked seven questions (four alcohol specific, three marijuana specific) regarding the likelihood of experiencing consequences related to driving while intoxicated, such as being stopped by the police, breath tested, arrested, in a traffic accident, or drug tested. Two composite scores were created for (a) likelihood of experiencing marijuana-related consequences ($\alpha = .91$) and (b) likelihood of experiencing alcohol-related consequences ($\alpha = .87$).

### *Analytic strategy*

LPA was conducted with Mplus Version 7.4 (Muthén & Muthén, 1998–2015). Maximum likelihood with robust standard errors was used to account for nonnormality in the data (Muthén & Asparouhov, 2002) and is considered adequate in managing missing data (Schafer & Graham, 2002). The LPA was used to estimate the latent structure of marijuana use, alcohol use, simultaneous use, and driving while intoxicated using 10 continuous indicators. LPA prevalence was produced through estimated probabilities that an individual would be in a specific latent profile and parameters based on a set of item-response probabilities that were linked to a latent profile (Collins & Lanza, 2010; Nylund et al., 2007). In this study, the membership probability for each latent profile was based on the risky behavior profile, and the item-response probabilities were based on marijuana use, alcohol use, simultaneous use, and co-drugged driving behaviors while aiding in the interpretation and labeling of each latent profile.

Selecting the latent profile structure was based on several criteria including Bayesian information criterion (BIC; Schwarz, 1978), sample-adjusted BIC (saBIC; Sclove, 1987), bootstrapped likelihood ratio test (BLRT; McLachlan & Peel, 2000; i.e., statistically significant values suggest current model is preferred over a model with one less class), Lo–Mendell–Rubin Likelihood Ratio Test (LMR-LRT; Lo et al., 2001; i.e., significant *p* values suggest current model preferred to model with one less class), and theory. Fit indices such as BIC and saBIC are considered better when values are lower. Entropy was used to assess the overall degree of classification uncertainty, with values above .80 suggesting distinct profiles (Celeux & Soromenho, 1996). In this study, the model was chosen using a balance among parsimony, theoretical interpretability, and goodness of fit. Multinomial logistic regressions were simultaneously conducted while fitting each model to predict profile membership. Perceived dangerousness and perceived likelihood of consequences when driving while intoxicated were modeled as independent variables, whereas latent profile membership was the dependent variable.

## Results

### *Descriptive statistics*

Bivariate correlations were conducted among all variables (Table 1). Perceived likelihood of consequences of driving after drinking alcohol was not significantly associated with past-month alcohol frequency or past-month HED frequency. All other variables were significant and correlated in the expected directions.

TABLE 1. Correlations, means, and standard deviations for risky behaviors and perceptions

