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The influence of choice environment on impatience, impulsivity and cravings:

A study of the decision to use cannabis faced by frequent cannabis users

Name student: Chloe Jacob
Student ID number: 505695
Supervisor: Dr. Chen Li
Second assessor: Dr. Tong Wang
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Abstract:

This thesis establishes the associations between a set of core measures: impatience, impulsivity and subjective craving strength and the real-life drug behaviours of current and former frequent cannabis users, using a quasi-hyperbolic model. The analysis is based on field data collected on the website Reddit, which includes detailed information on cannabis user's purchasing habits, consumption habits, visceral state and choice environment. The analysis finds that on average current cannabis users display higher levels of impatience than former cannabis users, while higher impulsivity is predictive of higher frequency of use for both current and former users. Craving strength, a form of subjective experience and common measure for problematic cannabis use, is strongly associated with both impatience and impulsivity toward cannabis. The results also indicate that residing in a criminalised choice environment, as well as visceral influences and visual cues present at the time a decision is made, systematically influence the core measures of interest. The combined exploration of impulsivity, impatience, subjective experiences and choice environment reveal that choice architecture and by definition choice architects influence the level of impatience and impulsivity associated with real life drug behaviours. This highlights that decision utility, experienced and remembered utility, visceral influences and choice environment are important to the study of self-defeating behaviours, which involve immediate benefits and delayed costs.

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1. Introduction

This thesis explores the impatience and impulsivity of frequent cannabis users toward cash and cannabis and its association with real-life drug behaviour using a quasi-hyperbolic model. A large number of studies which used quasi-hyperbolic models have found higher discounting of delayed outcomes are linked to the likelihood of engaging in frequent substance use and having substance use disorders (MacKillop et al., 2011). However, in contrast to this thesis, these papers do not consider the subjective experience and choice environment of former and current frequent drug users. This analysis is underpinned by a survey designed for former and current frequent cannabis users conducted on Reddit which elicited time preferences using hypothetical choice scenarios and collects detailed data on cannabis related behaviours and the environment of participants.

The aim of this thesis is to improve our understanding of the decision to use cannabis by frequent users. This decision is characterised by its benefit and cost structure, where benefits are immediate, and costs are delayed. A structure common to many observed self-defeating behaviours, where choosing the preferred option in the moment can lead to suboptimal outcomes over time. A person might want to use cannabis in a single instant, but they are unlikely to want to become dependent, yet the decision to use is directly linked with becoming dependent.

The first part of the analysis investigates whether impatience and impulsivity predict the likelihood of engaging in repeated self-defeating behaviours, in this case, using cannabis frequently. The thesis first explores whether being more impatience and impulsive towards cash is associated with being a frequent cannabis user currently compared to formerly. Additionally, the association between impatience and impulsivity for both cash and cannabis are regressed against frequency of use for both former and current frequent users. Higher impatience appears predictive of whether someone currently engages in frequent cannabis use, whereas higher impulsivity is linked with higher frequency of use in both former and current users. The subjective experience of frequent users is measured in two ways; the cravings for cannabis and the self-stigma experienced by participants over the last three months of frequent use. Considering both the measures for impatience and impulsivity and the subjective experience allows for the exploration of the links between revealed preferences and subjective experience or stated preferences. Experienced cravings are found to be strongly linked with both impatience and impulsivity, and impatience towards cannabis has the most explanatory power. Self-stigma also appears linked to revealed time preferences but in the opposite direction, as higher self-stigma is linked with lower impatience.

The core motivation behind criminalising the use of certain substances is to reduce substance related harms, by discouraging use through increasing the costs and risks associated with using drugs. However, the criminalisation of cannabis hasn't deterred the high number of frequent users currently residing within societies where the sale of cannabis is criminalised (Hari, 2015). Additionally, there is no legitimate evidence that criminalising a substance decreases its use in the long run.

The second layer of the analysis focuses on studying the impact of criminalising the choice environment and ultimately the decision-making process of frequent cannabis users. A government's approach to cannabis policy impacts various aspects of a frequent cannabis user's experience. For instance, within criminalised choice environments cannabis users are not able to purchase or consume cannabis in public, typically interact with and rely on criminal networks to procure cannabis and face legal penalties if caught. The overarching goal is to explore the links between choice environments and the likelihood of being a current user and using every day, through the core measures: impatience, impulsivity and craving intensity. The thesis explores the differences in real-life drug behaviour of frequent users residing within criminalised choice environments compared to users residing in practically decriminalised choice environments by exploring the systematic differences in the relationship between the core measures and the following elements: consumption habits, purchasing habits, effects of visceral events, presence of visual cues and institutional features of the choice environments. The results illustrate that users in criminalised environments with the same level of measured impatience, impulsivity and craving intensity differ in some of their consumption and purchasing habits compared to their counterparts. The visceral events considered, running out of cannabis and being under the influence of cannabis and the presence of a visual cues are found to be associated with systematic differences in impatience and impulsivity. These relationships also differ across different choice environments, specifically across countries, which provides solid evidence that choice environment is linked with levels impatience, impulsivity and experienced cravings.

The decision to use cannabis is complicated and affected by many aspects of an individual's characteristics and environment, for this reason this thesis considers this decision from the perspective of the frequent cannabis user within the field. This allows for the exploration of the impact of criminalisation, accessibility, visceral influences and visual cues on the decision-making process which have largely been ignored within the field of economics. This thesis deepens our understanding the role of experienced cravings, self-stigma, visceral influences, visual cues and

institutional features on the decision-making process of frequent drug users. With the aim of facilitating a more deliberate and psychologically informed design of choice environments and policy to ensure governments and other choice architects are not indirectly and accidently incentivising and fueling higher levels of drug use or self-defeating behaviours within their societies.

This thesis contributes to the broad literature on self-defeating behaviours by combining the study of revealed preferences, states preferences and choice environment. The combined analysis of impatience, impulsivity, craving strength, self-stigma and choice environment across different countries is novel and to the best of my knowledge has not been explored previously. This exploration combines a range of different behavioural economic elements which on their own have been able to inform the formation of self-defeating behaviours but have not been considered within the same study and decision-making process. These elements include the influence of visceral influences, visual cues, choice environment, social stigma and experienced utility on decision making. Additionally, prior studies on cannabis and time preferences surveyed participants in the lab, while this thesis targeted participants in the field. Finally, the exploration of the behavioural implications of criminalising behaviour using economics theory is novel and contributes a new approach to consider the systematic impact of choice environment on behaviour.

2. Cannabis and Public Health

The World Drug Report reveals that cannabis is the most widely used illicit substance in the world. It is estimated that approximately 3.9% of the world population between the ages of 15 and 64 used cannabis in the last 12 months (UNODC, 2018). The report also claims that the number of individuals seeking medical support for cannabis use disorder is increasing, while cannabis already accounts for the majority of individuals seeking substance related treatment in America, Africa and Oceania. This is surprising to many as cannabis is not typically considered an addictive substance, as it does not create strong physical withdrawal symptoms other substances such as heroin are commonly associated with.

The most common indicator of the prevalence of cannabis use across countries is constructed by measuring the number of individuals who have used cannabis in the last year. This indicator may be useful to gauge accessibility to cannabis within countries, but it does not provide information on the prevalence and characteristics of problematic or risky cannabis use (Hall & Degenhardt, 2009). The definition of problematic use is one that varies significantly across experts but simply put it refers to

a level of use which has harmful effects on an individuals and their society's well-being (European Monitoring Centre for Drug and Drug Addiction, 2013). Research suggests that 10% of individuals who try cannabis will, at one point become daily users (Hall & Pacula, 2003). Courtwright (2019) reports that over half of cannabis produced is consumed by users who spend over half their awake time under the influence of cannabis. These facts indicate that within the population of annual users, there exists a group of users who appear to use substantially more than the rest of users and as a result are more susceptible to being harmed by using cannabis. This study focuses on frequent users, not because it is synonymous with problematic use, but because frequent users are more likely to experience problematic use (EMCDDA, 2013).

The potential harms faced by individuals as a result of using cannabis are well established, and the World Health Organisation lists cognitive impairment, anxiety and mental illness, reduced ability to work, cannabis dependence, respiratory and cardiovascular disease as the primary 'health and social effects of non-medicinal cannabis use' (World Health Organisation, 2016). This thesis focuses on the factors contributing to high frequency use, which are likely to result in problematic use. One way of investigating the impact of different choice environments on the extent of cannabis use is to compare the prevalence and characteristics of frequent cannabis users across different societies. The United Nations Office on Drugs and Crime regularly collects information on the prevalence of drug use and treatment within countries and publish them in the World Drug Report (UNODC, 2018). The prevalence of illicit drug use is difficult to measure as social stigma and discrimination are endemic, and as a result, individuals are not encouraged to disclose their use. The majority of the data on the prevalence of cannabis use publicly available has been submitted by countries themselves, via a standard data collection template. Consequently, there is no way of comparing the data collection process across different countries (UNODC, 2018). A higher prevalence of drug use reported could mean either an actual higher level of use, or merely a higher level of disclosure (or both). For this reason, cross-country comparisons using these datasets are only indicative. The lack of reliable data also affects our ability to interpret trends across time, as public opinions or condemnation around using cannabis evolve over time, which affects the validity of the data available (EMCDDA, 2018).

To investigate the influence of environment and society on frequent cannabis users, it is essential to explore the perspective and experiences of cannabis users themselves. This view is advocated by the Global Drug Survey (GDS), an independent research organisation running a global annual survey targeting drug users, to develop 'unique insight into personal decision making about drug use' (GDS,

2019). To develop a deeper understanding of the decision to use cannabis, this thesis adopts a similar approach to the GDS and focuses on the perspectives of current and former frequent users. This is done by collecting detailed data on user's: real-life drug behaviour, the features of user's choice environment, their revealed impatience and impulsivity and self-reported subjective experience, and analysing the data to compare the associations between these elements across societies which employ different public health approaches to minimise the harms associated with cannabis use.

3. Background on addiction research

Substance addiction is broadly defined by a set of observed behavioural symptoms which appear in the substance user's life. Robinson and Berridge (2008) describe this experience as *a "compulsive pattern of drug-seeking and drug-taking behaviours, which occupies an inordinate amount of an individual's time and thoughts and persists despite adverse consequences*". Loewensten (1996) claims the persistence of drug-seeking and drug-taking behaviour despite the presence of adverse consequences demonstrates that there exist discrepancies between observed behaviour and perceived self-interest.

The determinants of addiction have been widely discussed and experts have long debated over whether addiction is inborn or learnt. A popular explanation within the medical field is that addiction is a "chronic, relapsing brain disease", and thus addicts themselves and by extension, their societies have no control over it (Heyman, 2009). Lewis (2015), a neuroscientist, proposes an alternative explanation; where addiction is the result of "motivated repetition that gives rise to deep learning". Within this paradigm, different models exist, including the choice model. Heyman (2009), a prominent advocate for the choice model, describes the underlying mechanism behind addiction as "a toxic mix of immediate pleasure and delayed penalties motivating excessive drug use". This evidence supports the view that the biological effects of the substances themselves are not necessarily the core determinant of addiction or compulsive behaviours, and that maladaptive behaviours can occur simply as a result of learning or habit formation (Lewis, 2015). However, this does not imply that some substances or even behaviours do not contain more addictive properties than others, only that these addictive properties are not deterministic over whether someone will become addicted. For example, a person that tries morphine is not automatically addicted after using it, despite its highly addictive properties, as many individuals are given morphine as part of their medical treatment and do not end up craving and pursuing it afterward (Hari, 2015). As the role played by the biological effects of substances in addiction is being questioned, the definition of

addiction broadens. Courtwright (2019) defines addiction as the end of the spectrum of harmful behavioural habits, where behaviours have become compulsive, strongly affected by environmental cues and ultimately self-ruinous. In line with Courtwright's view, non-substance related addictions are found to display many of the same characteristics as substance addictions (Grant & Chamberlain, 2014).

