

An assessment of traffic safety culture related to driving after cannabis use

Task 1 Report: Literature Review

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1 EXECUTIVE SUMMARY

Several states have legalized recreational cannabis use, and more are considering legalization. Increased use of cannabis among drivers may pose a barrier to achieving The National Toward Zero Deaths (TZD) initiative. The transformation of traffic safety culture is a primary element of the TZD strategy. A positive safety culture can significantly reduce crash fatalities and serious injuries. This research focuses on specific aspects of traffic safety culture that relate to the decision to drive after consuming cannabis. The project seeks to answer three critical questions:

- How does culture compare between users and non-users of cannabis?
- How does culture affect the decision to drive under the influence of cannabis?
- How does culture compare between states with and without legalized recreational use laws?

To inform this project a review of the literature of published research on values, attitudes, beliefs, and behaviors regarding driving under the influence of cannabis (Part A) and the impact of legislative changes on behavior (Part B) was completed. Through the literature review various research studies were found that looked at aspects of driving under the influence of cannabis (DUIC) and traffic safety, and these studies can be used to inform the question design for various constructs in the behavioral model used for this project. Results from this literature review revealed that there are gaps in the research. Minimal results were found that specifically looked at how state laws legalizing recreational use of marijuana influence cultural factors associated with driving under the influence of cannabis. A majority of the literature pertaining to legislative change affecting public opinion and beliefs on substances has focused on medical marijuana, particularly public use of the drug, attitudes, and views regarding use of the drug. By understanding the cultural factors that predict DUIC, (including the impact of legalization), we will be better able to bolster existing protective factors and develop interventions to address risk factors. Bolstering protection and reducing risk are critical steps in building a positive traffic safety culture that continues to reduce traffic related fatalities and serious injuries.

2 INTRODUCTION

Cannabis is the most commonly used illicit drug in the United States. For example, 7.5% of respondents aged 12 years and older reported using cannabis in the past month (SAMHSA 2014). This prevalence of recent use was higher than from 2002 to 2011. Moreover, the number of respondents reporting daily (or almost daily) use rose by over 60% in the period from 2002 to 2013 (from 4.8 million to 8.1 million reporting marijuana use on 20 or more days in the past month and from 3.1 million to 5.7 million reporting marijuana use on 300 or more days in the past year).

One reason for this increased usage may be attributed to changes in state laws regarding the decriminalization of cannabis (Ferner 2015). Notably, states that have legalized recreational cannabis use have higher use rates among all age groups as shown in Figure 1. Changes in state laws are also associated with increased prevalence of cannabis-related compounds in drivers on the road and those involved in crashes (Couper and Pederson 2014, p.569-574).

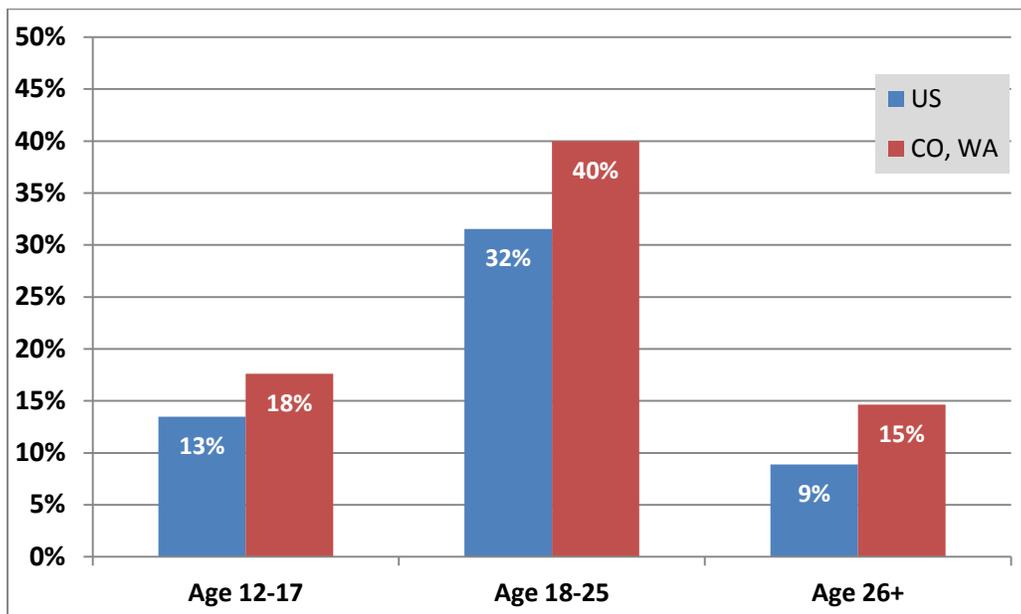


Figure 1. Past Year Cannabis Usage by Age (2012-2013)¹

The implication of changes in state laws and cannabis use is important because the consumption of cannabis may induce driving impairment that could increase crash risk (Laberge and Ward 2004, pp. 971-989; Ramaekers et al. 2004, pp. 109-119; Grotenhermen et al. 2007, pp. 1910-1917; Asbridge et al. 2014, pp. 395-404). Thus, factors that may increase the consumption of cannabis may impact traffic safety. Cultural beliefs and attitudes regarding cannabis will determine use by drivers – and therefore its contribution to crash risk. In turn, our cultural beliefs and attitudes will also determine the types of policies and strategies that might be

¹ National Survey on Drug Use and Health: Comparison of 2011-2012 and 2012-2013 Model-Based Prevalence Estimates (50 States and the District of Columbia).

acceptable and effective in our communities to improve traffic safety. It is therefore timely to better understand the culture regarding the use of cannabis and driving.

For example, attitudes and beliefs about driving under the influence of cannabis (DUIC) may be different than those for driving under the influence of alcohol. Rates of driving after using cannabis were much higher among college students using cannabis than driving after drinking rates among students using alcohol (Whitehill et al. 2014, pp. 618-624). Whitehill et al. found in their study, “20.3% of participants had used marijuana in the previous month, and of those using marijuana, 43.9% of males and 8.7% of females drove after using marijuana (2014, pp. 618-624). “Most students (65%) drank alcohol, and among this group 12% of male students and 2.7% of female students drove after drinking (Whitehill et al. 2014, pp. 618-624). Legalization may be leading people to believe that cannabis is a safe drug and reduce concerns regarding driving under the influence of cannabis. It is therefore important to determine how legalization influences cultural beliefs and attitudes about cannabis and traffic safety.

The primary purpose of this report is to review the types of questions and response scales used in previous research to inform the design of the survey instrument to be used in the current project. A secondary purpose is to review results of previous research. An overview of the main findings from the research that has used these questions and response scales is included to help understand the gaps in research that could be addressed by the current project. The results of this formative study would show which cultural factors are influencing not only the use of this drug when driving (Part A), but also the acceptance of common policies and strategies that are proposed in response (Part B).

3 METHODS

To obtain research articles for this review, a keyword search was conducted using the TRID database and Montana State University Library search engines “Academic Search Complete,” “EBSCO,” and “CatSearch.” Word search and phrase combinations included: “drugged driving,” “cannabis use while driving,” “illicit drugs and driving,” “cannabis impairment and driving,” “driving under the influence of cannabis,” “attitudes and cannabis,” “driver safety and cannabis use,” “cannabis use and driving,” “cannabis and perception of risk,” “cannabis dependence and driving,” “marijuana,” “weed,” “pot,” “cannabis,” “community norms,” “alcohol,” “medical marijuana laws,” “medical cannabis,” “legalized marijuana,” “decriminalization,” “drug abuse,” “drug control policy,” “voting,” “public health,” “substance use,” “legalization,” “adolescents,” “youth,” “history,” “legislation,” “intent,” “attitude,” “perception,” “beliefs on marijuana,” “view on cannabis,” “public opinion,” “prevalence,” “legislative effect on marijuana use,” “traffic fatalities,” “driving under the influence,” “drinking age,” and “minimum legal drinking age.”