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. MJ past-year frequency | 1.00 | | | | | | | | | | | | | | |
| 2. MJ past-month frequency | **.84** | 1.00 | | | | | | | | | | | | | |
| 3. MJ past-month quantity | **.76** | **.76** | 1.00 | | | | | | | | | | | | |
| 4. Alc. past-month frequency | **.40** | **.30** | **.24** | 1.00 | | | | | | | | | | | |
| 5. Alc. past-month quantity | **.45** | **.35** | **.35** | **.76** | 1.00 | | | | | | | | | | |
| 6. HED past-month frequency | **.45** | **.33** | **.28** | **.88** | **.81** | 1.00 | | | | | | | | | |
| 7. MJ/alc. past-year frequency | **.84** | **.74** | **.63** | **.44** | **.49** | **.47** | 1.00 | | | | | | | | |
| 8. Driving after HED past-year frequency | **.34** | **.27** | **.24** | **.31** | **.36** | **.32** | **.39** | 1.00 | | | | | | | |
| 9. Driving after MJ past-year frequency | **.79** | **.74** | **.62** | **.26** | **.35** | **.32** | **.72** | **.37** | 1.00 | | | | | | |
| 10. Driving after MJ/HED past-year frequency | **.41** | **.42** | **.36** | **.21** | **.33** | **.22** | **.49** | **.63** | **.50** | 1.00 | | | | | |
| 11. Perceived dangerousness of driving after HED | **-.17** | **-.15** | **-.14** | **-.18** | **-.22** | **-.21** | **-.22** | **-.29** | **-.21** | **-.27** | 1.00 | | | | |
| 12. Perceived dangerousness of driving after MJ | **-.53** | **-.44** | **-.42** | **-.28** | **-.35** | **-.31** | **-.47** | **-.28** | **-.51** | **-.28** | **.40** | 1.00 | | | |
| 13. Perceived dangerousness of driving after MJ/HED | **-.18** | **-.14** | **-.16** | **-.12** | **-.19** | **-.16** | **-.22** | **-.31** | **-.24** | **-.35** | **.67** | **.37** | 1.00 | | |
| 14. Perceived likelihood of consequences of driving after Alc. | **-.09** | -.07* | **-.10** | -.03 | **-.09** | -.05 | **-.11** | **-.17** | **-.15** | **-.21** | **.36** | **.19** | **.36** | 1.00 | |
| 15. Perceived likelihood of consequences of driving after MJ | **-.40** | **-.33** | **-.30** | **-.21** | **-.28** | **-.23** | **-.35** | **-.24** | **-.38** | **-.19** | **.25** | **.58** | **.21** | **.53** | 1.00 |
| *M* | 2.91 | 1.96 | 1.68 | 3.05 | 3.10 | 2.86 | 2.27 | 1.71 | 2.11 | 1.30 | 3.63 | 2.86 | 3.79 | 3.35 | 2.59 |
| *SD* | 2.75 | 2.13 | 1.52 | 2.11 | 2.24 | 2.09 | 1.97 | 1.48 | 2.25 | 1.03 | 0.68 | 1.04 | 0.54 | 0.69 | 1.00 |

*Notes:* MJ = marijuana; Alc. = alcohol; HED = heavy episodic drinking. **Bold** denotes significance at $p < .001$; *$p < .05$.

*Latent profile analysis*

Results of the LPA indicated a four-profile model provided parsimony and best goodness of fit (BIC = 27898.15; saBIC = 27672.67; BLRT: $p < .001$; LMR-LRT: $p = .004$), as indicated by the lower values for BIC/saBIC and the significant LMR-LRT. In comparison, the three-profile model (BIC = 28821.34; SABIC = 28656.20; BLRT: $p < .001$; LMR-LRT: $p = .002$) had higher BIC/saBIC, and the five-profile model (BIC = 27405.92; saBIC = 27139.15; BLRT: $p < .001$; LMR-LRT: $p = .522$) did not have a significant LMR-LRT. The indicators were theoretically supported and the degree of classification was high (entropy = .91) in the four-profile model.

The four-profile standardized means for engaging in substance-use risk behaviors by latent profile are depicted in Figure 1. Demographic information based on most likely profile membership is presented in Table 2. For the low-level engagers profile, there were extremely low rates of marijuana use or alcohol use and low rates of driving after substance use. In the alcohol-centric engagers profile, individuals engaged in higher rates of alcohol use but had lower rates of marijuana use and driving after use. The concurrent engagers profile had higher rates of marijuana use, alcohol use, and driving after use compared with low-level engagers and alcohol-centric engagers but lower rates of simultaneous use than the marijuana-centric/simultaneous engagers profile, which had the highest rates of marijuana use behaviors as well as marijuana-related driving behaviors. The low-level engagers and alcohol-centric engagers represented the largest percentages of the sample and consisted of a majority of Whites, freshmen, women, and individuals who reported higher grade-point averages. In contrast, the concurrent and marijuana-centric/simultaneous engagers' profiles consisted of a majority of men and those with reported lower grade-point averages.

