



## Young adult cannabis users report greater propensity for risk-taking only in non-monetary domains



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### ABSTRACT

**Background:** Though substance use is often associated with elevated risk-taking in real-world scenarios, many risk-taking tasks in experimental psychology using financial gambles fail to find significant differences between individuals with substance use disorders and healthy controls. We assessed whether participants using marijuana would show a greater propensity for risk-taking in distinct domains including, but not limited to, financial risk-taking.

**Methods:** In the current study, we assessed risk-taking in young adult (age 18–25) regular marijuana users and in non-using control participants using a domain-specific risk-taking self-report scale (DOSPERT) encompassing five domains of risk-taking (social, financial, recreational, health/safety, and ethical). We also measured behavioral risk-taking using a laboratory monetary risk-taking task.

**Results:** Marijuana users and controls reported significant differences on the social, health/safety, and ethical risk-taking scales, but no differences in the propensity to take recreational or financial risks. Complementing the self-report finding, there were no differences between marijuana users and controls in their performance on the laboratory risk-taking task.

**Conclusions:** These findings suggest that financial risk-taking may be less sensitive than other domains of risk-taking in assessing differences in risky behavior between those who use marijuana and those who do not. In order to more consistently determine whether increased risk-taking is a factor in substance use, it may be necessary to use both monetary risk-taking tasks and complementary assessments of non-monetary-based risk-taking measures.

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### 1. Introduction

Substance use disorder is characterized by an increased engagement in naturalistic risk-taking behavior, such that individuals continue to use a substance despite adverse consequences. Research on risk behavior has shown an association between substance use and self-reported engagement in risky behaviors, including extreme sports, delinquent and criminal behavior, and precocious sexual activity (Arnett et al., 1997; Zuckerman, 2007). However, many studies using traditional neuroeconomic tasks which assess monetary risk-taking fail to find differences between individuals who engage in substance use and non-using controls. In fact, in a recent systematic literature review of functional neuroimaging studies examining risk-related monetary decision making in individuals with substance use disorders, less than half of

the cited studies reported behavioral differences between individuals with substance use disorders and control participants (Gowin et al., 2013).

Risk-taking is a broad concept that is often assumed to be a stable personality trait (Hansen and Breivik, 2001). Neuro- and behavioral economists have developed models of risk-taking predominantly based on decision-making regarding monetary rewards, and these models often characterize individuals as either “risk-taking” or “risk-averse.” The standard microeconomic model of choice under risk, classical Expected Utility Theory, states that valuations of risk involve estimations of the reward magnitude and likelihood with which some outcome can be obtained (Bernoulli, 1958; Von Neumann and Morgenstern, 1944). Though Expected Utility Theory has proven to be a useful construct for predicting animal and human choices (Camerer, 1995), this model of risk-taking does not account for differences within independent domains of risk-taking across varied situations (Schoemaker, 1990). For example, laboratory studies have shown that people differ in the manner in which they make work-related versus personal decisions that involve risk and uncertainty (MacCrimmon and Wehrung, 1990). Differences

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have also been shown in propensity to take risks when individuals are asked to make decisions about personal versus company money, or about financial versus recreational risks (MacCrimmon and Wehrung, 1990). These studies question the assumption that risk attitude is a personality trait encompassing a single domain, and raise the question of whether risk-taking across multiple domains should be measured independently, particularly in clinical populations, where risk-taking in some domains may be abnormal while risk-taking in other domains may be intact.

Furthermore, neuroeconomic models of risk-taking have had limited success in differentiating substance-using from non-substance-using populations. In experimental psychology, a standard battery of gambling-type games is often used to measure risk-taking behavior in the laboratory, such as the Iowa gambling task (Bechara et al., 1994), Balloon analog risk task (BART; Lejuez et al., 2002), Wheel of fortune (Ernst et al., 2004), Game of chicken (Bjork et al., 2008), and Cambridge risk task (Rogers et al., 1999). In each of these tasks, participants are required to choose between “safe” and “risky” monetary gambles. Many studies fail to report performance differences between individuals with substance use disorders and control participants (e.g., Acheson et al., 2009; Adinoff et al., 2003; Bjork et al., 2008; Bolla et al., 2003; Cousijn et al., 2013; Ersche et al., 2005; Tanabe et al., 2007; Vaidya et al., 2012); but see (Bolla et al., 2005; Fein et al., 2004; Fishbein et al., 2005; Lane et al., 2010). These mixed results in risk-taking behavior have been replicated by our own group, which investigated risk-taking behavior in treatment-seeking alcoholic patients compared to controls and found no behavioral differences (e.g., Gilman et al., 2014). These laboratory results conflict with epidemiological evidence of increased real-life risk-taking in individuals with alcohol use disorders (e.g., increased aggression, criminal activities, risky sexual activity and unsafe driving; see Corte and Sommers, 2005 for a review). While it is possible that common risk-taking tasks used in experimental psychology do not relate to real-world risk-taking, it is also possible that a single domain of risk taking, limited to monetary-based decisions, is not fully representative of the multiple domains of risk-related decision making.