The field of economics, among others, have studied why many individuals continue to engage in habitual self-defeating and self-ruinous behaviours, even as they claim to be aware of their harmful consequences (Laibson 1997, Elster, J., 1989, Loewenstein, G. 1996, Litt, A., Khan, U., & Shiv, B.,2010). To better understand maladaptive behaviours economic models incorporate the conflict between multiple selves and competing goals. This is the case for Lundenberg and Levine's (2006) dual-self model, which investigates the conflict of interests between a short-sighted self which makes decisions in the moment, while facing temptations and visceral influences and a long-sighted self which plans and attempts to action long-term goals and by constraining the short-sighted self. Both the short-term and the long-term selves can display impatience and discount delayed outcomes, in other words individuals can simply want to consume today at a cost to the future (Andersen et al., 2008). However, the long-term self is expected to incorporate potential outcomes into its forecasted long-term budget and not be tempted by short-term temptations. As a result, the long-term self is expected to display constant impatience. On the other hand, the short-term self is often tempted by short-term rewards and avoiding approaching costs, which is expected to lead to decreasing impatience and preference reversals. The dual-self model posits that the long-sighted self-attempts to control the short-sighted self, but exerting this effort is costly. The costliness of self-control determines the trade-off between the consideration given to short-term gratification or the pursuit of long-term goals and thus the ability to delay gratification in order to pursue longer term benefits. The short-term temptations faced by decision makers are predicted to be highest when a decision involves potentially receiving an immediate reward or punishment, thus increasing the costliness of exerting self-control when choosing between an immediate outcome or a delayed outcome, increasing the likelihood of acting impulsively. Dalley, Everitt & Robbins (2011) identify impulsivity as a useful 'heuristic' to represent predispositions to compulsive behaviour and highlight the importance of exploring the factors which influence impulsivity. They predict that an individual's vulnerability to developing an addiction is considerably influenced by their environment and genetics. Ainslie (2001), who is both a psychiatrist and a behavioural economists, agrees and describes institutional and environmental factors as the scaffolding of intertemporal choice. This

view is also supported by Courtwright (2019), who affirms that choice environments impact our reward systems, the decisions we make, and consequently, the likelihood of developing compulsive behaviours towards a reward with harmful effects. This conviction motivates the combined study of impatience, impulsivity, self-control and choice environment.

4. Measuring utility

Individuals can only decide on a single course of action or alternative in the immediate moment, and for this to occur, decision makers must weigh up potential outcomes within one frame of reference or a common dimension. This common dimension is referred to as utility (Ainslie, 2001). Utility theory explores the process by which preferences for different outcomes (e.g. being under the influence of a substance) compete for resources (i.e. actions, time, money and attention) within the decision-making process. Heyman (2009) makes a useful distinction between analysing local and global choices; a local choice refers to the outcome of a specific decision, where the observed local choice reflects the options with the highest utility at a point in time. Whereas, a global choice relates to patterns of consumption or 'distributed choices' and by definition, the aggregation of a series of choices. The frequency of cannabis use over a period of time constitutes a global choice, whereas a single decision to use cannabis at any one time a local choice.

4.1. Decision being considered

Frequent cannabis users are continually faced with the decision (local) to use or not to use cannabis at different points in time, which adds up to the decision to use or not use cannabis over a period of time or a pattern of use (global choice). The global choice is never made directly and emerges from a set of single instance choices made by users. The local decision to use or not to use cannabis is equivalent to weighing up the immediate benefits of using (e.g. better health and reducing stress) and the perceived costs. The costs can be both shorter-term (e.g. being late to work) and longer-term (e.g. increased dependence), however it is important to notice that all costs are generally delayed with regards to benefits (Ida, 2014). As a result, the costs are discounted by decision makers according to their time horizon, where longer-term costs are discounted more heavily than shorter-term costs. This benefit and cost structure described above is typical of most observed self-defeating behaviours (Ainslie, 2001).

4.2. Decision vs Experienced utility

This thesis considers two types of utility; decision utility and experienced utility. Decision utility weights up the utility levels attached to different outcomes considered within the decision process, at the time the decision is made. As a result, decision utility accounts for the real-life decisions we observe and can be measured through revealed preferences. While, experienced utility refers to the subjective hedonic experience attached to a moment in time or an extended period of time, referred to as an 'episode'. The subjective experience of individuals emerges from the choices previously made by individuals (Kahneman, 1999). For example, if a user decides to use cannabis, they will have a very different experience to what they would have had, had they decided to abstain from using. The basic component of experienced utility is instant utility, which represents the real-time enjoyment or distress experienced. While, total utility is the other component of experienced utility and describes the retrospective evaluation of the overall utility of an episode. The result of the evaluation is referred to as remembered utility.

The distinction between decision and experienced utility is also discussed within the field of psychology, where it has become widely accepted that the process of 'wanting' is separate from the process of 'liking' (Berridge & Robinson, 2016). The hedonic experience or 'liking' was originally linked to brain dopamine networks, which are activated by rewards, driving the belief that maximising experienced utility was responsible for pursuit of rewards or goals. However, subsequent research has shown dopamine networks to be primarily linked to process of 'wanting'. Berridge describes the motivational process of 'wanting' as synonymous to decision utility and explains that is can be a fairly unconscious process. Berridge and O'Doherty (2014) describe the aim of decision utility or the process of 'wanting' as maximising experienced utility or 'liking', where they are disparate processes, which feed into each other.

Decision and experienced utility are known to be linked, where experienced utility influences decision utility and consequently the decisions made, which themselves determine the experience which emerges and the associated experienced utility (Kahneman, Wakker & Ravin, 1997). However, the way experienced utility influences decision utility is poorly understood. Kahneman, Wakker & Ravin found that remembered utility effectively predicts the outcome of future decisions before they occur, in other words remembered utility, a form of experienced utility, is predictive of the outcome of the decision utility maximisation process. An important implication of having disparate processed to evaluate experienced utility ('liking') and decision utility ('wanting') is that a decision which

maximises decision utility can have a negative impact on experienced utility, especially when we consider distributed choices. For example, addicts often report being unable to stop themselves from using after an extended period of abstinence, which suggests that using yields the highest decision utility level at the time of the decision. Yet, the same addicts also report regretting their actions immediately or soon after enacting their decision, which suggests experienced utility was impacted negatively. For this reason, this thesis considers both types of utility: decision (i.e. revealed preferences) and experienced (i.e. subjective experience).

The relationship between local and global choices is complicated and needs to be considered to improve our understanding of decision-making around real-life self-defeating behaviours. When individuals are asked which type of outcomes they value and pursue, they typically identify global outcomes, which are the result of distributed choices that occur over an extended period of time. This implies that individuals are more concerned with maximising total utility than instant utility. However, instant utility still plays an important role in the decision-making process, as total utility is constructed from sets of instant utility. The process through which total utility and consequently remembered utility is formulated is governed by simplifications and normative rules, which systematically impact the way events are remembered and valued (Kahneman, Wakker & Ravin; 1997). Experienced utility is not typically considered in the field of economics, but the authors state remembered utility can be measured and informative over an individual's decision process, especially when considering decisions which involve immediate benefits and delayed costs, as is the case for the decision being considered in this thesis. The subjective experiences considered are the craving strength and self-stigma experienced over the last three months.

4.3 Measuring utility for addictive consumption

Heyman (2009) identifies three principles which are fundamental to exploring addiction through the lens of choice;

1. Preferences are not independent, as choices impact the future value of outcomes
2. There are multiple ways to frame the same set of choices and,
3. Individuals choose the 'better' option available to them at the time

The first principle focuses on the effects of past consumption on the utility of future outcomes. Herrnstein and Prelec's (1991) theory of melioration provides a framework to conceptualise the

dynamic interaction between local and global choices. It posits that individuals evaluate the satisfaction they experienced from their past distributed choices through a process termed 'value accounting'. This process is analogous to the process of evaluating remembered utility from past choices and incorporating this information into decision utility calculations, as described by Kahneman, Wakker and Ravin (1997). Both papers find that errors in evaluating remembered utility can lead to suboptimal decisions over outcomes which are extended over time (i.e. global decisions). Herrnstein and Prelec suggest the source of this error stems from people's inability to fully incorporate the delayed costs associated with a single instant of use, as they are hard to imagine and only decrease future enjoyment incrementally. The costs mentioned by Herrnstein and Prelec are increased tolerance to the substance and reduced interest and enjoyment towards other alternatives activities. Kahneman, Wakker and Ravin found that preferences for or against repeating previous decisions are largely determined by remembered utility and declare that remembered utility does not accurately reflect experienced utility resulting in the failure to maximise experienced utility. Underpinning both explanations is a disconnect between decision utility or the desirability of a choice at the time a decision is made and the resulting experienced utility for a certain episode or broader pattern of use, which consequently emerges from these single instance decisions. In other words, individuals are limited in their ability to predict the impact of their decisions on their experienced utility over time, as well as on their future decisions.

The incentive sensitisation theory provides a viable explanation for the way experienced utility influences decision utility and relates to Heyman's second principle, which states that choices made by individuals can change simply from a change in the way a decision is framed (Berridge, 2012). The theory describes the process of 'wanting' as being influenced by different sources of information; remembered utility, cues or triggers associated with rewards and the current state of individuals. In contrast, 'liking' does not appear to be directly linked to cues. Berridge describes the 'wanting' process as an 'incentive salience attributor', which attributes salience or perceived desirability to different alternative choices. The theory predicts that repeated drug use increases the incentive salience attached to drug related outcomes and cues. The associated cues act as conditioned stimuli which can create motivation and localise attention toward pursuing the reward that it is linked to, which would not otherwise occur (Ainslie, 2001). Additionally, Ainslie states that regardless of whether motivation is conjured up by conditioned stimuli or an inborn appetite it has the same effect on decision making. On the other hand, incentive sensitisation decreases incentive salience, or desirability attached to other outcomes and their cues. Berridge and Robinson (2003) found that

once it is formed 'sensitised wanting' can motivate the pursuit of drugs years after an individual stops experiencing withdrawal symptoms or finding drugs appealing cognitively. These findings imply that incentive sensitisation can fuel the 'wanting' or desire for drugs without the presence of experienced pleasure when under the influence of the drug.

The 'wanting' or incentive salience attached to different outcomes is amplified by certain mental states including; stress, relevant appetite, intoxication or unconscious stimuli (Anselme & Robinson, 2016; Berridge, 2012; Childress et al., 2008). Robinson and Berridge (2008) suggest that subjective cravings; an intense desire for a substance, are a form of emotional cost experienced by individuals, which reflect their conscious desire for their substance of use. Cravings for cannabis vie for attention within the 'wanting' process and ultimately increase the desirability of cannabis in the moment. The melioration theory would predict that individuals do not fully anticipate the future cravings associated with the decision to use when deciding whether to use cannabis in a single instance, as future cravings fit the description of a cost which is hard to imagine and only increases incrementally with every single use. Loewenstein (1996) identifies visceral factors, which include cravings for substances, as the reason individuals lose control over their decision making and 'act against their self-interest in full knowledge that they are doing so'. He describes the decision to use which necessarily precedes a relapse as impulsive and fueled by cravings. This suggests that subjective cravings are both created by and fuel the process of 'wanting'. Shiffman et al. (2013) ran a study which support this position, by investigating the links between craving strength and smoking behaviour. They found that craving strength, measured immediately before smoking, was predictive of the number of cigarettes participants had, the intensity of cigarette inhales and the time it took for participants to start smoking, where participants who reported higher cravings smoked more and more quickly. In contrast, this thesis will focus on the association between cravings experienced over an extended period of time (3 months) and real-life behaviours. In conclusion, the impact of framing on decision utility depends on both the reward association of the cues and the current state of the individual.