When conducting a key word search for this review, general categories such as “driving under the influence of cannabis,” “cannabis use while driving” and “drugged driving” were used first. Once these articles were reviewed for relevance, additional key words were used in combination to narrow the search and the behavioral model used for this project guided the selection. Additionally, the reference lists of relevant articles were also reviewed for potentially relevant articles that may have been missed with key words.

4 RESULTS

4.1 PART A - Values, Attitudes, Beliefs, and Behaviors Regarding DUIC

The literature review revealed ongoing research taking place to better understand cannabis and traffic safety, and this review will help to inform the question design for various constructs in the behavioral model used for this project as shown in Figure 2. The goal of this project is to better understand which cultural factors are influencing not only the use of this drug when driving, but also the acceptance of common policies and strategies that are proposed in response. Best practices in effective intervention design recommend a strong theoretical foundation. The results of this project will provide a better understanding of the values, attitudes, and beliefs that predict DUIC based on the creation of a behavioral model using a strong theoretical foundation.

By knowing the relationship between values, attitudes, beliefs and behaviors, we can leverage existing strengths and address gaps in understanding to change behavior. Having a strong theoretical foundation will make future interventions more cost effective and thereby save public resources and improve overall safety. This behavioral model is the basis for the framework we are using to create the survey items. The model also guided the selection of keywords used in this literature review search to see how predictors of DUIC have been operationalized and what previous research has shown. The augmented, integrated behavioral model is based on the theory of reasoned action and the prototype willingness model (Fishbein and Aizen 2009, pp. 1-218; Gerrard et al. 2008, pp. 29-61). One of the intentions of this report is to not only review results of previous research, but also catalogue the types of survey items (questions and response scales) used. Tables 1-10 within this document are included to provide (example) questions.

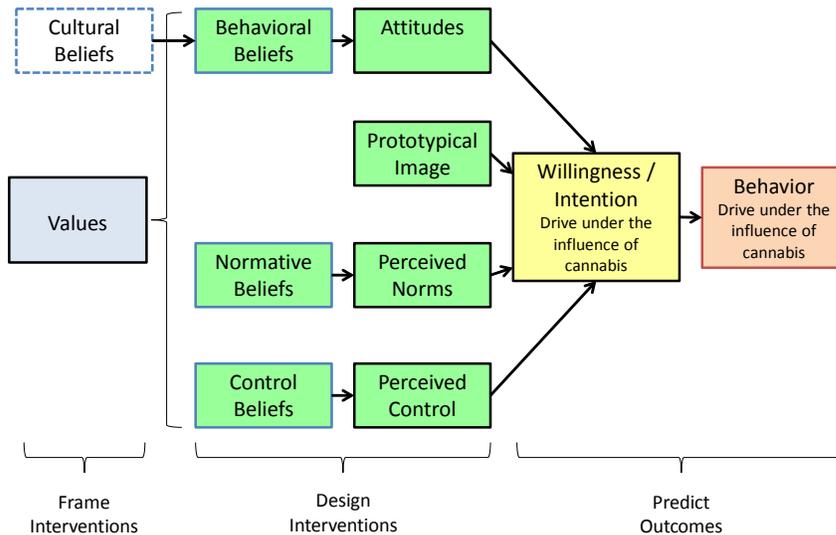


Figure 2. Behavioral Model

Construct measures useful to the project model which include values, attitudes, beliefs, and behaviors were identified in the literature review. Those include: 1) driving attitudes and behaviors, 2) perceived risk of DUIC, 3) perceived risk of getting caught/punished for DUIC, 4) peer affiliation, 5) reasons to DUIC/ reasons to avoid DUIC, and 6) intention to DUIC. Each construct is discussed in detail and includes tables, where appropriate, that provide the types of survey items used in previous research.

4.1.1 Driving Attitudes and Behaviors

The construct “Driving Attitudes and Behaviors” seeks to understand participants driving attitudes, risky driving behaviors, and their driving practices (See Table 1). Attitudes are the “subjective evaluation of an object or behavior in terms of emotional reaction (e.g., “Speeding is exciting”) and perceived utility (e.g., “Seat belts are useless”). Attitudes are a construct in the behavior model used for this project.

As part of one longitudinal study of young adults ages 21 to 25, Fergusson et al., (2008) examined the associations between DUIC and motor vehicle collisions, and looked at confounding factors such as driving attitudes and risky driving behaviors. The risky driving behaviors assessed in this study didn’t specifically include DUIC as a risky driving behavior, but looked at other behaviors such as not using a seat belt and exceeding the speed limit as confounding factors to DUIC and motor vehicle collisions (Fergusson et al. 2008, pp. 1345-1350). Driver attitudes were assessed using a 5-point Likert Scale rating the extent to which the participants agreed with a series of items regarding traffic violations (e.g. decreasing the speed limit on motorways is a good idea, penalties for speeding should be more severe) (Fergusson et al., p. 1346). Researchers found that when associations were adjusted for confounding factors, including distance driven and risky driving behaviors, the associations between driving under the influence of cannabis and motor vehicle collisions remained significant (Fergusson et al. 2008, pp. 1345-1350). The results suggested that in this study, participants’ risk of DUIC were greater than driving under the influence of alcohol (Fergusson et al. 2008, pp. 1345-1350).

Table 1. Examples of Questions and Response Formats from Previous Research to Measure Attitudes and Behaviors about Driving

Measurement Constructs	Response Formats	Source
<i>Driver Attitudes</i>		
Attitudes to driving practices	The Attitudes to Driving Violations Scale (West and Hall 1997, pp. 253-264) was used. This scale rates the extent to which subjects agree with a series of seven items regarding traffic violations (e.g. decreasing the speed limit on motorways is a good idea, penalties for speeding should be more severe). Ratings were made on a 5-point scale ranging from 1= strongly agree to 5 = strongly disagree and a total score was computed from a sum of the seven items. This score ranged from 7 to 34 with a high score	Fergusson et al. 2008, p. 1346

	indicating a laissez-faire attitude to driving violations.	
<i>Risky Driving Behaviors</i>		
Participants' involvement in risky driving behaviors	A modified version of the subscale of the Driver Behaviour Questionnaire (Reason et al. 1991) was used. The instrument assessed the frequency of 12 driving violations including: exceeding the speed limit; driving without a seat belt; deliberately driving through red lights; street racing; driving without a license; driving when the license had been suspended; driving without a current vehicle registration; driving without a current vehicle warrant of fitness; changing lanes without signaling; overtaking without a clear view of the road ahead; overtaking illegally; and driving too close to other vehicles.	Fergusson et al. 2008, p. 1346
<i>Driving Practices</i>		
Participants were asked about the weekly distance driven in the previous year.*	Weekly distance driven	Jones et al. 2007, pp. 83-86
Participant characteristics such as: daily driving, owning a car, ever being checked by police for impaired driving, ever having been involved in a motor vehicle accident as a driver, ever having been involved in a motor vehicle accident as a driver where drugs/alcohol played a role, ever having been involved in a motor vehicle accident as a driver where cannabis played a role.*	None reported.	Fisher et al. 2014, p. 191
Participants were asked about their driving experience.*	Types of motor vehicles driven and length of time participants had held a license.	Fergusson et al. 2008, pp. 1345-1350

