Drug and Alcohol Dependence 170 (2017) 174–180

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

The effects of perceived quality on behavioral economic demand for marijuana: A web-based experiment

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ARTICLE INFO

Article history:
Received 16 April 2016
Received in revised form
15 November 2016
Accepted 17 November 2016
Available online 21 November 2016

Keywords:
Marijuana
Behavioral economics
Purchase task
Demand curve
Reinforcement
Young adults

ABSTRACT

Background: Given the growing legalization of recreational marijuana use and related increase in its prevalence in the United States, it is important to understand marijuana's appeal. We used a behavioral economic (BE) approach to examine whether the reinforcing properties of marijuana, including "demand" for marijuana, varied as a function of its perceived quality.
Methods: Using an innovative, Web-based marijuana purchase task (MPT), a sample of 683 young-adult recreational marijuana users made hypothetical purchases of marijuana across three qualities (low, mid and high grade) at nine escalating prices per joint, ranging from $0/free to $20.
Results: We used nonlinear mixed effects modeling to conduct demand curve analyses, which produced separate demand indices (e.g., P_{max}, elasticity) for each grade of marijuana. Consistent with previous research, as the price of marijuana increased, marijuana users reduced their purchasing. Demand also was sensitive to quality, with users willing to pay more for higher quality/grade marijuana. In regression analyses, demand indices accounted for significant variance in typical marijuana use.
Conclusions: This study illustrates the value of applying BE theory to young adult marijuana use. It extends past research by examining how perceived quality affects demand for marijuana and provides support for the validity of a Web-based MPT to examine the appeal of marijuana. Our results have implications for policies to regulate marijuana use, including taxation based on the quality of different marijuana products.

1. Introduction

In the U.S., marijuana is the most commonly used illicit drug, particularly among young adults. Large-scale national survey data suggest marijuana use peaks at ages 18 to 25 and rates of marijuana use among young adults have steadily increased over time (Johnston et al., 2014). Daily use of marijuana, which increases risk of dependence by 25%-50% (Hall and Pacula, 2003), is at its highest rate (5.9%) among college students since 1980 (Johnston et al., 2014). Thus, young adults are an important population of focus for marijuana research.

Over the past decade, momentum toward legalization of recreational marijuana in the U.S. has increased. At this writing (November 15, 2016), eight states (AK, CA, CO, MA, ME, NV, OR, WA) and DC have legalized recreational use of marijuana, and 28 states and DC permit medical use to varying degrees. Although controversy exists, some research indicates greater access to marijuana may lead to more use among those who may otherwise have lessened or discontinued use, such as young adults, thereby increasing risk for negative consequences, including dependence (Volkow et al., 2014).

Behavioral economic (BE) approaches posit that substance use is a behavior of choice and addictive substances are powerful reinforcers (Bickel et al., 1998, 2014). Simulated purchase tasks provide a well-controlled way to assess demand for or perceived value of substances, including marijuana. In such tasks, participants are allowed to "purchase" a substance as its price increases (e.g., Murphy and MacKillop, 2006; Yurasek et al., 2011). Results of these tasks generate demand curves, or the plot of amount purchased by price (Pearce, 1992). Purchase tasks provide several indices of demand: *intensity of demand* (level of purchase at the lowest price), O_{max} (peak expenditure), P_{max} (price at O_{max} or point on

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http://dx.doi.org/10.1016/j.drugalcdep.2016.11.013
0376-8716/

curve where commodity moves from inelastic to elastic), *breakpoint* (first price at which purchasing is zero/suppressed) and *elasticity of demand* (price sensitivity or change in consumption as a function of change in price; Bickel et al., 2000).

To date, two studies have used purchase tasks to assess demand for marijuana (Aston et al., 2015; Collins et al., 2014). Collins et al. (2014) innovated use of a marijuana purchase task (MPT) in which young adult frequent marijuana users were asked how many average-sized joints of "high grade" marijuana they would purchase across a wide range of escalating prices ($0/joint to $160/joint). The sample was sensitive to the price of "high grade" marijuana (i.e., marijuana purchasing decreased as a function of price). In Aston et al.'s (2015) MPT, adult frequent marijuana users were asked how much "average quality" marijuana they would purchase across 22 escalating prices ($0 to $10/hit). Despite differences in sample demographics (e.g., age, ethnicity) and methods (e.g., price range, time frame, joints vs. hits, marijuana quality, statistical), both studies revealed significant associations between demand indices and marijuana use, supporting the construct validity of the MPT.

Perceived drug quality is usually defined as potency/strength and purity. For marijuana, quality may reflect presence/absence of seeds and stems, moistness, aroma, or "pressed" appearance (Sifaneck et al., 2007). Ethnographic research has revealed users will pay more for high quality marijuana, which they view as more potent (Sifaneck et al., 2007). Only two studies (Cole et al., 2008; Goudie et al., 2007) have examined how perceived quality affects BE demand for marijuana. In both studies, polysubstance users were asked to purchase alcohol and illicit drugs, including marijuana. The researchers varied drug quality; Goudie and colleagues also varied participants' disposable income for purchases. In the Goudie et al. study, there was no main effect of marijuana quality on purchasing. The purchase of poor and average quality marijuana was unaffected by disposable income; however, participants with more income purchased more good quality marijuana. Cole et al. found that marijuana users were price sensitive and quality affected purchasing, with more purchasing of good quality marijuana.