Heyman's last principle reminds us that the factors which influence decisions are time variant. All decisions are made at a certain point in time, which are associated with time and context specific influences. For example, a user with the same underlying hypothetical decision utility function is more likely to decide to use cannabis if they have used a lot of cannabis in the last week and are

surrounded by cannabis related cues, than if they have abstained in the last week and are not faced with cannabis related cues.

4.4. Time preferences as a measure for impatience and impulsivity

Decision utility, which will simply be referred to as utility going forward, is underpinned by a utility maximisation process characterised by individual preferences over outcomes, time and uncertainty (Andersen, Harrison, Lau, & Rutstrom, 2008). Time preferences are a measure of impatience, where individuals who discount delayed rewards more highly are considered more impatient. From an economic perspective, impatience predicts that an individual will allocate less of its resources investing in long-term well-being and more resources seeking short-term gratification. Impatience, as measured by elicited time preferences, has been linked to underinvestment in long-term health and well-being, and specifically substance and non-substance related maladaptive behaviours (Bradford et al., 2017). The source and nature of impatience is widely debated, and an important question remains, which time discount function specification best accounts for observed behaviours (e.g. daily amount of cannabis consumed) of frequent substance users (Grant & Chamberlain, 2014). Models of addiction can vary significantly in the manner they treat time preferences.

One category of models pioneered by Becker and Murphy (1988) are based on the theory of rational addiction. This theory accounts for time discounting of delayed outcomes using Samuelson's (1937) exponential discounting function (1), which assumes that all outcomes types (e.g. cash and substances) are discounted at a single constant rate (δ).

$$(1) \quad U(x_0, \ldots, x_T) = \sum_{t=0}^{T} \delta^t \, u(x_t)$$

By design, models of rational addiction assume constant impatience, as the utility of future outcomes ($u(x_1, \ldots, x_T)$) are discounted at a constant rate for each period of delay (Bradford, Courtemanche, Heutel, McAlvanah, & Ruhm, 2017). Constant impatience implies stable preferences over time and that user's decisions are not affected by temptations and visceral factors. Ultimately, it predicts that addiction is the outcome of a rational optimisation process. The theory of rational addiction attributes addiction the unusual properties of addictive substances, and the naivety of the decision makers (Ainslie, 2001). It predicts that consuming such a substance strongly incentivises the pursuit of further consumption and in parallel decreases the marginal utility of other goods or activities. However, once the individual is informed of these costs, as an individual who has previously

experienced addiction would be, the theory predicts the costs of using, including incremental costs which are typically hard to imagine, are fully anticipated and incorporated into the user's decision making process (Kahneman, Wakker and Ravin, 1997). Therefore, the theory accounts for individuals trying drugs for the first time and getting addicted, as a result of underestimating the biological and associated effects that using would have on their future decisions (Lewis, 2015). However, this contradicts the real-life behaviour of addicts. Extensive evidence shows drug addicts who have been sober for long periods of time and thus are not under the influence of a substance or naive to the consequences of addiction, commonly relapse multiple times (Ross, 2010). Additionally, addicts are known to use pre-commitment devices to support themselves in reducing or ceasing their use; common pre-commitment devices include taking drugs[1] that will turn the effects of a drug undesirable or voluntarily entering a rehabilitation centre where options are strictly limited. The use of pre-commitment devices implies that individuals predict their preferences will change over time (Ainslie, 2001). This illustrates that naivety and the biological effects of the substance cannot convincingly explain substance addictions. The melioration theory can account people relapsing, as individuals would still be susceptible to underestimating the costs associated with the decision to use after having experienced addiction but it cannot account for the common use of pre-commitment mechanisms, as it does not predict that individuals foresee the consequence of using on their future valuations.

Exponential discounting has failed to convincingly account for preference reversals, which are a defining feature of maladaptive behaviours (Bickel, Odum, & Madden, 1999). The assumption that individuals discount future rewards according to exponential discounting has been challenged by Ainslie (1991) and Laibson (1997), who suggest that individuals systematically place more emphasis on current consumption than on future consumption. This interpretation is in line with dual self-models, which model a conflict between short-term and long-term term interests. Laibson developed the quasi-hyperbolic discounting function (2) to model the conflict between the current self and all future selves, and states that the function is relevant as long as there are tensions between the current and future's selves' motivations.

$$(2) \quad U(x_0, \ldots, x_T) = u_0 + \beta \sum_{t=1}^{T} \delta^t \, u(x_t)$$

[1] Taking Disulfiram will bring on some of the symptoms of a hangover, while not inhibiting the typical effect of alcohol (i.e. getting drunk)

The constant or rational discount rate (δ) remains and a time-inconsistent discount factor (β) is added, where all future discounted utilities ($\delta^t\, u\,(x_t)$) are re-weighted by the time-inconsistent factor (β) relative to present consumption. $\beta < 1$ represents a tendency to prefer an immediate reward over a delayed reward, referred to as present bias. Ainslie (2001) describes this phenomenon as impulsiveness or decreasing impatience and believes it results in a 'high in-born susceptibility to drug reward'. If $\beta = 1$, the quasi-hyperbolic function is equivalent to the exponential discount function, which indicates time-consistent discounting and thus no violation of the stationary axiom (Ida, 2014). $\beta > 1$ indicates a preference for future consumption and thus increasing impatience, it is commonly observed in empirical studies, however it is rarely meaningfully interpreted. The use of a quasi-hyperbolic modelling approach allows for both time-consistent and time-inconsistent discount parameters to be measured and tested for associations with different real-life behaviours (Ida, 2014).

Studies within the fields of experimental psychology and behavioural economics have explored the links between impatience, impulsivity and self-defeating behaviours using hyperbolic and quasi-hyperbolic models. Bickel, Odum & Madden (1999) used a hyperbolic discounting model to explore the links between impulsivity and tobacco use and found that hyperbolic discounting accounted for smoking behaviour more convincingly than exponential discounting and smokers appeared to discount delayed outcomes more heavily than never-smokers and ex-smokers. In line with these findings, Ida (2014) used a quasi-hyperbolic model and found both present bias and constant discount factor account well for tobacco consumption, where more heavily addicted individuals tend to display higher present bias. These findings have been replicated over a range of substance; heroin, tobacco, cocaine, alcohol (Cheng, Gonzalez-Vallejo, Han, & Lu, 2012; Barlow, McKee, Reeves, Gelea and Stuckler, 2016; Kirby & Petry, 2004; Badger et al., 2007) and a range of potentially self-defeating behaviours credit card borrowing, self-reported health outcomes, overeating (Meier & Sprenger, 2010; Bradford et al. 2017; Epstein, Salvy, Carr, Dearing, & Bickel, 2010). Kirby & Petry (2004) found the discount factors for cash of dependent users who used illicit substances to be higher than that of those who consume alcohol. Finally, a study on heroin dependent participants found that participants who expose themselves to more risk, by sharing needles, display higher discount rates (Odum, Madden, Badger, & Bickel , 2000). This indicates that time preferences, which measure impatience and impulsivity over cash outcomes, are informative over real-life behaviour. Additionally, a number of studies have found that individuals discount direct consumption, in this case a user's substance of choice, at a higher rate than monetary outcomes, by comparing the discount factors of cigarettes

(Bickel et al., 1999) and cannabis (Stanger, et al., 2012) to the discount factors of cash. This suggests that impatience and impulsivity can vary with different outcome types, and in the context of this thesis, users could be more impatient and impulsive with regard to cannabis than they are with cash. These findings are in line with the view that impatience and impulsivity, measured by eliciting time preferences, are associated with the decision made by individuals over choices which involve immediate benefits and delayed costs (Bradford et al., 2017).

Only a small number of studies (Johnson, Bickel, Baker, Moore, & Badger, 2010; Stanger, et al., 2012; Heinz, Peters E, Boden, & Bonn-Miller, 2013; Lee, Stranger, & Budney, 2015; Peters, Petry, Lapaglia, Reynolds , & Carroll, 2013) have explored the links between cannabis use and time preferences, compared to the large number of studies which have considered other substances. These studies focused on individuals trying to cease or reduce their cannabis use; and elicited the time preferences of veterans, adolescents, and uni students. They used outcomes between $100 and $1000 and found mixed evidence on whether current cannabis dependent users discount delayed rewards systematically differently to non-current cannabis users. Findings in these studies are mixed. Johnson, Bickel, Baker, Moore, & Badger (2010) found no significant effect. Where significant differences were found (Peters, Petry, Lapaglia, Reynolds , & Carroll, 2013; Stanger, et al., 2012) they were smaller than the effects found in studies looking at non-cannabis substances and gambling (Stea, Hodgins, & Lambert, 2011). They also report mixed results on whether individuals discount cannabis more heavily than money.

This thesis explores the links between the time preferences of cash and cannabis, subjective cravings experienced by users, the context of the decision and the environment the user resides in. These factors have not been considered by one study before and this new approach will add to the understanding of the predictive nature of time preferences over maladaptive behaviour, as well as exploring how environment and context can affect time preferences.

5. Choice environment and choice architecture

"Decision makers do not make choices in a vacuum. They make them in an environment where many features, noticed and unnoticed, can influence their decisions." (Thaler, Sustein & Balz, 2010)

A choice environment is the context within which decision makers operate. It shapes the manner in which decisions are presented to decision makers and consequently their decision-making process.

The study of the impacts of presentation or framing on decision-making in the real-world is referred to as choice architecture. The influence of environment on substance use is often recognised by experts but rarely explored formally (Ainslie, 2010).

Thaler, Sustein and Balz (2010) found that the environments faced by decision makers impact their likelihood of experiencing systematic failures in self-control, planning and making predictions. A study designed different choice environments with the aim of reducing the impulsivity of its subjects, while investigating the role of experienced impatient thoughts, a type of experienced instant utility, within the decision process (Weber, et al., 2007). Their results indicated that choice environments can systematically affect individual's impulsivity and that the prevalence of impatient thoughts mediates the preference for immediate reward compared to delayed rewards. This suggests that impulsivity and thus time preferences can be influenced by choice environment and that measuring experienced utility informs the process.

Governments commonly implement small changes to choice architectures, referred to as 'nudges', with the aim of influencing behaviour in predictable ways (Thaler & Sunstein; 2008). These types of interventions are commonly found in the health and education sector, including in the strategies evoked to reduce consumption of legal substances such as tobacco and alcohol. For instance, in 2012 the Australian government was the first to introduce plain packaging laws for tobacco products with the aim of 'reducing the appeal to consumers' (Australian Government Department of Health, 2018). However, this thesis does not focus on the minor design aspects of the choice architecture for frequent cannabis users but on the influence of institutional features; such as criminalisation of drug taking, on the behaviour of frequent cannabis users, by exploring the links between choice environment, extent of cannabis use and impatience to provide insights on the internalities imposed on frequent cannabis users by different choice environments.