Mean scores for the perceptions of dangerousness of driving while intoxicated and for likelihood of consequences by latent profile are presented in Figure 2. The lowest and most variability in means scores was associated with marijuana-related perceptions of dangerousness and likelihood of consequences across profiles. Alcohol-related perceptions

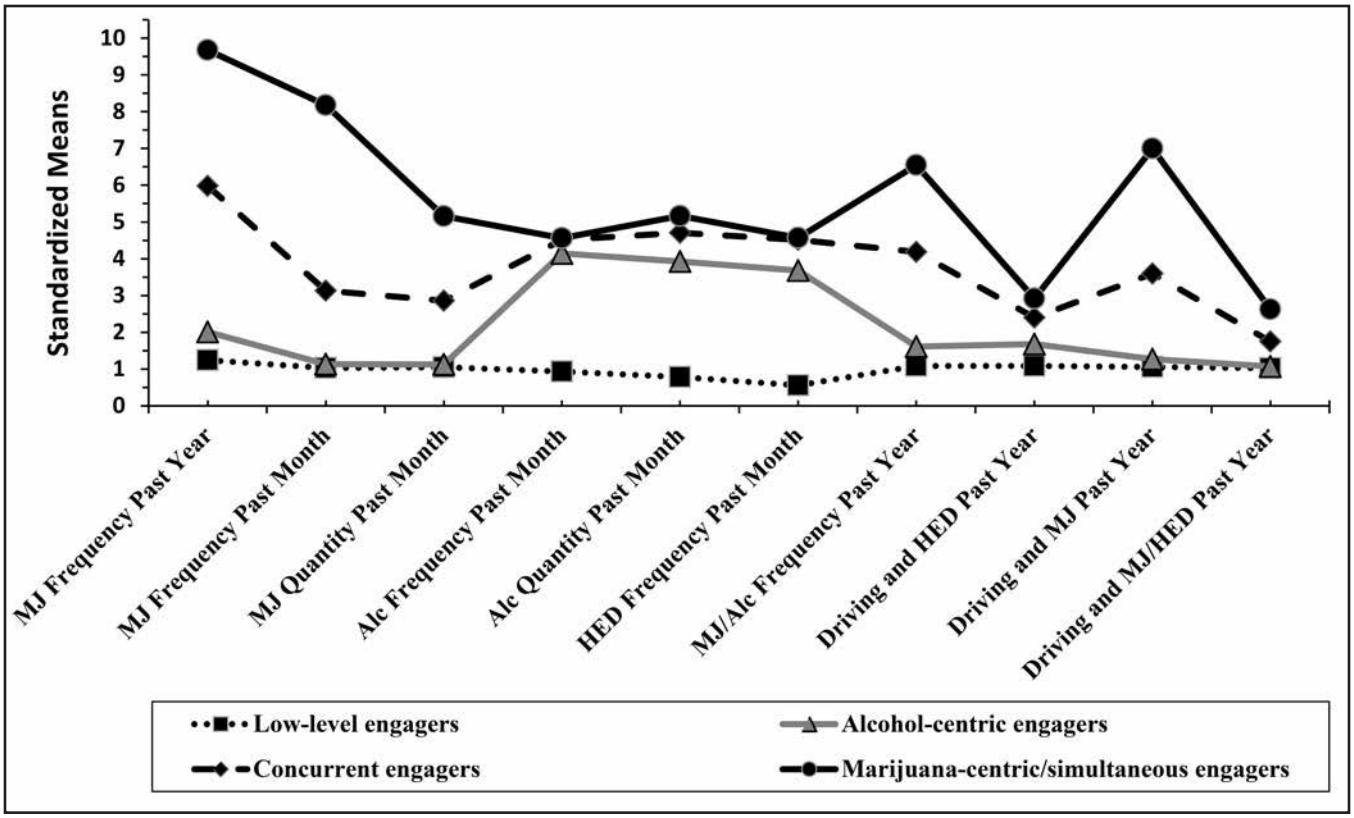


FIGURE 1. Standardized means for engaging in risk behaviors by latent profile. MJ = Marijuana; Alc = alcohol; HED = heavy episodic drinking.

of dangerousness had the highest mean scores and lowest variability across profiles. For simultaneous alcohol and marijuana use drugged driving perceptions of dangerousness and likelihood of consequences, the least variability and the highest mean scores were shown across profiles.