* indicates authors did not list exact question or response in original document

4.1.2 Perceived Risk of DUIC (Behavioral Beliefs)

Using data from a longitudinal study, Fergusson et al. (2008) compared rates of driving under the influence of cannabis and alcohol. Researchers found that 21% of participants self-reported driving under the influence of cannabis and 27.2% of participants self-reported driving under the influence of alcohol (Fergusson et al. 2008, p. 1348). However, the frequency of driving under the influence of cannabis was much higher than driving under the influence of alcohol. Specifically, participants “reported driving under the influence of cannabis on an average of 8.96 times over the 4-year study period, compared to 3.52 time for driving under the influence of alcohol.” (Fergusson et al. 2008, p. 1348). Potential reasons for the difference between the frequency of driving under the influence of alcohol and the frequency of driving under the influence of cannabis are perceptions of risk. It is widely accepted among road users that driving under the influence of alcohol is dangerous and impairs one’s ability to operate a vehicle (Swift et al. 2010, pp.573-586). In contrast, many road users do not have these same beliefs about DUIC (Swift et al. 2010, pp.573-586). Swift et al. (2010, pp. 573-586) found that over 97% of participants in their study believed that “driving while under the influence of alcohol alone and cannabis and alcohol together increased both the participants’ and other accident risk. However, only half (53%) believed driving under the influence of cannabis alone increased personal accident risk; 36% believed it had no effect, and 10% believed it decreased risk.” (p. 578). Jones et al. (2007, pp.83-86) found that believing that DUIC does not increase one’s accident risk was positively associated with a greater likelihood of DUIC. Fisher et al. (2014, pp.185-200) found that perception of one’s own ability to drive while not impaired by cannabis use was a significant factor associated with high frequency cannabis use and driving.

The construct “Perceived Risk of DUIC” seeks to understand participants’ perception of risk associated with DUIC. Table 2 provides examples of questions and response formats from previous research to measure the behavioral beliefs about the perceived risks of DUIC. Behavioral beliefs are expectations about the physical and social consequences of a behavior (e.g., “If I drink and drive, my friends will exclude me”).

Table 2. Examples of Questions and Response Formats from Previous Research to Measure the Behavioral Beliefs about the Perceived Risks of DUIC

Measurement Constructs	Response Formats	Source
Participants were asked to indicate (on a VAS) their likelihood of driving if they could be convinced that cannabis-intoxicated drivers were “about three to seven times more likely to be responsible for their crash [than] drivers [who] have not used drugs or alcohol.”	VAS (Visual Analogue Scales) “consists of a 100 mm line drawn on the page and marked with ‘not at all’ at the left extreme of the line and ‘definitely’ at the right extreme. Participants were asked to mark a cross on the line to indicate how likely they would be to drive under the conditions in the scenario.” (p. 855).	Jones et al. 2006, pp. 855-856
Participants’ perceived risk (both personal risk and risk to others) of driving under the influence of cannabis was assessed.*	Whether participants believed DUIC increased their personal and others’ accident risk, had no effect,	Swift et al. 2010, pp.573-586

	or believed it decreased personal and others' accident risk.*	
Participants' were asked about their perceptions of cannabis's effects on driving in general and for oneself.*	None reported.	Fisher et al. 2014, p. 189

* indicates authors did not list exact question or response in original document

4.1.3 Perceived Risk of Getting Caught/Punished for DUI (Behavioral Beliefs)

The research on deterrence and its association to DUI has been mixed. Some researchers have suggested a deterrent effect when there is perceived risk of apprehension for DUI (Jones et al. 2006, pp. 854-861; Jones et al. 2007, pp. 83-86; Swift et al. 2010, pp. 573-586). Jones et al. (2006, pp. 854-861) found that when the perceived risk of apprehension for DUI increased, the willingness of road users to DUI decreased. These researchers also looked at the severity of punishment in relation to DUI. Results showed “no evidence to suggest that DUI would be discouraged by doubling the magnitude of existing fines or license disqualifications periods for DUI” (Jones et al. 2006, p. 859). Swift et al. (2010, p.581) found that “discouragingly, few participants reported that strategies other than those based on increasing the likelihood of apprehension would dissuade them from continuing to DUI”. Swift et al. (2010, p. 581) reported,

“when asked if there was anything, apart from evidence of increased accident risk that might convince them to refrain [from DUI], the most common response was ‘nothing’ (32%). The other notable responses were: police presence or random drug testing; and an accident, injury or death involving self or others (each 24%). Education and ad campaigns, personal recognition of intoxication and concerns expressed by passengers appeared to have little influence (each ≤10%).”

Fisher et al. (2014, pp. 185-200) found in their study to identify distinguishing characteristics associated with high-frequency cannabis use and driving activity that there was a limited deterrence effect when looking at participants' expectations about future traffic-related offenses. Specifically, those participants categorized as having high-frequency cannabis use and driving characteristics had a high expectation of getting ticketed/ charged in the next 12 months (Fisher et al. 2014, pp. 185-200).

The construct “Perceived Risk of Getting Caught/Punished for DUI” seeks to understand the participant's perception of risk associated with getting caught or punished for DUI including expectations of getting ticketed/charged, and the perceived severity of the punishment associated with DUI. Table 3 provides examples of questions and response formats from previous research to measure behavioral beliefs about perceived risk of getting caught/punished for DUI. Control beliefs are beliefs about one's ability to engage or not engage in the behavior based on factors that are either internal or external to oneself (e.g., “Crashes are determined by fate,” “I am comfortable not speeding even if everyone around me is”).

Table 3. Examples of Questions and Response Formats from Previous Research to Measure Behavioral Beliefs about the Perceived Risks of Getting Caught/Punished for DUI

Measurement Constructs	Response Formats	Source
<i>Expectations of Getting Ticketed/Charged</i>		
Perceived risk of apprehension*	Believe unlikely/very unlikely to be caught DUI	Jones, et al. 2007, p. 84
“You are more at risk of having an accident if you drive while feeling intoxicated by alcohol than if you drive while feeling intoxicated by cannabis.”	Likert Scale*	Swift et al. 2010, p. 578
<i>Severity of Punishment Associated with DUI</i>		
Maximum fine for DUI allowed in New South Wales*	No fine, ≤ \$550, \$1100, \$2200, No maximum	Jones et al. 2007, p. 84
Willingness to drive under the scenario conditions*	Visual Analogue Scales (VAS) were used. The VAS consisted of a 100 mm line drawn on the page and marked with ‘not at all’ at the left extreme of the line and ‘definitely’ at the right extreme. Participants were asked to mark a cross on the line to indicate how likely they would be to drive under the conditions in the scenario.	Jones et al. 2006, p. 855
Participants were asked to rate: (1) their chances of being caught by the police given the scenario, and (2) how big a problem the penalties for the offence would create for them if they decided to drive and were caught and convicted.*	VAS scale	Jones et al. 2006, p. 856
To assess the absolute deterrent effect of sanctions, participants were asked how likely they would be to drive home under the circumstances in the scenario if there was no possibility of being caught, convicted, and punished.	VAS Scale: Scores ranged from 0 (not at all likely) to 100 (definitely).	Jones et al. 2006, p. 856

* indicates authors did not list exact question or response in original document

4.1.4 Peers Affiliation (Normative Beliefs)

It is well known that peers influence one’s behaviors. The construct “Peers Affiliation” seeks to better understand the participants’ peer affiliations, including being a passenger in a vehicle driven by a person who is DUIC, deviant peer affiliations, and peers who DUIC (See Table 4). These constructs may inform normative beliefs associated with cannabis use and driving. Normative beliefs are beliefs about (1) what behaviors are most common in a group (e.g., “All my friends speed”); (2) what important people in that group expect (e.g., “My parents expect me to wear a seat belt”); and (3) what are the shared characteristics of people perceived to typically engage (or abstain) in that behavior. Normative beliefs are a construct in the behavioral model used for this project.