Given the dearth of research, the present study was designed to investigate the effects of perceived quality of marijuana on demand for marijuana as exemplified by purchasing behavior. Based on the law of demand and prior research (Aston et al., 2015; Collins et al., 2014), we predicted as the price of marijuana increased, purchasing would decrease. We also hypothesized perceived quality of marijuana would influence demand and demand would be greater for high grade (HG) vs. low grade (LG) or mid grade (MG) marijuana. Since marijuana use peaks during young adulthood, we focused on young adults. This study also is the first to use a Web-based MPT, a novel method enabling data collection from a large and varied sample, making it more representative, efficient, and cost-effective than traditional "in-person" methods. Thus, another aim was to determine the validity of a Web-based MPT, as indicated by the association between demand curve indices and typical marijuana use.

2. Methods

2.1. Participants

Using a Web-based format, we administered the MPT to all interested members of a prominent nonprofit marijuana lobbying group. Of the 3951 sent an e-mail invitation, 2531 (64%) completed the study. Participants were assured anonymity and confidentiality. They provided informed consent prior to participation and had the opportunity to enter a raffle to win a $100 retail gift card. The University at Albany, SUNY Institutional Review Board approved the study.

The sample was restricted to young-adult (i.e., age 18–25) recreational marijuana users. Medical users and current non-users were excluded. We also omitted participants reporting >24 joints at any price point based on our judgment that users would be unable to smoke more than 6 joints/hour over an evening of about 4 hours. Indeed, most reported <10 joints in the MPT. Based on these criteria, the sample was reduced to 683 participants. The sample consisted of 683 young adult (M = 21.2 years, SD = 2.2) recreational marijuana users. They were mostly male (84%) and European-American (88%), with highest level of education some high school/high school diploma (19%), some college (56%), Associate's (6%), Bachelor's (16%), or advanced degree (3%).

2.2. Design and procedure

2.2.1. Web-based simulated marijuana purchase task. In this within-subject design, each participant completed the MPT three times: for LG, MG, and HG marijuana, in that order. Due to attrition during the task, sample sizes were 683, 665, and 608 for LG, MG, and HG, respectively. Examples for each grade of marijuana were provided, including *schwag* (LG), *schwan*, *mid*, *50* (MG), and *kindbud* (HG).

Because the demand curve analysis of Collins et al. (2014) indicated demand for HG marijuana became elastic at less than $15 per joint ($P_{max}$ = 12.38), we used a narrower range of prices in this experiment, with a maximum price of $20/joint. Participants reported their use of marijuana for nine marijuana prices, ranging from $0 (free) to $20/joint. They were asked to imagine they had *some free time one evening and [could] hang out at home and smoke marijuana.* They also were told they could not save the joints for a later day and the marijuana would be smoked only by them and not shared. An average-sized joint was defined as approximately ½ gram, 5 bong hits, or 10 puffs. Participants were asked, *How many average-sized joints of [LG/MG/HG marijuana] would you use if they were* $____*?* Price per joint was Free ($0), $2.50, $5.00, $7.50, $10, $12.50, $15, $17.50, and $20.

2.2.2. Demographics and typical marijuana use. Prior to the MPT, participants answered demographic and background questions, including top three preferred smoking methods, frequency of use, and real-world purchasing behavior. Typical marijuana use was self-reported grams of marijuana/week in the past 3 months.

2.3. Data analyses

To examine the "orderliness" of purchase task data, researchers have developed algorithms to identify nonsystematic demand data (e.g., Bruner and Johnson, 2009; Stein et al., 2015). We applied Stein et al.'s three quantitative criteria for identifying nonsystematic data: (1) *trend* (generally, consumption decreases as price increases), (2) *bounce* (no or few price increments involve a consumption increase), and (3) *reversals from zero* (consumption ceases at a certain price, then resumes at a higher price). All data met bounce and reversal criteria. Low percentages of data did not meet the trend criterion [12.6% LG (95% CI: 0.10–0.15); 4.8% MG (95% CI: 0.03–0.07); 6.3% HG (95% CI: 0.04–0.09)], with significantly more LG than MG or HG data failing to meet this criterion. Moreover, trend violations that involved no purchasing at any price were significantly lower for HG (5%; 95% CI: 0.01-0.18) compared with MG (78%; 95% CI: 0.60–0.91) or LG (94%; 95% CI: 0.87–0.98). Given its overall orderliness, we retained all participant data.

Conventional methods for analyzing BE demand curve data use linear models with log-transformed data (e.g., Murphy and MacKillop, 2006) or nonlinear models fit for each individual (e.g., Madden et al., 2007). To overcome methodological limitations, new