5.1. Choice architects

A choice architect is most simply defined as an individual or organisation who indirectly influences the decisions of a group of decision makers (Thaler & Sunstein; 2008). Government laws and regulations set the rules within the choice environments for substances and ultimately determine the way choice architectures emerge. Ainslie (2001) predicts that a system which aims to control behaviour through regulations will not simply be followed by reason, instead the constraints are incorporated within the decision-making process (e.g. decision to use) resulting in a web of

underground motives. Ainslie believes the 'underground economy of motives' which emerges unintentionally from regulation determines what gets done, and not the regulation itself. Tolerating the sale of cannabis allows the government to deliberately design the choice architecture, as was done by the government of Canada who imposed strict regulations on the advertising of cannabis products, including plain packaging, to limit seller's ability to promote their products (Government of Canada, 2019). Criminalising the sale and the use of cannabis brings the trade underground, which prevents governments from directly overseeing and enforcing regulations. This does not imply that governments do not influence the behaviour of users within criminalised architectures, as within that system the approach to policing, punishment and care will also influence the choice environment and consequently the behaviour of users (Vanderplasschen, et al., 2013). For instance, the probability of being caught for using illegal substances and the punishment associated with it impact the behaviour of potential illicit substance users (Becker, 1968). Following this logic, it becomes clear that criminals and criminal institutions are influential choice architects within the choice environments of illicit drugs. In contrast, this role is primarily filled by legal employees in societies where cannabis is sold legally. This thesis explores systematic differences between residents of criminalised and non-criminalised choice environments.

5.2. Features of choice architectures

The following four features of choice architecture standout as most relevant to the behaviour of frequent cannabis users. These features are directly influenced by a government's approach to policing the procurement and use of cannabis.

Incentives and *prices* are consequential features of choice architecture which influence the demand for a good (Thaler & Sustein, 2008). The first major difference comes from the criminalisation itself, decision makers in criminalised choice environment face a threat of punishment, which is not present in societies where cannabis is practically legal. Litt, Khan, & Shiv (2010) ran experiments to explore the impact of being 'jilted', by which they mean being prevented from acquiring a desired reward. They found that being jilted simultaneously increased the pursuit of the reward, measured by the willingness to pay for the reward or 'wanting' and decreased the attractiveness or 'liking' of the reward measured by the willingness to trade. In line with these findings, Brehm (1966) developed the theory of psychological reactance, which predicts reducing freedom of choice can motivate the pursuit of the goal. The *price* of cannabis varies significantly across countries surveyed for this study (refer to Appendix Table 1.3). The strength and types of cannabis (e.g. flowers vs cartridges) used

are not easily comparable across users and countries, for this reason prices are not included in the analysis. The other noticeable differences are the quantity limits on purchases[2] and the prevalence and magnitude of quantity-based discount. The quantity limit for the Netherlands can be expected to influence purchasing behaviour, however it cannot be decoupled from being a Dutch resident. Quantity based discounts can be expected to incentivise the purchase of larger quantities.

Accessibility and safety are highly linked with the criminal status of a choice environment. The presentation of choices and the type of transactions undertaken are in the hands of criminal institutions where the purchase of cannabis is criminalised. This typically makes the procurement process more ambiguous and time-consuming compared to walking into a dispensary and placing an order. For example, Australian cannabis users face more uncertainty (e.g. no formal opening hours, no information on quality, can I get it if I go on holidays?) and risk (e.g. I have to interact with an illicit drug dealer, I could get caught by the policy for possession, I could buy a bad batch) when procuring cannabis, then their Dutch counterparts. Accessibility and safety can still be impacted by government policies. The Dutch government controls the number of dispensaries (i.e. Dutch coffeeshops) across the country but does not regulate the production of cannabis. These differences are important and in general cannabis is more readily available and safer to acquire in practically decriminalised choice architectures.

The prevalence of *cues, triggers and advertising* related to cannabis varies across different societies. Criminalisation is expected to reduce the prevalence of public cues and bring the sale underground, which as a consequence further reduces the number of cues (e.g. the coffeeshop itself is a drug cue). Advertising can be regulated, as is the case in the Netherlands, where it is banned (Government of the Netherlands, 2019). However, the ability to display cues at the point of sale is not regulated in the Netherlands and the sale of cannabis is not hidden from the public. The landscape for cues and triggers is complicated and hard to measure. This thesis will not attempt to determine where cues and triggers are more prevalent, instead it explores whether the presence of cues can affect impatience or impulsivity. Ainslie (2001) explains that cues can have multiple associations to different outcomes (e.g. using and abstaining) which must vie for the attention of the decision maker. This phenomenon can be observed in Amsterdam, where the omnipresence of coffeeshops is not particularly exciting to its locals but attract a large number of drug tourists every year, this

[2]The Dutch government set a legal limit of 5 grams for purchases and possession

exemplifies that people residing in different environments can be influenced differently by the same cues.

Social norms and social stigma are hard to formally measure and imagine. Social norms are the rules created and upheld, both through the shared belief and approval of the norms by the society and through the feelings of embarrassment or shame felt by individuals who perceive themselves as violating the norms (Elster, 1989). The latter is referred to as self-stigma. Luoma, et al., (2007) investigated the links between self-stigma and substance abuse by surveying individuals receiving treatment for substance abuse and found higher levels of secrecy to be associated with higher levels of perceived stigma, shame and lower quality of life. Ainslie (2001) describes social norms as the greatest incentive for individuals to exert self-control, as going against social norms typically results in loss of self-esteem. This loss which stems from violating social norms is an additional cost potential faced by frequent cannabis users. The impact of social stigma or self-stigma on impulsivity does not appear to have been explored, yet the potential impact of social stigma could be important. A summary of the self-stigma questions and answers are illustrated in Table 1.5.

5.3. Approach to exploring the impact of choice environment

In order to explore whether frequent cannabis users residing in criminalised or non-criminalised choice environment display any systematic differences, a particular focus of this study will be on frequent cannabis users residing in Australia and in the Netherlands. Both Australia and the Netherlands have displayed stable annual rates of use over the last decade (respectively: 10.4% in 2016, 8.7% in 2015). Additionally, both countries report near identical statistics on the proportion of individuals being treated for drug-related issues who report cannabis as their primary drug is use, 36% in Australia and 35% in the Netherlands (UNODC, 2017). Australia and the Netherlands have historically and to this day, treated the sale and consumption of Cannabis in two very distinct ways. The Australian government criminalised Cannabis in 1928 and the possession and sale of cannabis remains prohibited in all states. Australian states differ on whether they impose criminal or civil penalties for possessing small amounts (Parliament of Australia, 2001). Overall the Australian government describes its approach to reducing cannabis consumption as underpinned by harm minimisation principles, while 'the epidemiology of cannabis use and related harms in Australia 1993-2010' report refers to the number of cannabis-related arrests as high and stable (Roxburgh A. , 2010). In contrast, the Netherlands has tolerated the recreational use of cannabis officially since 1976, and thus users (over the age of 21) are able to buy and consume cannabis openly (Korf, D. J.,

2019). In many ways, Australian and the Netherlands are comparable places to live. The 2019 World Happiness Report ranked the Netherlands 5th and Australia 11th out of 153 countries and both countries were given consecutive ranks on the dimensions of freedom (Netherlands 19th and Australia 17th), generosity (Netherlands 7th and Australia 6th), corruption (Netherlands 12th and Australia 13th), while the other rankings only differed by less than 10 ranks; social support (Netherlands 15th and Australia 7th), GDP per capita (Netherlands 12th and Australia 18th) and life expectancy (Netherlands 18th and Australia 10th) (Helliwell, J., Huang, H., & Wang, S. 2018). The comparison of these two countries exploits their similarities in living standards and their distinct approaches to cannabis policy. Additionally, the comparison hinges on the fact that users residing in Australia are not able to simply drive to another country to find more liberal cannabis regulations. However, a key difference remains culture and social norms, as it can be expected when comparing an Anglo-Saxon country and a European country. It is impossible to decouple the differences in culture, social norms and attitudes toward cannabis use, which emerge from the differences in policy approaches and the differences which reflect other fundamental differences between the social norms of both countries. Where systematic differences between the users residing in Australia and the Netherlands are identified, the hypothesised source of these divergences will only be speculative.

This analysis will also look at frequent cannabis users residing outside of Australia and the Netherlands, users who reside both in criminalised and non-criminalised choice environments. This allows for the exploration of the links between time preferences, craving strength, choice environments and real-life behaviours within a larger sample and against other Anglo-Saxon countries and approaches to cannabis regulation. Two countries which make up a large portion of this data are the USA and Canada. Cannabis is found to be most prevalent in the United States and Canada (respectively: 17% in 2016, 14.73% in 2015), two countries where reported incidence of cannabis use has been increasing steadily over the last ten years (UNODC, 2017). It is important to note that the USA and Canada have undergone significant changes to their cannabis policy approach recently. As of January 2020, there will be 11 US states where recreational use of cannabis is legal and many more where the use of medicinal cannabis is tolerated, while Canada legalised cannabis nationally, effective July 2018 (Esquire, 2019). The recent changes in Canada make it a good candidate to compare to the Netherlands, as Canada is in many ways similar to Australia and hasn't had a stable choice environment over the last year.

6. Hypotheses

The analysis is divided into two hypotheses, both further divided into sub-hypotheses. Elicited time preferences (i.e. impatience and impulsivity) and experienced cravings are the core measures and focus of this thesis. Hypothesis 1 first explores the links between the core measures and experienced self-stigma and real-life behaviours (H1a and H1b). This allows for the exploration of the links between three different types of measures; revealed preferences, stated experiences and distributed choices or patterns of use. The second half of hypothesis 1 explores the associations between the core measures and past consumption (H1c), purchasing behaviour (H1d), visceral events (H1e) and institutional features (H1f), in order to examine whether time preferences and experienced cravings are systematically associated with these factors. Hypothesis 2 investigates the impact of the presence of outcome-related visual cues on impatience and impulsivity, at the time and place a decision is being made, to explore whether decision-makers can be systematically influenced by changes in their decision context. The second half of hypothesis 2 explores whether the effect of visual cues is contingent on whether someone resides in a criminalised choice environment or not.

Sub-hypothesis (SH) 1a: Higher impatience and higher impulsivity increase the probability of currently being a frequent cannabis user and the probability of using every day

This analysis under this sub-hypothesis explores the links between impatience and impulsivity and the real-life behaviours: being a frequent cannabis user and frequency of use, separately. This section scrutinises the links between the (global) decision to use cannabis frequently and impatience and impulsivity for three different outcome types (cash, chocolate and cannabis), which constitute local decision. This sub-hypothesis is in line with the findings from past studies, which have found evidence that frequent substance users to be both more impatient and impulsive than non-substance users.

SH1b: Higher time discounting is associated with higher levels of self-reported cravings and self-stigma

Subjective craving strength and self-stigma are experienced costs or disutility associated with using cannabis frequently. It is expected that cravings are associated with an increase in the frequency and magnitude of past consumption. As a result, I predict that increases in experienced cravings over a period of time is associated with higher levels of impatience and impulsivity. Self-stigma refers to the negative thoughts and associations one feels as a result of identifying with a social group or behaviour

that is recognised as socially undesirable or intolerable. It can be felt as embarrassment or shame for not meeting societal expectations. This subjective experience of feeling self-stigmatised has been linked to self-control by Elster (1989) who suggests social stigma increases the level of self-control of individuals and therefore potentially decreasing the levels of impatience and impulsivity, and thus is associated with lower time discounting.

SH1c: Higher past consumption is associated with higher discounting of delayed costs

This sub-hypothesis explores the links between past consumption, revealed preferences and experienced cravings. In line with the theory of melioration, it predicts that higher past consumption is linked with higher discounting of delayed outcomes.

SH1d: Purchasing habits are associated with time preferences

Purchasing habits are closely linked to choice architecture and for this reason are expected to be linked to the core measures. Limited research has been completed on the topic and it is not clear how they could be linked; therefore, the sub-hypothesis does not predict a direction.