Deviant peer affiliations were assessed as a confounding factor to driving under the influence of cannabis and alcohol and motor vehicle collisions in a study by Fergusson et al. (2008, pp. 1345-1350). The specific confounding variable, deviant peer affiliations, did not remain statistically significant after forward and backward selection of covariates to arrive at a stable model (Fergusson et al. 2008, p. 1349). Likewise, Jones et al. (2007, pp. 83-86) also looked at peer networks where DUIC was more common, and their predictive value to one’s risk of DUIC, but ultimately this covariate was dropped from the final model for predicting likelihood of DUIC in the previous 12 months.

Alvarez et al. (2007, p. 114) found that approximately 19.9% of participants reported being a passenger in a vehicle driven by a person under the influence of cannabis and did so on several occasions in the previous year (5.7 times, respectively). Alvarez et al. (2007, pp. 111-116) also found that those between the ages of 14 and 19 years old were most likely to be a passenger in a vehicle driven by a person under the influence of cannabis, and this behavior decreased with age.

Table 4. Examples of Questions and Response Formats from Previous Research to Measure Peers Affiliation

Measurement Constructs	Response Formats	Source
Past year being a passenger in a vehicle driven by a person under the influence of cannabis.*	Number of days this was done by those who reported cannabis use in the previous year.	Alvarez, et al. 2007, p. 112
Deviant peer affiliations were assessed using questions concerning the extent to which their friends used tobacco, alcohol or illicit drugs, had problems associated with substance use, or engaged in criminal behavior or had problems with the law.*	These items were summed to provide a scale measure of the extent of affiliations with delinquent or substance-using peers at each age....the resulting scale scores were averaged to provide a measure of the extent of deviant peer affiliations over the period 21-25 years.	Fergusson et al. 2008, p. 1347
Peers who DUIC*	Scale: (none, a few/about half, most/all)	Jones et al. 2007

* indicates authors did not list exact question or response in original document

4.1.5 Reason to DUIC/ Reasons to Avoid DUIC (Willingness)

Of interest to Swift et al. (2010, pp. 573-586) was to better understand the motivations for DUIC and specifically, reasons participants choose to DUIC or choose to avoid DUIC. These reasons may provide guidance for measuring the willingness of a participant to DUIC or not. Willingness is defined as the predisposition to commit a behavior if an unexpected situation arises and is a construct in the behavioral model used for this project.

Swift et al. (2010, p.573) found that 78% of participants in their study reported DUIC in the last year, and of those, 27% did so at least weekly. The majority of participants (> 70%) reported “the need to get somewhere – to socialize, get home, drive intoxicated passengers, do tasks such as shopping, or get drugs” were common reasons for DUIC (Swift et al. 2010, p. 578). Less than 10% reported they DUIC “for fun or relaxation, because it was a part of everyday life, and especially for DUIC, because cannabis was not considered dangerous, or as less dangerous than alcohol” (Swift et al. 2010, p. 578). For those choosing to not DUIC, the perceived risk of this behavior on one’s ability to drive safely and the risks to self and others’ safety were the primary reasons to not DUIC (Swift et al. 2010, pp. 573-586).

4.1.6 Intention to DUIC (Intention)

Intention is the deliberate decision to commit a behavior in an anticipated situation. The construct “Intention to DUIC” seeks to understand the expectations of participants to use cannabis and drive. Table 5 looks at research specifically from Fisher et al., (2014, pp. 185-200). They found that those participants categorized as high-frequency cannabis use and driving had high expectation of engaging in cannabis use and driving in the next 12 months and had a high expectation of cannabis use and driving in conjunction with alcohol use in the next 12 months (Fisher et al., 2014, p. 190).

Table 5. Examples of Questions and Response Formats from Previous Research to Measure Intentions to DUIC

Measurement Constructs	Response Scales	Source
Participants were asked about their expectation of cannabis use and driving in the next 12 months.*	None reported.	Fisher et al. 2014, p. 190
Participants were asked about their expectations of cannabis use and driving in conjunction with alcohol use in the next 12 months.*	None reported.	Fisher et al. 2014, p. 190

* indicates authors did not list exact question or response in original document

The behavioral model used in the project informed and guided the selection of constructs chosen for this literature review, specifically, values, attitudes, and beliefs regarding DUIC. Various researchers have studied DUIC and constructs that help predict the likelihood of DUIC. A review of the main findings and types of questions and response scales used in previous research will

help to build the survey design for this project. Additional contributing factors, not in the model, that contributed to our understanding were also included in this task report.

4.2 Contributing Factors

This section includes constructs that are not part of the behavioral model used for this project but are important factors that will contribute to our understanding of what has been researched and how constructs have been operationalized. Those constructs include 1) DUIC, 2) Cannabis Use, 3) Perceived Risk of Cannabis Consumption on Health, and 4) Strategies Employed to Reduce DUIC Risk.

4.2.1 Driving Under the Influence of Cannabis (DUIC)

The construct DUIC seeks to understand the behaviors of participants who drive after using cannabis. Constructs include DUIC, frequency of DUIC, time between finishing cannabis and driving, and the practice of carrying passengers while DUIC. Table 6 provides examples of questions and response formats from previous research to measure DUIC behaviors.

The widespread use of cannabis among road users and the prevalence of driving under the influence of cannabis (DUIC) are public health concerns (Swift et al. 2010, pp. 573-586; Jones et al. 2006, pp. 854-861; McGuire et al. 2011, pp. 248-259; Fisher et al. 2014, pp. 185-200). Cannabis use and driving is common (Alvarez et al. 2007, pp. 111-116). Alvarez et al. (2007, p. 114) specifically found that of participants who used cannabis in the past year, 9.7% had driven under the influence of cannabis and had done so several times in the previous year (on average 8.1 times). Fergusson et al. (2008, pp. 1345-1350) found that reports of driving under the influence of cannabis were approximately 2.5 times greater than reports of driving under the influence of alcohol. Similarly, McGuire et al. (2011, p. 252) found that respondents were “significantly more likely to drive under the influence of cannabis than to drive while under the influence of alcohol or a combination of cannabis and alcohol”. One suggested conclusion for the differences between DUIC and driving under the influence of alcohol may be that perhaps public concerns about DUIC have not been made as strongly or repeatedly as has driving under the influence of alcohol (Fergusson et al. 2008, pp. 1345-1350).

Epidemiological, experimental, and cognitive studies have been conducted to better understand DUIC. Epidemiological studies have demonstrated that $\Delta 9$ -tetrahydrocannabinol (THC, the active ingredient of cannabis) induces driving impairment and increases crash risk in a dose related manner (Ramaekers et al. 2004, pp. 109-119; Grotenhermen et al. 2007, pp. 1910-1917; Asbridge et al. 2014, pp. 395-404). In response, experimental studies have been conducted to assess the basis of behavioral impairment responsible for this increase in crash risk (Asbridge et al. 2014, pp. 395-404; Hartman and Huestis, 2013, pp. 478-492). Asbridge et al. “study examined whether acute cannabis use leads to increased collision risk” (2014, p. 395). Their results suggested that cannabis use increased collision risk. Specifically, “regression results measuring exposure with blood data indicated that cannabis use alone was associated with a fourfold increased (OR 4.11; 95 % CI: 1.98–8.52) odds of a collision. In a review of literature on cannabis’ effect on driving, Hartman and Huestis found that “recent smoking and/or blood THC concentrations 2–5 ng/mL are associated with substantial driving impairment, particularly in occasional smokers” (2013, pp. 478, p. 478). However, some research has reported

inconsistent findings prompting Sewell et al (2009, pp. 185-193) to suggest the need for additional research on cannabis and driving.