*Multinomial logistic regression.* Results of the multinomial logistic regressions for perceived danger and perceived likelihood of consequences when driving after alcohol and/or marijuana use are reported in Table 3. The marijuana-centric/simultaneous engagers' profile served as the reference category. Individuals who reported having a higher perceived danger of driving while high were more likely to be in the low-level, alcohol-centric, or concurrent engagers profiles (adjusted odds ratios = 1.93–5.73, $p$s < .01). Those who indicated having a higher perceived likelihood of consequences when driving while high were more likely to be in the low-level engagers profile (adjusted odds ratio = 1.94, $p < .01$). In contrast, perceived dangerousness and perceived likelihood of consequences when driving after drinking did not significantly inform profile membership.

## Discussion

Reducing alcohol and marijuana use that results in drugged driving remains a public health priority, particularly during the young adult, college years—a period marked by heightened rates of heavy drinking, marijuana use, and simultaneous use of both substances. The purpose of this study was to examine whether specific drugged-driving risk perceptions are associated with risk groups identified by both substance use and related driving behaviors. The present study empirically identified four profiles of young adults, ranging from those who do not typically engage in alcohol or marijuana use to those who use these substances frequently and heavily and also report driving while high, after heavy drinking, and after simultaneous alcohol/marijuana use. Findings suggest that perceived dangerousness of driving after marijuana use was a better predictor of the riskiest substance use and drugged-driving profiles than (a) perceived likelihood of negative consequences and (b) risk perceptions for driving after heavy drinking or simultaneous drinking and marijuana use.

Our findings extend previous literature by using a person-centered approach to examine concurrent and simultaneous alcohol and marijuana use, as well as related driving behaviors in a single model evaluating the influence of specific drugged-driving risk perceptions. We distinguish between risk perceptions associated with drugged driving among young adults and assess risk perceptions for driving after heavy drinking, after marijuana use, and after both.

TABLE 2. Latent class counts and proportions for the total sample and demographic information for each class

| Variable | Low-level engagers | Alcohol-centric engagers | Concurrent engagers | Marijuana-centric/ simultaneous engagers |
|---|---|---|---|---|
| Total sample ($n$ = 897) | 318 (35.5%) | 370 (41.2%) | 143 (15.9%) | 66 (7.4%) |
| Gender | | | | |
| Male | 121 (38.1%) | 159 (43.0%) | 86 (60.1%) | 44 (66.7%) |
| Female | 197 (61.9%) | 211 (57.0%) | 57 (39.9%) | 22 (33.3%) |
| Race/ethnicity | | | | |
| White | 240 (75.5%) | 323 (87.3%) | 113 (79.0%) | 52 (78.8%) |
| Black/African American | 41 (12.9%) | 19 (5.1%) | 15 (10.5%) | 8 (12.1%) |
| Year in school | | | | |
| Freshman | 248 (78.2%) | 269 (72.7%) | 114 (79.7%) | 49 (74.2%) |
| Sophomore | 42 (13.2%) | 61 (16.5%) | 19 (13.3%) | 11 (16.7%) |
| Junior/senior | 27 (8.6%) | 40 (8.1%) | 10 (3.5%) | 6 (7.6%) |
| Grade-point average | 3.18 (0.63) | 3.15 (0.58) | 2.93 (0.67) | 2.65 (0.69) |

*Note:* Mean (*SD*) presented for grade-point average; *n* (%) presented for all other variables. Low-level engagers had low rates of marijuana use or alcohol use and low rates of driving after substance use. Alcohol-centric engagers engaged in higher rates of alcohol use and lower rates of marijuana use and driving after use. Concurrent engagers had higher rates of marijuana use, alcohol use, and driving after use and lower rates of simultaneous use. Marijuana-centric/simultaneous engagers had the highest rates of marijuana use and marijuana-related driving behaviors.