SH1e: Events associated with an increase in visceral factors (running out of cannabis and being under the influence of cannabis) are associated with increased discounting of delayed outcomes

Loewenstein (1996) predicts that visceral influences, including craving for drugs, direct the attention of individuals towards mitigating these experienced urges. Thus, it is predicted that running out of cannabis will increase impatience and impulsivity temporarily. Being under the influence of cannabis is perceived as having taken the decision to choose immediate gratification over delayed benefits and for this reason it seems reasonable to predict that being under the influence will be associated with increased impatience and impulsivity, leading to overall higher discounting of delayed outcomes.

SH1f: Living in a criminalised choice environment compared to living in a practically decriminalised choice environment is associated with higher time discounting by frequent cannabis users, moderated by institutional differences in price structure, accessibility and other unidentified differences across countries.

The increased difficulty and risk associated with procuring cannabis in criminalised societies is expected to increase impatience and impulsivity for users, as it can be expected to strengthen the drive or 'want' for cannabis, without necessarily impacting the experience of being high. Some of the

key differences faced are accessibility, discounts, regulation and social norms and thus the differences are expected to be moderated by these factors. Regulations and social norms cannot be decoupled from the country itself.

SH2a: The presence of visual cues on choice lists increases the impatience and impulsivity of decision makers, compared to the same choice lists without the visual cues.

Visual cues are expected to trigger the desire or 'want' for a substance if a user has been sensitised to it, as it is expected to be the case for frequent cannabis users. Thus, the presence of visual cues is expected to increase impatience and impulsivity. The causal effect visual cues on impatience and impulsivity will be explored separately.

SH2b: Visual cues increase impatience and impulsivity for rewards more in users residing in criminalised societies than in users residing in non-criminalised societies.

Ainslie (2001) predicts that the same cues can have different associations and thus impact on different individuals. This sub-hypothesis predicts that the effect of the cues will be greater for users who are criminalised as the cues are likely to be less common in their societies.

7. Method

7.1 Data collection

The analysis is based on data collected through an online survey. The survey was hosted on Qualtrics and distributed on the website Reddit. An image of the post can be found in the Appendix (item 4). Reddit is a collection of themed forums (subreddits), where individuals can post and comment on content, which allows for targeted recruiting of participants, as researchers can target only the most relevant subreddits to their study, from over 100,000 active subreddits. Reddit was particularly suited to this thesis as frequent cannabis users are known to be active on the site and thus the data was collected within a natural setting for the participants. Additionally, Reddit facilitated the targeting of Australian and Dutch residents. No financial compensation was offered to participants for completing the survey. This makes it less likely that individuals provided low-quality answers, as there were no penalties for participants who do not finish the survey or incentive to complete the survey for individuals not within the target group (Shatz, 2017). The participants were asked to not discuss their answers in the comments section in order to avoid contamination between participants

and the comments under the posts were monitored to ensure it did not take place. The possibility that some of the participants provided low-quality answers is still present and to mitigate the risks, data that appears to be of low quality (e.g. multiple switch points in a choice list) was excluded. The observations excluded are listed in Appendix Table 3.

The survey was posted on 11 different Reddit forums (i.e. subreddits), a copy of the post can be found in Appendix 1. The subreddits where the survey was posted include both cannabis related communities and non-cannabis related communities. A variable 'weedsub' was used throughout the analysis to ensure any systematic differences between the users from both types of subreddits are controlled for. The first round of data collection did not capture enough data from participants residing in the Netherlands, this is mainly due to not being given permission to post on the main Dutch subreddit (r/TheNetherlands). As a result, two more rounds of data collected were undertaken to target Dutch residents on smaller subreddits linked to the Netherlands. The number of participants recruited from each post varied greatly, as the subreddits vary in size and the visibility of the post depends on whether participants vote for the post. The same of the subreddits and the number of participants recruited are listed in Appendix Table 2.

7.2 Participants

Current frequent users are the focal point of this study as they face significant health risks as a result of their use, and it is reasonable to assume that they are highly affected by the choice architecture for cannabis. Frequent users are defined as users who consume cannabis at least 3 days a week for most of the year. While frequency of use is categorised within the following three categories: 3-4 days, 5-6 days and every day, to allow for differentiation in frequency of use among the current users. Former users are included in the study to use as a comparison group to current users. Numerous studies (Bickel, 1999, Kirby & Petry, 2004) employed this approach to evaluate the links between drug use and time preferences and found that current users discount future outcomes at a higher rate than former users. This approach controls for the possibility that time preferences of all cannabis users are innate to the individual (e.g. personality traits or genes) (Johnson et al., 2010). However, Bickel (1999) found evidence that ex-smokers and never-smokers did not differ in their time preferences.

A total of 1732 individuals were sampled, of them, 1436 (83%) current frequent users and 296 (17%) former frequent users. The large number of current users can be explained by the number of participants (1283, 74%) recruited on r/trees, a subreddit centered around cannabis, which attracts

primarily current frequent users. The observations include 207 (12%) Australian residents and 212 (12%) Dutch residents, which will be used to investigate the differences between Australian and Dutch residing users. The entire sample will be used to explore the links between the core measures and different features of choice environment more broadly. The sample contains 1390 (80%) male and 342 (20%) female observations. These figures are in line with the EMCDA's findings that 78% of daily or nearly daily users in Europe are male, as well as 84% of individuals seeking treatment (EMCDA, 2013). A summary of all the questions and answers to the survey are available in Appendix Table 1 and demographic information can be found in section 1.1 of the table.

7.3. Attrition

A total of 508 surveys were started by participants but not completed. It is possible that individuals who did not finish the survey are on average systematically different to the participants who completed the survey. For instance, the participants who failed to complete the survey could be more impatient or more intoxicated by cannabis. However, this is not a significant concern as the analysis focuses on comparison between different measures and groups and not the absolute values measured, as long as each of the groups being compared was affected in the same way. It is plausible that individuals who are most impatience and impulsive are underestimated in the sample of completed surveys and if this is the case it can be expected that the estimated differences in impatience and impulsivity between groups are underestimated. Additionally, the estimated differences between individuals who are under the influence of cannabis and individuals who are not under the influence of cannabis could be underestimated as individuals who are most affected by cannabis are less likely to complete the survey, as cannabis is known to inhibit one's ability to concentrate.

7.4. Survey

Participants either completed a survey for current users or a slightly adjusted survey adapted for former users, according to how they self-identified (i.e. current or former user). The introduction to the survey is illustrated as Appendix Item 2. The differences are described in Appendix Table 1. The survey took approximately 10 minutes to complete and participants were not able to go back once they had submitted an answer. It was a priority to make the survey as simple and short as possible, to maximise the completion rate and quality of answers participants (Shatz, 2016). This is especially important as participants are being recruited online via forums. The survey included a short introduction, two multiple price lists each made up of 11 choice scenarios (MPL) for former users

(cash and chocolate) or three MPLs for current users (cash, chocolate and cannabis) and questions organised within the following themes: history of use, consumption habits, purchasing habits, craving strength and controls. The choice scenarios in the survey were hypothetical and by definition, none of the rewards mentioned in the scenarios were paid out to participants. Providing real incentives was not feasible for a number of reasons. Firstly, it would require that individuals provide contact details, which could act as a deterrent to completing a survey asking highly personal questions. Secondly, even if some of the choice scenarios were paid out, it is unsure the participants recruited on Reddit would trust this to be the case, especially for delayed payments. Finally, cannabis is one of the discounted outcomes and it would not have been possible to send out cannabis to participants. Hypothetical choice scenarios cause concerns around whether participants are motivated enough and able to accurately predict their real-life preferences (Frederick, Loewenstein & O'Donoghue, 2002). Research on the effect of using hypothetical choices compared to incentive compatible choices have found that the discount rate tends to be lower with hypothetical choices (Kirby & Marakovic, 1995). However, other studies have not found these predictions to hold after controlling for additional factors (Coller & Williams, 1999). This is not a material concern, as long as the difference in elicited time preferences between hypothetical choice scenarios and incentive compatible choice scenarios is the same for all groups being compared, as the aim of this thesis is to investigate associations between time preferences and a range of factors and not to estimate the 'true' or absolute value of time preferences. It is plausible that individuals under the influence of cannabis or individuals running out of cannabis would be affected differently to the rest of the participants by hypothetical scenarios. However, it is not clear how these groups would be affected, and this concern should be considered while interpreting the results. All the survey questions are presented in Appendix Table 1.

8. Measures

8.1. Impatience and impulsivity

The quasi-hyperbolic discounting function estimates a time-consistent discount factor (δ) which represents the rate of constant impatience, hereinafter referred to as impatience, and a time-inconsistent discount factor (β) which represents relative preference for current consumption over delayed consumption, hereinafter referred to as impulsivity. Only β is suggestive of potential preference reversals, while δ represents rational or stable impatience.

The value of δ and β elicited is sensitive to the method used. The following features of MLPs; presentation, time delays, type of rewards and value of rewards have been found to influence the value of the discount factors (Frederick, Loewenstein & O'Donoghue, 2002). The features adopted for this study were chosen to resemble the (local) decision to use cannabis in a single instance, as closely as possible.

8.1.1 Elicitation method

The field of behavioural economics commonly elicits time discount factors using multiple price lists (MPLs). They are easiest to explain and the least time-consuming elicitation method to implement through an online survey (Andersen et al., 2008). The MPLs are made up of two blocks, each consisting of 11 choice scenarios. Each choice scenario represents a choice between receiving a smaller reward earlier or a larger reward at a later date. The only difference between the first and second block is the time period over which the reward is being discounted, which shifts from today vs 1-months' time to 1-month vs 2 months' time.

MPLs have been found to report upwardly biased discount factors compared to other elicitation methods including 'convex time budget' (CTB) (Andreoni, J., & Sprenger, C., 2012a). This is the result of assuming a linear utility function (i.e. $U(x)=x$), when it is typically found that individuals have concave utility functions, as the time and risk preference are intertwined in the time discount factor. Andersen et al. (2008) developed an approach to elicit both risk and time preferences using MPLs, according to Laibson's (1997) approach. However, Bradford et al. (2017) who elicited both the time and risk preferences using a quasi-hyperbolic discounting function, found evidence that risk aversion is not significant for small outcomes (approx. $30) and concluded that a linear utility assumption is not to be problematic over small outcomes. Risk preferences were not elicited (i.e. the utility function was assumed to be linear) in order to keep the survey as simple as possible and as it appears to be a less problematic assumption for smaller outcomes, which are the focus of this thesis.

8.1.2 Framing

Visual cues are commonly featured on websites and in shops where individuals buy cannabis and the presence of visual cues can be regulated by choice architects. A treatment was introduced to explore the causal effect of a small change in framing on time preferences, and specifically the addition of a visual cue related to the outcomes being discounted. This is done by introducing a small image of the reward being discounted (i.e. cash, chocolate and cannabis) under the written instructions of MPLs used to elicit time preferences. The control group was identical to the treatment but did not include

the small image of the reward. Subjects were randomly assigned to the treatment and control groups. Refer to Appendix Item 1 to see the introduction to the choice lists and the examples of both the treatment (including picture) and control (excluding pictures) MPLs.

8.1.3 Time Delays

Andersen et al. (2008) state that delaying reward by at least 1 month, removes 'immediate temptation', which ensures the delayed outcome is incorporated entirely with future consumption. A number of studies elicit time preferences using MPLs with 3 blocks of time: today vs in 1 month, today vs in 6 months, and in 6 months vs in 7 months (Andersen et al., 2008, Ida 2014, Bradford et al., 2017). However, using 3 blocks to elicit the parameters of each reward type would increase the number of blocks to be completed from six to nine for each current frequent cannabis users completing the survey. To minimise the length and effort required to complete this study only uses the minimum number of blocks per reward type (i.e. 2). This is done by only keeping the delay period of 1 month (i.e. today vs. in 1 month and in 1 month vs. in 2 months).