DUIIC is an emerging concern in many countries and yet continues to not be well documented (Walsh et al. 2008, pp. 1258-1268). Concerns about driving under the influence reach across the social ecology with various opportunities to better understand this growing problem.

Table 6. Examples of Questions and Response Formats from Previous Research to Measure DUIIC Behaviors

Measurement Constructs	Response Formats	Source
<i>DUIIC and Frequency</i>		
“Did you more than once drive a car, motorcycle, truck, boat, or other vehicle when you were under the influence of a medicine or drug?”	(Yes/No). Participants responding positively to this question were then asked which medicines or drugs this happened with.	Le Strat, et al. 2015, p. 2
Participants were asked whether they had driven under the influence of cannabis in the past year.	(Yes/No). For those who responded positively, they were asked the number of days this was done.	Alvarez et al. 2007, p. 111-116
Participants’ reported the likelihood of driving within one hour of using cannabis in the previous year, without using alcohol or other drugs.	(0=no, 1=yes)	Jones et al 2007, pp. 83-86
Participants were asked the number of times in the previous month (30 days) they had: (1) driven a car within two hours of using marijuana (cannabis).	Responses were scored 0 (no times) or 1 (one or more times).	Begg, et al. 2003, p. 670
...driven a motor vehicle within four hours of cannabis use in the last 12 months?	Eligibility for the study required a positive response.	Fisher et al. 2014, p. 189
Sample was divided into low frequency cannabis use and driving (CUD) (12 or less incidents of CUD in the past year) and high frequency cannabis use and driving (13 or more CUD incidents).	Number of incidents of CUD in the past year.	Fisher et al. 2014, p. 189
...driven a car within two hours of (a) cannabis use; (b) alcohol use; (c) combined alcohol and cannabis use within the last 30 days. If ‘yes’:	(Yes/No) for each substance. If the answer was ‘yes’, number of days	McGuire et al. 2011, p. 251

Measurement Constructs	Response Formats	Source
on how many days in the last 30 days they had engage in the respective drug-use and driving behaviors.		
Participants were asked about the number of occasions on which they had driven under the influence of (a) cannabis and (b) alcohol, during each year from ages 21 to 25. A precise definition of “under the influence” was left to the determination of the individual participant.	Number of times for each substance.	Fergusson et al. 2008, p. 1346
DUIC was defined as driving within one hour of using cannabis without any other drugs. DUICA was defined as driving within one hour of using cannabis and any alcohol together (without using any other drugs). DUICO was defined as driving within one hour of using cannabis and other drugs together (with or without using alcohol).*	None reported*	Swift et al. 2010, p. 576
Median (range) time between finishing cannabis and driving.*	In Minutes (1-60)	Swift et al. 2010, p. 579
“On the most recent occasion of driving under the influence of cannabis only [did you] use cannabis while actually driving?”	(Yes/No)	Swift et al. 2010, p. 579
<i>Carrying Passengers while DUIC</i> Experiences of participants on their most recent occasion of driving under the influence of cannabis only.*	Carrying passengers (none, friends, siblings/parents, partner, child(ren))	Swift et al. 2010, p. 579

* indicates authors did not list exact question or response in original document

4.2.2 Cannabis Use

A variety of factors have been studied to better understand cannabis use and to help to predict the likelihood of DUIC. The age a person starts to use cannabis was a construct used in many research studies. Jones et al. (2007, pp. 83-86) found that those who initiated cannabis use later (age 16 and older) were less likely to report DUIC in the previous year. Similarly, when comparing participants who started using cannabis at age 21 or after with those who started using cannabis before age 14, Le Strat et al. (2015, p. 3) found that those who initiated cannabis before

the age of 14 were four times more likely to have a history of cannabis dependence and three times more likely to report having driven under the influence of cannabis.

In addition to age of onset, many studies also looked at the frequency of cannabis use as a construct to better understand cannabis use behaviors (Begg et al. 2003, pp. 669-675; Jones et al. 2007, pp. 83-86; Fisher et al. 2014, pp.185-200). Fisher et al. (2014, p. 190) found that “high frequency cannabis use and driving respondents were more likely than low frequency cannabis use and driving respondents to report at least weekly cannabis use”. Le Strat et al. (2015, p. 1-5) assessed frequency of cannabis use by asking participants about their lifetime use of cannabis and the period of heaviest use. Their study showed that having a history of cannabis dependence was associated with increased risk of DUI. Similarly, other researchers also found that being cannabis dependent was positively associated with an increased likelihood of DUI (Begg et al. 2003, pp. 669-675; Jones et al. 2007, pp. 83-86; Swift et al. 2010, pp. 573-586).

Alvarez et al. (2007, p. 114) specifically asked participants about the problems they may have had in the previous year associated with the consumption of cannabis, including such things as work accidents and arrests by the police. Results suggested that reports of cannabis related problems were a predisposing influence on reporting driving under the influence of cannabis in the previous year. Additional factors in this study found to be associated with DUI included population size of a community, number of drugs consumed, and those who reported being a passenger in a vehicle driven by a person under the influence of alcohol (Alvarez et al. 2007, pp. 111-116).

The construct “Cannabis Use” seeks to understand cannabis use behaviors and their relationship to DUI among participants, including age of first use, frequency, problems related to cannabis use, cannabis dependence, and heaviest use. Various researchers have measured similar constructs. Table 7 provides examples of questions and response formats from previous research to measure cannabis use.

Table 7. Examples of Questions and Response Formats from Previous Research on Cannabis Use

Measurement Constructs	Response Formats	Source
<i>Cannabis Use and Age of Onset</i> “Have you ever used marijuana, hash, THC, or grass?” “How old were you when you FIRST used marijuana, hash, THC, or grass?”	(Yes/No). Positive responses were followed up with age of first use.	Le Strat et al. 2015, p. 2
Those surveyed were asked if they had consumed cannabis in the year prior to the survey and the starting age of cannabis consumption.	(Yes/No). Starting age of cannabis consumption	Alvarez et al. 2007, pp. 111-116
Participants were asked the age they first used cannabis.	Starting age of first use of cannabis	Jones et al. 2007, pp.83-86
Cannabis use frequency in the past 12	Five-point scale (once or twice; every few	Swift et al.