Of note, perceived dangerousness and likelihood of consequences of driving while high may have a stronger influence on drugged driving than perceived dangerousness or likelihood of consequences of drunk driving. Those with higher scores of perceived dangerousness of driving while high were more likely to be in the low-level, alcohol-centric, or concurrent engagers' profiles. Higher scores of perceived likelihood of consequences when driving while high were associated only with the low-level engagers profile. In contrast, perceived dangerousness and perceived likelihood of consequences of driving after heavy drinking were not significantly associated with profile membership.

Studies examining drug-specific outcomes among marijuana users have indicated that those who perceive driving while high to be less dangerous and perceive themselves to be less likely to experience consequences when driving while high were more likely to engage in the behavior more frequently (Arterberry et al., 2013; Aston et al., 2016; Terry & Wright, 2005). In the present study, mean marijuana use was higher and mean alcohol use was relatively similar across higher risk profiles, and marijuana-related risk perceptions were associated with higher risk behaviors. These results provide evidence that marijuana use and related risk perceptions may be a barometer for the potential to engage in drugged driving behaviors, such as drunk driving and/or driving while high.

This study also highlights the importance of continued research to understand the distinct role of THC in vehicle-crash risk and how this risk is altered when alcohol is also on board. This work is needed to inform drugged-driving intervention and prevention efforts that seek to target the potential dangers of and attitudes associated with driving while high.

Although prior research showed associations of drunk-driving–related risk perceptions with frequency of driving after drinking (McCarthy & Pedersen, 2009), the current study did not show that alcohol-related risk perceptions predicted young adult risk profiles based on concurrent or simultaneous substance use and drugged-driving behaviors. This finding could be a function of not assessing for driving-related information such as access to a vehicle or frequency of driving. By not accounting for general driving behaviors, differences in perceptions may not have been detected among those who drive less. Another explanation for this difference could be ceiling effects for perceived danger of driving after simultaneous use and driving after alcohol. Wider variability in scores for perceived danger of driving after marijuana, compared with unanimously high scores for perceived danger of driving after heavy drinking (with or without simultaneous marijuana use), may partially explain its prediction of behavior. This may also be related to the fact that alcohol's contribution to crash risk has been well