8.1.4 Reward type

There is strong evidence that time preferences vary across reward type (Chapman & Elstein, 1995), this was found to be the case with for cigarette smokers who discounted cigarettes more heavily than cash (Bickel, Odum & Madden, 1999). A different MPL was used to elicit both δ and β for each of the three reward types (cash, chocolate and cannabis[3]). This allowed for the comparison of time preferences across different rewards, where two of the outcomes can be consumed directly (i.e. chocolate and cannabis) and one is not directly linked to consumption (i.e. money).

8.1.5 Size of reward

The magnitude effect predicts that the size of the reward will impact the discount rate, expecting that individuals discount smaller rewards more heavily (Frederick, Loewenstein and O'Donoghue, 2002). This analysis is interested in the daily and recurrent decision to purchase cannabis and this decision typically involves small stakes as smoking cannabis on any one day is relatively cheap. One gram of cannabis is a standard amount commonly available across countries. The medium price reported for 1 gram of cannabis in the survey is 10 euros in the Netherlands, 10 Canadian dollars in Canada, 10 American dollars in the USA and 20 Australian dollars in Australia. These prices match the value of the outcomes discounted on all choice lists completed by the participants from Australia, the

[3] Only for current frequent users.

Netherlands, Canada and the USA. This allows the measures for impatience and impulsivity to be compared across all reward types.

8.1.6 Measuring impatience and impulsivity

Each block allows for 12 different outcomes if the blocks are completed as expected. Participants can either indicate that they would rather consume all the rewards at the sooner time, switch between sooner and later at one of the 10 switch points or delay all consumption. MPLs where at least one block included answers with multiple switch points, or a violation of the preference monotonicity were excluded from the analysis. Only a small number of MPLs were excluded, which indicates that the vast majority of individuals interpreted the question correctly. The number of observations for each of the 12 possible answers along with the discount factors associated with each block ($\beta\delta$ for block 1 and δ for block 2, explained respectively in equations 4 and 5) and the observations excluded are tallied in Appendix Table 3. Please note that these discount factors are not equivalent to the δ and β in the quasi-hyperbolic model.

$$(4) \qquad x_{t=0} = \beta\delta(x_{t=1}) \rightarrow \beta\delta = \frac{x_{t=0}}{x_{t=1}}$$

$$(5) \qquad \beta\delta x_{t=1} = \beta\delta^2(x_{t=2}) \rightarrow \delta = \frac{x_{t=2}}{x_{t=1}}$$

The individual values of δ and β were obtained by dividing equation 4 by equation 5, and their sample distributions are illustrated in Appendix Table 4. The empirical values of δ and β are not the focus of the study, nonetheless, comparing the parameters elicited to the parameters of other studies is worthwhile. The estimated magnitudes for δ for all three rewards are in line with other research and as expected appear slightly lower than δ elicited for larger rewards (Bradford, 2017). The estimated average values for the time-inconsistent discount parameters (β) are slightly higher than 1, indicating that the average participant in the sample is mildly future biased ($\beta > 1$) when discounting outcomes of very small value. Future bias is commonly found in empirical studies using MLPs, but they are typically less prevalent (Meier & Sprenger, 2010). This difference could be due to the reward value being even lower than the values in the studies using 'small rewards' or the effect of completing MPLs while under the influence of cannabis, as was the case for approximately 800 of the participants. The estimated β are highly heterogeneous and range from above 0.7 to below 0.13 from the 5th to the 95th percentile across all reward types.

8.2 Experienced cravings score

This score captures the intensity of cannabis user's cravings or desire for cannabis. Current users were asked about their experiences over the previous three months, while former users were asked to reflect on the three months before they last stopped using cannabis frequently. The questions used to measure cravings come from the Drug and Alcohol Problem (DAP) screen developed by Schwartz and Wirtz (1990), which were designed to measure the risk and intensity of an individual's substance use. The DAP screen questions are used within the Global Drug Survey's Drug Meter application designed to assess whether a drug user's use is problematic. The DAP screen contains 30 questions, only eight questions were included in the survey, in order to minimise the time of completion. The questions which related the most to experienced cravings and desire for a substance were selected. This was determined by whether questions focused on aspects of cannabis consumption associated with difficulties in cutting down or stopping as identified by the Global Drug Survey (Global Drug Survey, 2019). Each answer can score a maximum of four, where zero indicates no or minimal cravings and four intense cravings. The scores from the 8 questions were added up to create a total score, with a maximum score of 28. A summary of the distribution of the scores is available Appendix Table 4 and a summary of the answers given to each question are listed in Appendix Table 1.

8.3 Dependent variables and controls

8.3.1 Self-Stigma

Two different types of stigma have been identified; public stigma refers to the systematic devaluation of certain characteristics (e.g. skin colour, mental health) by others towards individuals perceived to embody these characteristics (e.g. addiction, overweight). While self-stigma is the other type, and describes the internalisation of public stigma, where individuals perceive their own characteristic(s) as socially undesirable, typically accompanied by a sense of shame and embarrassment (Latalova, Kamaradova & Prasko, 2014). The survey includes three questions aimed at measuring self-stigma, the questions are adapted from the *Substance Abuse Self-Stigma Scale (SASSS) and* enquire about the participant's level of disclosure and their perceived embarrassment towards their level of use (Luoma et al., 2013). Each question is scored out of 5 and therefore the highest self-stigma score possible is 15.

8.3.2 Consumption history and habits

The consumption habits section of the survey included questions on the amount used, the method, whether one mixes cannabis with tobacco, the history of use and whether an individual restricts their use.

8.3.3 Purchasing habits

This section captured participant's purchasing habits. This includes how often users purchase cannabis, how much they typically purchase at once, where they purchase and the types of negative experiences, they have had in the time they have been cannabis users.

8.3.4 Visceral events

In order to investigate the influence of visceral factors, it is necessary to identify events which are expected to be linked with changes in visceral factors. Burghart, Glimcher & Lazzaro (2013) observed that being under the influence of alcohol affects risk preferences, as they found that intoxicated individuals to be less risk averse than sober individuals. This study focused on the effects of being under the influence of cannabis on time preferences. Two questions were used to identify individuals who had used cannabis in the recent past (less than 8 hours) and captured the amount of time elapsed since last use. The second event captured was 'running out of cannabis', as this experience is expected to trigger the pursuit for cannabis. This pursuit is associated with an increase in the experienced intensity of craving strength and attention given to cannabis. The survey captures whether participants have enough cannabis for the next 24 hours and if not, whether they have enough for their next use. The answer to this question will indicate whether participants are running out or not and explore whether running out is associated with changes in levels of impatience and impulsivity.

8.3.5 Institutional features

A number of institutional features linked with the impact of criminalisation are included in the analysis to explore their associations with the core measures. This section focused on the 'buyer experience'. The survey included a question were participants were asked to provide the prices they typically face for different specific amounts[4] when purchasing cannabis. This question was not mandatory as participants are unlikely to know the standard price of cannabis at all these prices points, and some participants do not purchase cannabis regularly or at all. This information was used

[4] The amount surveyed were: 0.5-gram, 1 gram, 2 grams, 3.5 grams, 5 grams, 7 grams, 14 grams and 28 grams

to estimate the average reduction in price per gram associated with an increase in quantity purchased from 1 gram to 28 grams. The discount was calculated by regressing the price per gram on quantity for all participants who provided a minimum of three price points. As a result, his variable is available for 975 current users out of 1436 current users and the discounts computed are only a rough estimation of the discount faced by individuals. Another feature assesses is accessibility, which was measured by asking participants how long it takes them on average to procure cannabis. Finally, the survey included questions to identify where participants reside and whether they reside in criminalised or practically decriminalised choice environments.

8.3.6 Controls

Finally, the survey included questions on demographics, which have previously been found to impact individual's time preferences: age, income, gender and employment status, in order to control for these differences. Age was not asked directly but in categories, to alleviate concerns over identifiability of participants due to the sensitive nature of the survey. A number of additional controls relevant to this study were also included: time spent residing in current country, how stressful life is currently and how much one likes chocolate. The time spent in current location is important as an environment could affect individuals who have spent less time within it differently to individuals who have lived there for longer. Severe life disruptions are generally associated with the frequent use of certain substances (e.g. heroin) (Bickel, Odum, & Madden, 1999). However, it is not clear whether this is relevant of cannabis use. To control for this, a question on participant's perceived current level of stress in their lives was included. Participants were asked whether they like chocolate to control for stated preferences in the elicitation of chocolate discount parameters.

The questions and a summary of the answers are included in Appendix Table 1. A list and description of the variables included in the analysis is included as Appendix Table 5.

9. Empirical model

The first part of the analysis (SH 1a & 1b) focuses on establishing the links between the impatience (δ) and impulsivity (β) and the following variables of interest: probability of being a current user, frequency of use, intensity of experienced cravings and self-stigma. The model used for this part of the analysis takes the regression form described by equation (6):

$$y_i = \gamma_0 + \gamma_1 \delta_i + \gamma_2 \beta_i + \gamma_3 Z_i + \gamma_4 X_i + \epsilon_i \qquad (6)$$

where i identifies each observation, y represents the dependent variable of interest, γ_0 the constant term, γ_1 the coefficient for impatience, γ_2 the coefficient for impulsivity, γ_3 the coefficient for whether a participant received the treatment, γ_4 a vector of coefficients for the standard set of controls (X) and ϵ_i the error term. The standard set of control variables is included in each of the models within the thesis. The set includes the following dummy variables: male, student, employed, observations obtained on cannabis related subreddits, residing in current country for less than 1 year, residing in current country for over 3 years, Australian resident, Dutch resident, Canadian resident and European resident excluding the Netherlands. Additionally, age was included as a continuous variable and income as a categorical variable.

The second part of the analysis, which included sub-hypothesis 1c to 2a, focused on the associations between the main measures (i.e. δ_cash, β_cash, δ_cannabis, β_ cannabis and craving scores) and the independent variables of interests: consumption habits (Z_1), purchasing habits (Z_2), visceral events (Z_3), institutional features (Z_4) and treatment dummy (Z_5). A model is set up for each of the core measures, with all of the independent variables of interest included in each of the five models, as described in equations 7, 8, 9, 10 & 11. All the independent variables were included together as the analysis aims to establish which of the variables are most strongly associated with the measures of interests.

$$\delta\_cash_i = \alpha_0 + \alpha_1 Z_{1,i} + \alpha_2 Z_{2,i} + \alpha_3 Z_{3,i} + \alpha_4 Z_{4,i} + \alpha_5 Z_{5,i} + \alpha_6 X_i + \varepsilon_i \quad (7)$$

$$\beta\_cash_i = \alpha_0 + \alpha_1 Z_{1,i} + \alpha_2 Z_{2,i} + \alpha_3 Z_{3,i} + \alpha_4 Z_{4,i} + \alpha_5 Z_{5,i} + \alpha_6 X_i + \varepsilon_i \quad (8)$$

$$\delta\_cannabis_i = \alpha_0 + \alpha_1 Z_{1,i} + \alpha_2 Z_{2,i} + \alpha_3 Z_{3,i} + \alpha_4 Z_{4,i} + \alpha_5 Z_{5,i} + \alpha_6 X_i + \varepsilon_i \quad (9)$$

$$\beta\_cannabis_i = \alpha_0 + \alpha_1 Z_{1,i} + \alpha_2 Z_{2,i} + \alpha_3 Z_{3,i} + \alpha_4 Z_{4,i} + \alpha_5 Z_{5,i} + \alpha_6 X_i + \varepsilon_i \quad (10)$$

$$Cravings_i = \alpha_0 + \alpha_1 Z_{1,i} + \alpha_2 Z_{2,i} + \alpha_3 Z_{3,i} + \alpha_4 Z_{4,i} + \alpha_5 Z_{5,i} + \alpha_6 X_i + \varepsilon_i \quad (11)$$

where $\alpha_1, \alpha_2, \alpha_3, \alpha_4, , \alpha_5$ and α_6 represents the coefficients for each of the independent variable categories and the standard controls. The lincom command in Stata was used to estimate the difference in the measured dependent variables between two independent variables (e.g. Australia and the Netherlands) and test for statistical significance (command: lincom Australia – Netherlands).