Measurement Constructs	Response Formats	Source
month	months; about once a month; once a week or more; every day), while detailed last month frequency and quantity of use was assessed using the validated Timeline Followback method (Sobell, Sobell, Leo, & Cancilla, 1988).	2010, p. 576
	The TL [Timeline Followback] method “requires subjects to provide estimates of their actual daily alcohol consumption over a specified time period.” (Swift et al., 2010) used this method to estimate actual daily cannabis consumption.	Sobell et al. 1988, p. 394
<i>Cannabis-Use Related Problems</i> “Have you, at any time during the past year, had any of the following problems as a consequence of the consumption of cannabis?”	(i) Work accidents or other problems requiring urgent medical attention; (ii) Arrest by the police or forces of public order; (iii) absence from work (or school) for one or more days; (iv) Argument, discussion, or serious conflict without physical aggression; (v) Fight or physical aggression.	Alvarez et al. 2007, p. 112
<i>Cannabis Dependence</i> Cannabis Dependence*	Interview Format. Score of three or higher on the Severity of Dependence Scale, Gossop et al., 1995; Swift et al., 1998)	Jones et al. 2007, pp. 83-86; Jones et al. 2006, pp. 854-861; Swift et al. 2010, pp. 573-686
<i>Heaviest Use</i> “At the time you were using marijuana the most, about how many joints did you usually smoke in a single day?”	Number of Joints	Le Strat et al. 2015, p. 2

* indicates authors did not list exact question or response in original document

4.2.3 Perceived Risk of Cannabis Consumption on Health (Behavioral Beliefs)

Research has also been conducted to look at perception of risk of cannabis consumption on health. Table 8 provides an example of a question and response format from research completed by Alvarez et al. (2007, pp. 111-116). In the study done by Alvarez et al. (2007), 2500 people, aged 14 to 70 were surveyed about their consumption of alcohol and illicit drugs. “15.7% of those surveyed reported cannabis consumption in the previous 12 month, of whom 9.7% reported driving a vehicle under the influence of cannabis during this period, on average eight times” (Alvarez et al. 2007, p. 111) Alvarez et al. (2007, p. 113) found that 36.7% of respondents

considered the regular consumption of cannabis to be little to no risk to health, while 63.3% considered it to be fairly or very risky. The construct “Perceived Risk of Cannabis Consumption on Health” seeks to understand participants’ perceptions of health risk associated with consuming cannabis (see Table 8).

Table 8. Example of a Question and Response Format from Previous Research to Measure the Behavioral Beliefs about the Perceived Risks of Cannabis Consumption on Health

Measurement Constructs	Response Scale	Source
The opinion of those surveyed regarding the health consequences of regular cannabis use was recorded. Participants were asked about their perception of risk regarding regular consumption of cannabis on their health.*	Allowed responses were “very high”, “quite high”, “not very high”, and “not high at all.”	Alvarez et al. 2007, p. 112

* indicates authors did not list exact question or response in original document

4.2.4 Strategies Employed to Reduce DUI Risk

In driving and simulator studies, “marijuana smokers tend to compensate effectively for their impairment by utilizing a variety of behavioral strategies such as driving more slowly, passing less, and leaving more space between themselves and cars in front of them.” (Sewell et al. 2009, p. 190). Similarly, Swift et al. (2010, p. 579) found that the most common strategies employed to reduce DUI-related risk were to compensate for perceived impairment by “driving more slowly or limiting the amount of cannabis smoked, rather than planning ahead”. Researchers suggested that “the difficulty of modifying DUI-related attitudes and behaviors is well illustrated with the common beliefs that drivers can compensate for perceived cannabis intoxication” (Swift et al, 2010, p. 582). Research in this project will support the need for additional information to inform which cultural factors are influencing the use of this drug when driving. The “Strategies Employed to Reduce DUI Risk” construct seeks to better understand the approaches that people use to reduce their risk when driving under the influence of cannabis. This construct may help us to better understand perceived control, a construct in the behavioral model use for this project. Perceived control is the perception of our ability to determine our own behaviors (e.g., “I can choose my own speed in traffic”). Strategies found in the literature review are included below to guide development of the survey for this project (See Table 9).

Table 9. Constructs to Understand Strategies Employed to Reduce DUI Risk

Measurement Construct	Response Scale	Source
<i>Strategies Employed</i>		
The following were measured: Drive more slowly Limit the amount smoked Wait for effects to disappear/ decrease before driving	Scale: “never/rarely, sometimes, often/always”	Swift et al. 2010, p. 580

Get alternative transport
Ask a non-intoxicated friend to drive
Leave your car at home/work*

* indicates authors did not list exact question or response in original document

4.3 PART B - Impact of Legalization on Culture and DUIC

A second purpose of this study is to summarize effects of legalization on indicators of culture. The implication of changes in state laws and cannabis use is important because the consumption of cannabis may induce driving impairment – and as a result – could increase crash risk (Laberge and Ward 2004, pp. 971-989; Ramaekers et al. 2004, pp. 109-119; Grotenhermen et al. 2007, pp. 1910-1917; Asbridge et al. 2014, pp. 395-404). Thus, factors that may increase the consumption of cannabis may impact traffic safety. Legalization may be leading people to believe that cannabis is a safe drug and reduce concerns regarding DUIC. It is therefore important to determine how legalization influences cultural beliefs and attitudes about cannabis and traffic safety, an aim of this study. Understanding how changing laws can ultimately impact related behaviors can be useful to the public and to policy makers.

To date, Washington DC and 23 states have legalized marijuana for medicinal purposes, and four states have outright legalized marijuana (National Organization for the Reform of Marijuana Laws, 2015). With such drastic policy shifts occurring on a frequent basis, it makes sense that researchers would focus their attention on marijuana when analyzing the effects of legislative change on public attitudes and views toward use of the drug. A majority of the literature found pertaining to legislative change affecting public opinion and beliefs on substances has focused on medical marijuana, particularly the public’s use of the drug, and attitudes and views toward use of the drug. One article was found focusing on the link between legalization of medical marijuana in Colorado and incidence of traffic fatalities, and no articles were found that specifically explored the effect of minimum age drinking laws on public perceptions and views of alcohol.

Schuermeyer et al. (2014, pp. 145-155) utilized National Survey on Drug Use and Health (NSDUH) data, and captured information from the years 2003-2011 to compare Colorado’s 2009 decision to legalize medical marijuana against 34 other non-medical marijuana states. The study employed a difference in difference regression analysis to find that after Colorado had implemented the medical marijuana legislation, there was a comparatively lower risk perception of the use of marijuana amongst all age groups in that state. There was also evidence of increased marijuana dependence/abuse amongst adolescents in Colorado when compared to nonmedical marijuana states (Schuermeyer et al. 2014, pp. 145-155). Specifically, Schuermeyer et al. (2014, pp.152-153) found within Colorado those indicating that they thought their marijuana use posed a “great-risk” dropped significantly in all age groups studied between 2007–8 and 2010–11. The percentage dropped from 45% to 31% for those 26 years and older. Additionally, for adult Coloradans 26 years and older there was a significant increase in the perception that marijuana was fairly/very easy to obtain (Schuermeyer et al. 2014, pp.152-153). This was obtained by measuring respondents’ answers to questions administered in the NSDUH. Other studies that have attempted to capture the results of legislative change on the perception of marijuana have not found quite the same results as the Schuermeyer et al. paper, however. One such study by Harper, et al. (2012, pp. 207-212) found that although there was still a lower risk perception of

marijuana use in medical marijuana states, there was no evidence suggesting that the change in laws was the causal mechanism. In fact, the study claimed that states with higher marijuana use were more likely to implement less restrictive laws regarding the substance in the first place (Harper et al. 2012, pp. 207-212).

Gorman and Huber (2007, pp.160-167) used a combination of arrestee drug abuse data from the National Institute of Justice and data on cannabis use amongst emergency department visits in various metropolitan areas to find that the introduction of medical marijuana laws was not associated with an increase in use of cannabis in either dataset. The study suggested that the use of the drug by those who are actually sick may “de-glamorize” its use amongst the general public. De-glamorization, coupled with the relatively small number of people affected by medical cannabis laws, lead to the conclusion that if there was an effect on the public’s beliefs and attitudes toward marijuana, it would be relatively small and negative - that is to say that the de-glamorization made the general public less likely to view marijuana as a “cool” drug to use (Gorman and Huber, 2007, pp. 160-167).