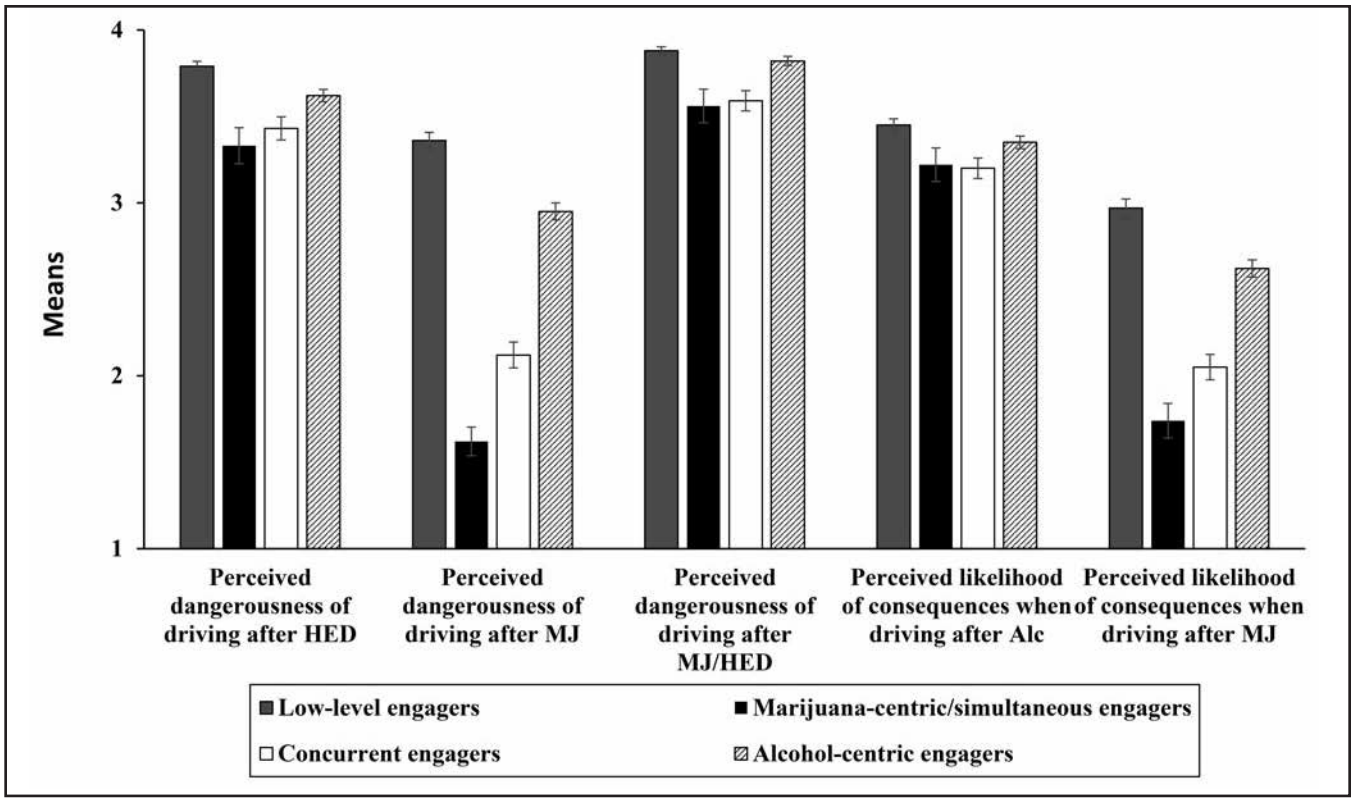


FIGURE 2. Drugged driving perceptions of dangerousness and likelihood of consequences mean scores by latent profile. MJ = Marijuana; Alc = alcohol; HED = heavy episodic drinking.

TABLE 3. Multinomial logistic regressions of profile membership by driving-related attitudes

| Variable | Adjusted odds ratio | 95% CI | *p* |
|---|---|---|---|
| Perceived dangerousness of driving after heavy episodic drinking | | | |
| Low-level engagers profile | 1.17 | [0.63, 2.15] | .677 |
| Alcohol-centric engagers profile | 1.12 | [0.65, 1.92] | .735 |
| Concurrent engagers profile | 0.82 | [0.47, 1.45] | .575 |
| Perceived dangerousness of driving after marijuana use | | | |
| Low-level engagers profile | **5.73** | **[3.88, 8.45]** | **<.001** |
| Alcohol-centric engagers profile | **1.93** | **[1.34, 2.77]** | **.003** |
| Concurrent engagers profile | **3.92** | **[2.73, 5.61]** | **<.001** |
| Perceived dangerousness of driving after marijuana use and heavy episodic drinking | | | |
| Low-level engagers profile | 1.04 | [0.55, 1.97] | .915 |
| Alcohol-centric engagers profile | 0.86 | [0.51, 1.45] | .638 |
| Concurrent engagers profile | 1.29 | [0.75, 2.22] | .445 |
| Perceived likelihood of consequences when driving after alcohol use | | | |
| Low-level engagers profile | 0.70 | [0.45, 1.08] | .179 |
| Alcohol-centric engagers profile | 0.84 | [0.56, 1.26] | .469 |
| Concurrent engagers profile | 0.82 | [0.55, 1.23] | .424 |
| Perceived likelihood of consequences when driving after marijuana use | | | |
| Low-level engagers profile | **1.94** | **[1.29, 2.94]** | **.008** |
| Alcohol-centric engagers profile | 1.15 | [0.78, 1.69] | .552 |
| Concurrent engagers profile | 1.52 | [1.02, 2.28] | .087 |

*Notes:* Marijuana-centric/simultaneous engagers = reference category. **Bold** indicates significance. CI = confidence interval.

established (Berning & Smither, 2014; National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). Further, because of the development of alcohol per se laws in prevention/intervention efforts surrounding drunk driving, young adults have consistently received the message that alcohol can lead to serious negative consequences.