A final model was used to test hypothesis 2b, the model is an adaptation of the models described in equations 7, 8, 9, 10 & 11. The dummy variable for treatment was replaced by the following four

dummy variables: received treatment and residing in a criminalised environment, received control and residing in a criminalised environment, received treatment and residing in a practically decriminalised environment and received control and residing in a practically decriminalised environment, in order to test whether the effect of the treatment systematically differed across criminalised and practically decriminalised participants using a difference in differences approach. This approach investigates the difference between the elicited dependent variables of the participants who received the treatment and the individuals who received the control. All factors, apart from the treatment, were kept identical, which ensures that the only difference between the treatment group and control group stems from this manipulation. The lincom command in Stata was used to calculate the difference between the treatment group and control group and determine whether the estimated difference is statistically significant (command: Lincom (Pic*Crim - NoPic*Crim) - (Pic*Decrim - NoPic*Decrim)).

δ and β were standardised with a mean of zero and a standard deviation of 1 for each outcome type, in order to simplify the interpretation of the coefficients across different models and outcome types. As a result, a one unit increase in the standardised discount factors can be interpreted as a one-standard deviation increase in discount factors. The independent variables are a mix of binary, ordinal and count variables. The binary variables are estimated with probit models, the ordinal variables with ordered probit models and the count variables with standard ordinary least square regression models. The core analysis uses parametric tests as the empirical strategy relies heavily on the inclusion of a large number of dependent variables and control variables. The robustness checks include the fisher exact test a non-parametric test to verify that the main findings can be replicated using non-parametric tests.

10. Results

10.1 Main results

SH1a: Higher impatience and higher impulsivity increase the probability of currently being a frequent cannabis user and the probability of using every day

Table 1: Variable description Sub-Hypothesis 1a

Variable name	Description	Category
Current vs Former	Binary variable which classifies participants as either current frequent cannabis users or former frequent cannabis users. Frequent cannabis use is defined as using cannabis at least 3 times a week for most of the year	Real life drug behaviour
Freq of use	Ordered categorical variable which classifies frequency of use within the following three categories: 3-4 days, 5-6 days and every day.	Real life drug behaviour
δ_cash	Standardised time-consistent discount factors for cash	δ parameter
β_cash	Standardised time-inconsistent discount factors for cash	β parameter
δ_cannabis	Standardised time consistent discount factors for cannabis	δ parameter
β_cannabis	Standardised time-inconsistent discount factors for cannabis	β parameter
δ_chococolate	Standardised time-consistent discount factors for chocolate	δ parameter
β_chocolate	Standardised time-inconsistent discount factors for chocolate	β parameter

Table 1 contains the variable description and Table 2 the summary statistics of the variables introduced in sub-hypothesis 1.

Table 2: Summary statistics for Sub-hypothesis 1a

	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
δ_cash	0.744 [0.169]	0.5	0.513	0.607	0.69	0.955	0.955	0.955
β_cash	1.047 [0.2]	0.723	0.801	1	1	1.096	1.298	1.381
δ_chocolate	0.728 [0.196]	0.5	0.5	0.5	0.69	0.955	1	1
β_chocolate	1.017 [0.231]	0.624	0.774	1	1	1	1.241	1.382
δ_cannabis	0.718 [0.176]	0.5	0.5	0.541	0.69	0.955	0.955	0.955
β_cannabis	1.007 [0.179]	0.723	0.777	1	1	1.054	1.194	1.297

Table 3 and Table 4 illustrate the marginal effects for the first dependent variable: being a current frequent user compared to being a former frequent user, including only the δ and β for cash and chocolate, as the δ and β for cannabis were only elicited for current frequent cannabis users. Table 5 displays the coefficient for the second dependent variable: frequency of use and only presents the δ and β parameters for cash and cannabis.

Table 3: Hypothesis 1a - Current vs Former frequent users - Cash

	(1) All	(2) Aus_NL	(3) Aus	(4) NL
δ_cash	-0.088*	-0.203**	-0.223*	-0.169
	[0.045]	[0.087]	[0.123]	[0.132]
β_cash	-0.068	-0.040	-0.087	0.082
	[0.045]	[0.095]	[0.128]	[0.156]
N	1720	417	205	211

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.*

Table 3 presents the associations between the measures for impatience and impulsivity over small amounts of cash and being a frequent cannabis user currently compared to being a former frequent cannabis user. The δ_{cash} is weakly significantly negatively associated with being a current user in the full, Aus and NL and Australian samples. The coefficient in the NL sample is also negative and approaching significance with a p-value of 0.200. The strongest association is found within the Australian sample, where a one standard deviation increases in δ_{cash} is associated with approximately a 20% decrease in the likelihood of being a current user. While, the average marginal effect observed in the full sample is approximately half of the effect observed in the Australian sample. This provides evidence that increased impatience is predictive of an individual's real-life drug behaviour and specifically that steeper discounting of delayed outcomes is positively associated with being a current frequent cannabis user. However, the magnitude of the association appears to vary across different societies. The marginal effect for β_{cash} is also negative for the first three models but insignificant, while the marginal effect in the full sample approaches significant ($p>|z| = 0.123$), which suggests that β_{cash} is somewhat associated with being a current user. However, it is clear that impatience towards cash is more strongly associated with being a current user than the impulsivity towards cash.

Table 4: Hypothesis 1a - Current vs Former frequent users - Chocolate				
	(5)	(6)	(7)	(8)
	All	Aus_NL	Aus	NL
δ_choc	0.000	0.035	0.072	0.038
	[0.041]	[0.073]	[0.102]	[0.112]
β_choc	-0.012	0.052	0.141	0.005
	[0.041]	[0.076	[0.118]	[0.106]
N	1685	407	201	205

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 4 presents the same results as Table 3 but looking at the associations between the parameters for chocolate and being a current cannabis user. In this case, neither δ nor β appear associated with being a current user. This highlights that impatience and impulsivity for the same group of individuals will vary across different outcome types.

Table 5: Hypothesis 1a - Frequency of use - Cash and cannabis								
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	All For	All Cur	All Cur	All Cur	Aus_NL For	Aus_NL Cur	Aus_NL Cur	Aus_NL Cur
δ_cash	-0.018	-0.166***		-0.087*	0.016	-0.074		0.091
	[0.090]	[0.038]		[0.049]	[0.158]	[0.087]		[0.115]
β_cash	-0.193**	-0.114***		-0.060	-0.066	-0.179*		-0.085
	[0.093]	[0.038]		[0.041]	[0.168]	[0.095]		[0.103]
δ_cannabis			-0.162***	-0.118**			-0.159**	-0.239**
			[0.036]	[0.047]			[0.080]	[0.108]
β_cannabis			-0.145***	-0.121***			-0.201**	-0.191**
			[0.035]	[0.038]			[0.086]	[0.091]
N	294	1426	1423	1415	124	293	293	291

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 5 explores the relationship between frequency of use and impatience and impulsivity toward cash and cannabis. The full and Aus_NL samples are both divided into former (9 & 13) and current sub-samples (10, 11, 12, 14, 15 & 16). The dependent variable *Freq of Use* is categorical and as a result an ordered probit model was used. In order to reduce and simplify the figures displayed, the coefficients of δ and β and not the marginal effects are presented and thus the magnitude of the effects

cannot be interpreted meaningfully. The results in column (9) indicate that within the full sample more impulsive (towards cash) former users used more often while they used frequently. While frequency of use for former users does not appear related to impatience (towards cash). In the case of current users, both δ_{cash} and β_{cash} are significantly negatively associated with increased frequency of use, as seen in column (10). The results imply that β_{cash} is better able to predict the frequency of use of a former user than that of a current user. This suggests that the trait of impulsivity with regards to cash is innate to the individual, as former users who used more frequently appear at least as impulsive towards cash after ceasing their use. While being impatient, as measured by δ_{cash}, is only linked to using currently and therefore appears more circumstantial. The results from the Aus_NL sample are less pronounced and the coefficient for β_{cash} is negative but insignificant in the former sample (13) and only weakly significant in the current sample (14). However, the direction of the effects is in line with the results of the full sample and both samples illustrate similar trends. Interestingly, it appears δ_{cash} accounts best for being a current user, while β_{cash} is more predictive of frequency of use. This suggests that within the sample of current users there are systematic differences in the impulsivity of individuals, which appear to be linked to how often they use.

The magnitude and significance of the coefficients for δ_{cash} and β_{cash} reduces when $\delta_{cannabis}$ and $\beta_{cannabis}$ are introduced. Only δ_{cash} in column (12) remains weakly significant. The results in columns (11 & 12) and (15 & 16) suggest that both the parameters for cannabis account well for frequency of cannabis use. The coefficient for $\delta_{cannabis}$ and $\beta_{cannabis}$ stay substantial and statistically significant when included with δ_{cash} and β_{cash} in the model. The results imply that individuals who use cannabis most frequently (i.e. 5-6 days a week or daily) are both more impatient and more impulsive when faced with choices over cannabis than individuals who only use 3-4 days a week. Additionally, the results reveal that impatience and impulsivity towards cash are predictive of frequency of use but the parameters for cannabis are more informative and relevant to the decision to use cannabis. Considering the results in Table 3 & 5, it appears that becoming a current user is linked with being more impatience than former users, this indicated that engaging in frequent cannabis use is more contextual or 'learnt', as it is not fixed. In contrast, deciding how often to use appears to be highly linked with impulsivity towards cash for both former and current users and thus appears less contextual and more innate to the individual.

The overall results are in line the sub-hypothesis H1a, which predicts that current users are more impatient and impulsive than former users. However, the evidence that current users are more

impulsive than former users is weak and inconclusive. Former users who used more frequently appear more impulsive but not more impatient than former users who used less frequently. While, current users who use more frequently appear both more impatience and more impulsive than current users who use less frequently.

SH1b: Higher time discounting is associated with higher levels of self-reported cravings and self-stigma

Table 6 - Variable description Sub-Hypothesis 1b

Variable name	Description	Category
Subjective Cravings	Craving scores out of a possible 28 points	Subjective experience
Subjective Self-Stigma	Self-stigma scores out of a possible 15 points	Subjective experience

Table 6 presents the variable description and Table 7 the summary statistics for the variables introduced in sub-hypothesis 1b.

Table 7: Summary statistics for Sub-hypothesis 1b

	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
Craving strength scale	7.435 [4.94]	1	2	4	7	10	15	17
Self-stigma	4.257 [2.888]	0	1	2	4	6	8	9

Table 8 explores the links between experienced cravings, which can also be thought of as desire for cannabis and impatience and impulsivity for cash and cannabis. In line with the sub-hypothesis, all the coefficients for the parameters for current users, apart from the coefficient for δ_{cash} in column (8), are negatively correlated with cravings. However, before the introduction of $\delta_{cannabis}$ and $\beta_{cannabis}$ this coefficient was weakly significantly associated with cravings. These results suggest that experienced cravings are strongly associated higher discounting of delayed outcomes. Interestingly, the link between impulsivity towards cash and cravings appears to hold within both the former and current user samples. A possible explanation is that individuals who are more impulsive with cash are more prone to experiencing cravings and desire cannabis more when they are using.