Cerda et al. (2012, p. 2227) from Columbia University looked at the relationship between state-level legalization of medical marijuana and marijuana use, abuse, and dependence to conclude that states that enacted medical marijuana laws had much higher rates of use and abuse, although just like previous studies, there was not strong enough evidence to establish that the enactment of the laws was the causal mechanism. The researchers suggested that community norms in different states may be more or less conducive of passing less restrictive laws pertaining to marijuana (Cerda et al. 2012, p 2227). Yet another study had a particular emphasis on whether the passage of medical marijuana laws increased use among adolescents due to increased accessibility and appeal. By using data from the Youth Risk Behavioral Surveillance Survey between 1991 and 2011, the researchers utilized a difference in difference regression to conclude that there were no statistically significant differences in marijuana use amongst adolescents before and after policy changes in states that implemented medical marijuana laws (McConnell et al. 2015, pp. 160-167).

Since Washington’s legalization of recreational marijuana use, there have been a few studies attempting to gauge the state’s residents’ views of marijuana use after the policy change. Although the research conducted by Moreno et al. (2015, pp. 25-29) made no attempt to gauge how college students perceived the safeness of marijuana prior to the passage of legislation legalizing recreational use, the study did attempt to answer how the legislation affected the students’ views on the safeness of marijuana. After comparing perceptions between students affected by the legislation and students not affected by the legislation, the researchers found 46.3% of the Washington respondents claimed that they had voted for legalization of marijuana, and a majority of respondents said that the legalization of marijuana had no effect on their view of the drug, though some participants said that they would view the substance as safer to use because of legalization (Moreno et al. 2015, pp. 25-29). This would lead one to believe that the legalization of recreational marijuana in Washington was not the causal factor in determining whether the students polled perceived the drug to be safe. In fact, the voters’ previously held perceptions seemed to be the causal factor in the determination of whether or not marijuana would be legalized, and the legalization itself actually had a small effect in determining how safe one viewed the drug to be.

While most studies found have attempted to produce quantitative evidence of legislation affecting public perception of substances, some have taken a more qualitative approach and focused on the psychological effect that policy has on an individual’s view of a substance. Ferraiolo (2007, pp. 147-179) suggested that strict laws of a particular substance may lead to a “latent social consensus” of the substance’s perceived harm and danger. Ferraiolo also concluded that those who frame the policy debate around a particular substance have much more leverage in how the public may perceive a substance than those who do not, suggesting that those who have the most effective public messaging campaign have significant influence on the public’s perception. Reuband (1998, pp. 321-336) found that decriminalization of certain substances did not affect a society’s moral attitude, nor was there any sign that it affected citizens’ views of the substance in the long run. Reuband concluded that informal, rather than formal, norms determine the public’s perception and behavior toward a substance; an informal norm being a social standard that is not recognized through an institution, whereas a formal norm would be a standard backed by a formal institution such as legislation.

MacCoun (1993, pp. 497-512) described various “mechanisms” by which prohibition of a drug affects the public’s behavior toward drug use and perception. These mechanisms combine to explain human rationale for avoidance of drugs in the face of prohibition. Ultimately, MacCoun concluded that there is little evidence that decriminalization of a drug has any effect on the public’s perception and use of the drug, and thus the effect of a change in legislation cannot be met with certainty.

The most commonly used dataset found in the research articles on the impact of legalization was the NSDUH. It is a nationally representative sample of adult citizens in the United States that administers a private, anonymous questionnaire for the subject to fill out regarding his or her habits with drug use. The Youth Risk Behavior Surveillance System (YRBSS) administers the same type of questions, the only difference being that the questions from YRBSS are geared toward youth. Alongside common demographic, socioeconomic, and mental health questions, the surveys include the following types of questions separated by drugs that are necessary to gauge one’s drug use habits (See Table 10).

Table 10. Types of Questions and Response Formats to Gauge Drug Use Habits

Specific Questions and Response Scales	Response Format	Source
Have you ever tried or used [cigarettes, smokeless tobacco, alcohol, marijuana, various hard drugs]?		National Survey on Drug Use and Health, 2015
If you were given the opportunity to try or use [cigarettes, smokeless tobacco, alcohol, marijuana, various hard drugs] would you?		
If you have used [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs] how old were you the first time you tried it?		
When was the last time you used [cigarettes,		

Specific Questions and Response Scales	Response Format	Source
smokeless tobacco, marijuana, alcohol, various hard drugs]?		
On average, how often would you say you use [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs]?	only once, year, month, week, day	
After not using [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs] for a while, you need to use to feel less irritable.	extremely true, very true, moderately true, somewhat true, not at all true	
You sometimes have strong cravings for [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs].	extremely true, very true, moderately true, somewhat true, not at all true	
You tend to avoid places that don't involve use of [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs].	extremely true, very true, moderately true, somewhat true, not at all true	
Do you have any friends who do not use [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs].	Yes, No	
You sometimes worry that you will run out of [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs].	Yes, No	
Have you ever received professional treatment of counseling for your use of [cigarettes, smokeless tobacco, marijuana, alcohol, various hard drugs]?	Yes, No	

Moreno et al. (2015, pp. 25-29) developed their own survey in an effort to gauge college students' views toward marijuana in Washington. They then compared these views to those of college students in Wisconsin, a state in which use of marijuana is still illegal. The survey was administered via an anonymous phone conversation and used a Likert scale to rank the students' answers. Important questions from this survey are included in Table 11. Amongst both sets of college students, the student's perception of the safety of marijuana was not gauged using the Likert scale (although they did use a Likert scale for the questions in which the scale could be used). Instead, researchers opted to give students the option of answering "more negative", "stayed the same", or "more positive."

Table 11. Examples of Questions from Research to Gauge Views toward Marijuana in Washington

Specific Questions and Response Scales	Source
On a scale of 0 to 6, 0 being very negative 6 being very positive, how would you say your own attitude toward marijuana is?	Moreno et al., 2015, p 6-9
On a scale of 0 to 6, 0 being not at all likely 6 being very likely, how likely is it that you will consume marijuana in the next six months?	
What percentage of your friends would you say approve of the use of marijuana?	
As you probably know, in the past year Washington State passed proposition I502 which legalized recreational use of marijuana for those over age 21 years. If you are from Washington, did you vote for this measure? If you are from [another state where marijuana is not legal], would you have voted for this measure?	
(For residents of Washington) since passing I502, is your attitude toward marijuana now more positive, negative or has it stayed the same?	
(For residents of Wisconsin) since learning these bills were passed in Washington and Colorado is your attitude toward marijuana now more positive, negative or has it stayed the same?	
Why has your attitude become more positive, negative or stayed the same?	
(For residents of Washington) since passing this bill, is your intention to use marijuana now more likely, less likely or has it stayed the same?	
(For residents of Wisconsin) since learning these bills were passed in Washington and Colorado is your intention to use marijuana now more likely, less likely or has it stayed the same?	
Why are you more likely, less likely, or just as likely to use marijuana?	
(For residents of Washington) since the bill passed in Washington State have you used marijuana more often, less often or has it stayed the same?	
(For residents of Wisconsin) since learning these bills were passed in Washington and Colorado have you used marijuana more often, less often or has it stayed the same?	
Why do you intend to use marijuana more often less often, or the same?	