Marijuana users in particular may show increased rates of risk-taking in specific domains. Chronic marijuana users show impairments relative to controls behavioral and cognitive processes, including response perseveration, adaptation, and flexibility decision making, using laboratory tests such as the Wisconsin Card Sort Task (WCST), the Stroop Test, and the Iowa Gambling Task (Bolla et al., 2002; Pope et al., 2003; Solowij et al., 2002; Whitlow et al., 2004), all of which may relate to increased risk-taking. Marijuana also disrupts processes involving learning and motivation (Lane et al., 2005, 2004; Paule et al., 1992), which may also affect propensity for risk-taking. Many of these cognitive processes appear to be related to deficiencies in mesolimbic and prefrontal regions of the brain, regions high in cannabinoid receptors (Quickfall and Crockford, 2006), the targets of delta-9-tetrahydrocannabinol (THC; the principle active constituent of marijuana). Indeed, adolescent marijuana users compared to non-users demonstrated greater rates of impulsive decision-making (Solowij et al., 2012) and higher levels of risky sexual behavior among young adult marijuana users (Schuster et al., 2012). It is not known whether marijuana users show increased rates of risk-taking across other domains.

In the current study, we assessed risk-taking in young adult (age 18–25) regular marijuana users and in non-using control participants using both a domain-specific risk-taking self-report scale (DOSPERT; Blais and Weber, 2006; Weber et al., 2002), and a laboratory risk-taking task (Lane and Cherek, 2000). The DOSPERT was developed to capture an individual's likelihood of engaging in hypothetical risk behaviors across five risk domains; financial,

health, social, recreational, and ethical. The DOSPERT has been shown to have high reliability and consistency (Weber et al., 2002), and is associated with real-life risk-taking activities within a number of the same domains (Hanoch et al., 2006). Based on previous literature and our prior study, we hypothesized that monetary risk-taking would not be different between groups, but that marijuana users would score higher than controls in health/safety or ethical risk-taking domains that may be more relevant to drug-taking.

## 2. Material and methods

### 2.1. Participants

Participants in this study were 70 young adults, age 18–25; 36 who regularly used marijuana, and 34 non-using controls. Marijuana users used marijuana at least once a week, and were asked to refrain from using substances on the day of the study. Marijuana users completed a time-line follow-back (Sobell et al., 1986) asking them to indicate, for the past 90 days, the days that they smoked marijuana, along with how much they smoked (in joint equivalents) on any given occasion. Controls had used marijuana on less than 5 lifetime occasions, and had not used marijuana in the past 3 months. All participants also completed a time-line follow-back for alcohol use (Sobell et al., 1986). All participants were medically healthy, with no current psychiatric disorders (verified by the Structured Clinical Interview for DSM-IV (SCID; First et al., 2002) except for cannabis use disorders in the marijuana group. Participants were not excluded if they had used other illegal drugs in the past; however, they were excluded if they met abuse or dependence criteria for any drug, including alcohol and nicotine. Twelve marijuana users met DSM-IV criteria for marijuana abuse and two for marijuana dependence. Three marijuana users had past depression, and one control had past panic disorder. No participants were regular cigarette smokers; three marijuana participants reported smoking cigarettes in the past year (two smoked one cigarette per month, and one smoked one cigarette per week).

Before study procedures were initiated, we performed a qualitative urine drug screen (Medimpex United, Inc.) that tested for marijuana, amphetamines, methamphetamines, cocaine, and opiates, in order to ensure that no participant tested positive for any drug other than cannabis, and that no control participants tested positive for cannabis. Of 36 marijuana users, 25 tested positive for cannabis (approximately 70%), indicating recent use. No participant was visibly intoxicated during the study visit.

Participants completed a written, documented informed consent form prior to initiation of study procedures. All study procedures were approved by the Partners Human Research Committees.

### 2.2. Measures

Participants completed the Domain-Specific Risk-taking (DOSPERT) scale (Blais and Weber, 2006; Weber et al., 2002), a psychometric scale that assesses self-report of risk-taking in five content domains: social risk (e.g., disagreeing with a parent, wearing unconventional clothing), recreational risk (e.g., bungee jumping, downhill skiing), financial risk (investing and gambling risk), health/safety risk (e.g., engaging in unprotected sex, riding a bicycle without a helmet), and ethical risk (e.g., shoplifting, cheating on an exam). The questionnaire was completed twice by each participant, to measure two separate indices; the first asked participants to rate, on a scale of 1–5, their likelihood of engaging in each activity (risk *behavior*), and the second asked participants to rate, on a scale of 1–5, how risky they perceived each activity to be (risk *perception*).

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