In contrast to the robust evidence regarding alcohol-related crash risk, the same has not been unequivocally demonstrated for marijuana because of lack of clarity regarding THC's distinctive role in motor vehicle crashes. The ability to detect THC in body fluids weeks after intoxication makes its role in motor vehicle crashes difficult to determine via a roadside test (NIDA, 2017), and discrepancies in traffic studies limit understanding of the connection between intoxication and crash risk (Berning & Smither, 2014; NASEM, 2017). Although several studies suggest that presence of THC increases the odds of motor vehicle crashes and fatalities (Asbridge et al., 2012; Compton & Berning, 2009; Li et al., 2011), these studies are limited to assessing presence/absence of THC, which does not equate to impairment (Berning & Smither, 2014).

Further, a recent study conducted by the National Highway Traffic Safety Administration did not find an increase in crash risk associated with marijuana after controlling for demographic characteristics and alcohol (Compton & Berning, 2015). In addition to the discrepant findings in traffic studies, there are currently no guidelines that exist for "safe levels" of marijuana intoxication or for how long to wait before driving once it is consumed; this is especially important in relation to different routes of administration (e.g., edibles vs. smoking) and quantity of use before driving. In sum, when studying both alcohol- and marijuana-related risk behaviors, perceptions of risk associated with marijuana may have wider variability—and thus more influence—because of inconsistencies in traffic studies and lack of clear guidelines regarding driving after marijuana use. These factors may have led marijuana users to be apprehensive in believing that driving while high is dangerous and could result in negative consequences.

There were limitations to the current study. Although we obtained a large sample, the findings of this study may not be generalizable to more diverse populations because participants were from the same Midwestern university with little ethnic diversity. The cross-sectional design did not allow for the investigation of temporal or causal relationships. Although reports were anonymous, there could be potential for recall bias because the data were gathered from self-report. Because of the wording of questions, question choice may have influenced response profiles, where we included past-year and past-month use to ensure inclusion of individuals who engage in both low- and high-level marijuana use, and low base rate behaviors such as drugged driving. Because the current study was concerned with drugged-driving perceptions and not actual risk of drugged driving, we did not assess for participants' ability to drive a vehicle, access to a vehicle, or general driving frequency. This could have introduced bias, as people with more driving accessibility may endorse and perceive drugged driving behaviors differently than those who have limited access to a vehicle or no experience driving.

One common limitation in marijuana-related research has been assessing quantification and route of administration. The most common route of administration (i.e., smoking) and general quantity consumed in the past month were used in this study. Yet, the driving-while-high question assessed whether the individual had driven 2 hours after smoking and did not differentiate levels of consumption or routes of administration.

This was one of the first studies to examine simultaneous and concurrent use of alcohol- and marijuana-related drugged driving behaviors and perceptions of risk among young adults using a person-centered approach. The current study elucidated that risk perceptions associated with driving while high may have more influence than drunk driving perceptions in relation to alcohol, marijuana, combined use, and drugged driving behaviors. Although the combination of alcohol per se laws and preventions targeting perceptions of risk have been successful in reducing drunk driving, the same has not been developed for driving while high or drugged driving. This could be because of the inconsistent reports of crash risk in relation to THC presence in epidemiological studies versus laboratory studies of THC intoxication, unclear legal standards, and feasibility issues in determining roadside level of impairment from THC concentration in the blood.

These factors have continued to burden policy makers and may contribute to lower perceived risk of driving while high (DuPont et al., 2011; Huestis, 2015). Providing young adults with empirically supported and balanced information about the realistic dangers associated with driving while high is an important step in changing attitudes and preventing drugged driving.

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