Results showed that “8 out of 283 respondents (2.8%) had a more negative view, 201 out of 283 respondents had a view described as “the same,” 71 out of 283 respondents had a more positive view, and 3 out of 283 respondents weren't sure how they felt (Moreno et al. 2015, pp. 25-29). The following information can be summarized in Table 12.

Table 12. Results from Moreno et al. 2015 (pp.25-29) Perceived Impact on Personal Marijuana Use

Perceived Impact on Personal Marijuana Use	Washington N=121		Wisconsin N=162		Total N=283	
	N	%	N	%	N	%
More Negative	6	4.9	2	1.2	8	2.8
The Same	83	68.6	118	72.8	201	71.0
More Positive	32	26.5	39	24.2	71	25.1
Not Sure/Don't Know	0	0	3	1.8	3	1.1

4.4 Self-Reported Data

Many researchers have recognized the limitations of self-report data, including those that have specifically looked at driving under the influence of cannabis (Alvarez et al. 2007, pp. 111-116; Begg et al. 2003, pp. 669-675; Fischer et al. 2014, pp. 185-200; Whitehill et al. 2014, pp. 618-624). Fisher et al. (2014, p. 193) expressed that sample bias and validity limitations are possible with participants who are self-reporting on cannabis use behaviors. Whitehill et al. (2014, p. 623) suggested that self-reported data may be influenced by recall and social desirability bias. Additionally, Tourangeau and Yan (2007, pp. 859-883) suggested that sensitive topics like drug use can affect surveys outcomes such as response rates and response accuracy.

Validity of self-reported health-risk behaviors can be affected by both cognitive factors and situations factors (Brener et al. 2003, pp. 436-457). Questions of validity can arise from cognitive factors which include the “mental processes underlying self-reported data” (Brener et al. 2003, p. 437). Three cognitive factors identified by Brener et al. that could potentially impact validity specific to alcohol and drug behaviors included: the time frame for the behavior, participants’ not understand terms being used by the researchers, and problems with “defining and using reference periods” (2003, p. 438). Suggested strategies to improve response quality included using language that is common and “short reference periods” to enhance recall (Brener et al. 2003, pp. 438). Situational factors include “factors related to social desirability and interviewing conditions” (Brener et al. 2003, p. 437). Situational factors specific to alcohol and other drug use behaviors include social desirability and fear of repercussions (Brener et al., 2003, p. 439). It is believed that participants may alter their responses to sensitive questions for a

variety of reasons including: to avoid reprisal, or to avoid feeling embarrassed (Tourangeau and Yan 2007, pp. 859-883). It has been suggested that social desirability is “contextual” and depends on both the participants’ situation and on how the data is collected (Tourangeau and Yan 2007, pp. 859-883). Privacy and confidentiality are important considerations when designing procedures as these issues can affect the validity of self-reports of alcohol and drug behaviors (Brener et al. 2003, pp. 439).

Using the test-retest reliability method to assess validity has been used in a variety of studies investigating alcohol and other drugs (Brener et al. 2003, p. 439). Brener et al. stated, “in general, reliability levels are generally high for all self-reported measures considered” (2003, p. 439). Using self-report data is a common practice among researchers and despite the limitations of such data, using self-report measures can yield important findings. Brener et al. suggested that “researchers should familiarize themselves with the threats to validity inherent in this type of assessment and design research that minimizes these threats as much as possible” (2003, p. 455).

5 CONCLUSIONS

The purpose of this report is twofold. First, the literature review was conducted to understand previous research on cultural predictors of DUIC and, second, to understand the best methods to measure these predictors (Part A). A review of the literature of published research on values, attitudes, beliefs, and behaviors regarding driving under the influence of cannabis revealed little consensus as to the best ways to measure these predictors as many different constructs to predict DUIC have been used. Our model can make an important contribution to this field by providing a systematic way to identify relevant constructs. The augmented, integrated behavioral model is based on the theory of reasoned action and the prototype willingness model (Fishbein and Aizen 2009, pp. 1-218; Gerrard et al. 2008, pp. 29-61).

Some of the main findings of the literature review include:

- Cannabis use and driving is common (Alvarez et al. 2007, pp. 111-116). Alvarez et al. (2007, p. 114) specifically found that of participants who used cannabis in the past year, 9.7% had driven under the influence of cannabis and had done so several times in the previous year (on average 8.1 times). Fergusson et al. (2008, pp. 1345-1350) found that reports of driving under the influence of cannabis were approximately 2.5 times greater than reports of driving under the influence of alcohol. Similarly, McGuire et al. (2011, p. 252) found that respondents were “significantly more likely to drive under the influence of cannabis than to drive while under the influence of alcohol or a combination of cannabis and alcohol”.
- Frequency of driving under the influence of cannabis may be higher than driving under the influence of alcohol (Fergusson et al. 2008, p. 1348).
- Perceptions of risk may be an influencing factor in one’s decisions to DUIC. It is widely accepted among road users that driving under the influence of alcohol is dangerous and impairs one’s ability to operate a vehicle (Swift et al. 2010, pp. 573-586). In contrast, many road users do not have these same beliefs about DUIC (Swift et al. 2010, pp. 573-586).
- Research on deterrence and its association to DUIC has been mixed. Some researchers have suggested a deterrent effect when there is perceived risk of apprehension for DUIC (Jones et al. 2006, pp. 854-861; Jones et al. 2007, pp. 83-86; Swift et al. 2010, pp. 573-586), while others have found a limited deterrent effect when looking at participants’ expectations about future traffic-related offenses (Fisher et al. 2014, pp. 185-200).
- Reasons people choose to DUIC or choose to avoid DUIC are varied. Swift et al. (2010, p. 573) found that the majority of participants (> 70%) reported “the need to get somewhere – to socialize, get home, drive intoxicated passengers, do tasks such as shopping, or get drugs” were common reasons for DUIC (Swift et al. 2010, p. 578). Less than 10% reported they DUIC “for fun or relaxation, because it was a part of everyday life, and especially for DUIC, because cannabis was not considered dangerous, or as less dangerous than alcohol” (Swift et al. 2010, p. 578). For those choosing to not DUIC, the perceived risk of this behavior on one’s ability to drive safely and the risks to self and others’ safety were the primary reasons to not DUIC (Swift et al. 2010, pp. 573-586).
- Factors such as the age a person starts to use cannabis and a history of being cannabis dependent may help to predict DUIC.

- Jones et al. (2007, pp. 83-86) found that those who initiated cannabis use later (age 16 and older) were less likely to report DUI in the previous year. Similarly, when comparing participants who started using cannabis at age 21 or after with those who started using cannabis before age 14, Le Strat et al. (2015, p. 3) found that those who initiated cannabis before the age of 14 were four times more likely to have a history of cannabis dependence and three times more likely to report having driven under the influence of cannabis.
- Being cannabis dependent was positively associated with an increased likelihood of DUI (Begg et al. 2003, pp. 669-675; Jones et al. 2007, pp. 83-86; Swift et al. 2010, pp. 573-586).

Second, a literature review on the impact of the legalization of cannabis on the values, attitudes, and beliefs associated with DUI was conducted to also guide survey development (Part B). A majority of the literature found pertaining to legislative change affecting public opinion and beliefs on substances was focused on medical marijuana, particularly the public's use of the drug, as well as attitudes and views toward use of the drug. No results were found that specifically looked at how legalization influences cultural beliefs and attitudes about DUI and traffic safety. The review of research revealed that changes in attitudes and use of marijuana have been associated with changes in legalization, but it is unknown how changes in legislation specifically impact DUI.

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