Table 8: Hypothesis 1b - Subjective Cravings - Cash and cannabis

	(1) All For	(2) All Cur	(3) All Cur	(4) All Cur	(5) Aus_NL For	(6) Aus_NL Cur	(7) Aus_NL Cur	(8) Aus_NL Cur
δ_cash	-0.486	-0.594***		-0.024	0.594	-0.630		0.489
	[0.381]	[0.145]		[0.191]	[0.675]	[0.398]		[0.527]
β_cash	-1.296***	-0.472***		-0.273	-1.299	-1.349***		-1.091**
	[0.390]	[0.140]		[0.149]	[0.856]	[0.400]		[0.453]
δ_cannabis			-0.837***	-0.854***			-0.998*	-1.450***
			[0.135]	[0.184]			[0.371]	[0.513]
β_cannabis			-0.482***	-0.397***			-0.480	-0.216
			[0.134]	[0.145]			[0.387]	[0.416]
N	294	1426	1423	1415	124	293	293	291

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Whereas δ_{cash}, the parameter which is most highly associated with the probability of being a current user, appears to be the least associated with cravings. Impatience towards cannabis accounts for craving intensity more convincingly than impulsivity towards cannabis. The experience of cravings appears to motivate the decision to use cannabis without the need for impulsivity. $\delta_{cannabis}$ is linked both with craving intensity and frequency of use. The commonality is not surprising, as one would expect that the frequency of use and subjective cravings are linked, where both the real-life behaviour and the subjective experience feed into each other. This is both true for former and current users, as former users who used more frequently are more likely to have experienced stronger subjective cravings. There are two main differences between the full and Aus_NL samples: the magnitude of the coefficients for β_{cash} and $\delta_{cannabis}$, which are larger within the Aus_NL sample, suggesting a stronger association between cravings and discounting, and the coefficient for $\beta_{cannabis}$ which is highly significant in the full sample and insignificant in the Aus_NL sample. This indicates that the strength of these links varies across different societies. Overall, there is clear evidence to support the sub-hypothesis that subjective cravings are associated with both impatience and impulsivity in current users and the parameters which appear to best explain the variation in the experienced cravings of current users across both samples are β_{cash} and $\delta_{cannabis}$.

Table 9: Hypothesis 1b - Subjective Self-Stigma - Cash and cannabis

	(9) All For	(10) All Cur	(11) All Cur	(12) All Cur	(13) Aus_NL For	(14) Aus_NL Cur	(15) Aus_NL Cur	(16) Aus_NL Cur
δ_cash	-0.036	0.251***		0.227*	0.195	0.223		0.663*
	[0.229]	[0.095]		[0.127]	[0.439]	[0.282]		[0.349]
β_cash	-0.149	0.057		0.022	-0.123	-0.394		-0.381
	[0.220]	[0.093]		[0.104]	[0.440]	[0.250]		[0.300]
δ_cannabis			0.203**	0.070			-0.122	-0.614**
			[0.085]	[0.118]			[0.228]	[0.290]
β_cannabis			0.145*	0.127			-0.060	0.022
			[0.087]	[0.098]			[0.240]	[0.275]
N	294	1426	1423	1415	124	293	293	291

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

The main finding from Table 9, which investigates the links between self-stigma and time preferences, is the significant positive association between δ_{cash} and self-stigma for current users, which itself is associated with the probability of being a current user. This suggests that feeling more stigmatised is associated with reduced impatience towards delayed cash outcomes. This association is not found among former users, for which time preferences do not appear associated to the self-stigma experienced during their time of use. An interesting result appears in the Aus_NL sample within column (16), where a higher level of self-stigma is associated with both a higher δ_{cash} but an equally lower $\delta_{cannabis}$. In column (15), the coefficient for $\delta_{cannabis}$ is also negative but a third of the size of the coefficient in column (16) and no statistically significant, this indicates that the results in column (16) are not necessarily reliable. This result is not observed in the full sample, where $\delta_{cannabis}$ is both substantially and statistically insignificant and only δ_{cash} appears to be associated with self-stigma. The coefficient for β_{cash} in column (16) is negative and approaching significance (P-value=0.172), which suggests that stigma is potentially negatively correlated with impulsivity towards cash. However, overall there is little evidence that β_{cash} or $\beta_{cannabis}$ and self-stigma are linked, suggesting that self-stigma and impulsivity are fairly independent. In conclusion, only δ_{cash} appears to be significantly associated with self-stigma. The results provide mixed evidence for the sub-hypothesis H1b, where stigma appears to increase δ_{cash} in both samples, which would suggest stigma has the effect predicted and potentially discourages individuals from being current user. However, the results within the Aus_NL sample show that stigma decreases the patience for cannabis,

which is highly associated with increased frequency of use and this result is not in line with sub-hypothesis H1b. Thus, it is plausible that self-stigma has opposite effects on the impatience for cash and impatience for cannabis, however this finding is only speculative.

SH1c: Higher past consumption is associated with higher discounting of delayed costs

Table 10 - Variable description Sub-Hypothesis 1c

Variable name	Description	Category
Dly_amt	Average daily amount used over the last 3 months	Consumption habits
Dly_amt*Crim	Average daily amount used over the last 3 months for users residing in criminalised choice environment	Consumption habits
Daily	Dummy variable identifying daily users	Consumption habits
Daily*Crim	Dummy variable identifying daily users residing in criminalised choice environment	Consumption habits
Tobacco	Dummy variable identifying users who mix cannabis with tobacco	Consumption habits

Table 10 illustrated the variable description and Table 11 the summary statistics for the continuous variables introduced in sub-hypothesis 1c.

Table 11: Summary statistics for Sub-hypothesis 1c

	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
Dly_amt	0.856 [0.850]	0.25	0.25	0.25	0.5	1	2	2.5
Dly_amt*Crim	0.845 [0.892]	0.35	0.25	0.25	0.5	1	2	2.5

Table 12 presents the association between the average consumption of users over the past 3 months and their time preferences. Daily amount used is not significantly associated with time preferences when we consider only individuals residing in practically decriminalised choice environments. The association between daily use and time preferences becomes significant when considering the users in criminalised choice environments, it appears that higher levels of past consumption are associated with lower discounting of cash outcomes, both in terms of impatience and impulsivity. However, the association is reversed when looking at the parameters for cannabis, where higher consumption is associated with high discounting of outcomes.

Table 12: Hypothesis 1c - Past consumption

	(1) δ_cash	(2) β_cash	(3) δ_cannabis	(4) β_cannabis	(5) Cravings
Dly_amt	-0.060	-0.042	0.065	0.060	0.475
	[0.038]	[0.045]	[0.045]	[0.058]	[0.289]
Dly_amt*Crim	0.129**	0.126*	-0.101	-0.126	0.032
	[0.057]	[0.072]	[0.062]	[0.085]	[0.404]
Daily	-0.018	0.082	-0.050	-0.131	1.669***
	[0.083]	[0.087]	[0.092]	[0.095]	[0.428]
Daily*Crim	-0.023	-0.034	0.123	0.104	0.027
	[0.100]	[0.116]	[0.108]	[0.129]	[0.573]
Tobacco	0.027	-0.020	0.063	0.013	1.164***
	[0.049]	[0.060]	[0.052]	[0.068]	[0.306]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

This predicts that users in criminalised environments are more likely to use cannabis more frequently, as both the cannabis parameters are highly associated with frequency of use. Increasing daily consumption by 1 gram is associated with an increase in cravings of approximately 0.5 points, this effect is nearly weakly significant with a p-value of 0.1. The daily amount used by participants ranges from below 0.25 grams to above 5 grams, which indicates that on average users who use large quantities are likely to experience substantially more intense cravings. The association between the reported experience of users (i.e. subjective cravings) appears to be stable across both types of environment, however the revealed preferences and thus potentially the choices made by users appear to differ with the criminalisation status. This suggests that individuals who experience the same level of cravings make different decision when faced by criminalised environment than when faced with practically decriminalised environments. These results are not simple to interpret, however a potential explanation could be that users in criminalised societies are less interested in cash and more focused on cannabis, as cash does not translate into cannabis as easily for criminalised users, who face more risk and uncertainty when procuring cannabis.

Both using daily and mixing cannabis with tobacco do not appear to be significantly associated with impatience or impulsivity once the full set of independent variables and controls are added to the model. However, both being a daily user and mixing with tobacco are highly associated with higher

intensity of cravings. The relationship between daily use and experienced cravings appears to be the same for both users in criminalised and practically decriminalised choice environments.

The results provide mixed evidence regarding the predicted associations. It appears that users in criminalised environment who consume higher levels of cannabis are both more impatience and impulsive towards cannabis. However, they are also on average less impatience and impulsive towards cash than users in the same environment who consume less. While the other consumption behaviours considered do not appear to be associated with time preferences.

SH1d: Purchasing habits are associated with time preferences

Table 13 - Variable description Sub-Hypothesis 1d

Variable name	Description	Category
AmtPur	Average amount purchased at one time over the last 3 months	Purchasing habits
AmtPur*Crim	Average amount purchased at one time over the last 3 months for users residing in criminalised choice environment	Purchasing habits
PurFreq	Categorical variable capturing the frequency of purchase	Purchasing habits
PurFreq*Crim	Categorical variable capturing the frequency of purchase for users residing in criminalised choice environment	Purchasing habits

Table 13 presents the variable description and Table 14 the summary statistics for the continuous variables introduced in sub-hypothesis 1d.

Table 14: Summary statistics for Sub-hypothesis 1d

	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
AmtPur	12.135 [29.480]	1	2	3.5	7	14	28	28
AmtPur*Crim	13.913 [36.720]	2	3	3.5	7	14	28	28
PurFreq	3.279 [1.543]	1	2	2	3	5	6	6
PurFreq*Crim	3.142 [1.464]	1	2	2	3	4	5	6

The associations between the user's purchasing habits and the core measures are presented in Table 15. The amount users purchase does not appear to be significantly and meaningfully associated with any of the measures. Whereas the frequency of purchase is highly associated with craving strength for users in all choice environments. However, the frequency of purchase is only associated with steeper discounting of cash outcomes in criminalised choice environments. This result could be related to the fact that users in criminalised societies typically face larger quantity-based discount and thus buying more often is often 'bad value for money'. There is little evidence of association between the cannabis parameters and purchasing frequency.

Table 15: Hypothesis 1d - Past consumption

	(1) δ_cash	(2) β_cash	(3) δ_cannabis	(4) β_cannabis	(5) Cravings
AmtPur	-0.001	-0.003	-0.000	-0.003*	0.016
	[0.002]	[0.002]	[0.001]	[0.002]	[0.010]
AmtPur*Crim	0.002	0.004*	0.000	0.004**	-0.011
	[0.002]	[0.002]	[0.002]	[0.002]	[0.011]
PurFreq	0.013	-0.008	-0.027	-0.052	0.458***
	[0.026]	[0.031]	[0.027]	[0.040]	[0.156]
PurFreq*Crim	-0.120***	-0.094**	0.017	0.048	-0.143
	[0.035]	[0.044]	[0.035]	[0.050]	[0.222]
N	950	951	952	953	954

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

In line with sub-hypothesis H1d, there is evidence that time preferences and craving intensity are associated with purchasing habits and it appears the associations depend on the type of environment users face for time preferences but not for cravings. However, not all reported purchasing habits appear to be associated.

SH1e: Events associated with an increase in visceral factors (running out of cannabis and being under the influence of cannabis) are associated with increased discounting of delayed outcomes

Table 16 - Variable description Sub-Hypothesis 1e

Variable name	Description	Category
No24	Dummy variable identifying users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*Crim	Dummy variable identifying users who do not have enough cannabis to last the next 24 hours for users residing in criminalised choice environment	Visceral events
No24*Dly_amt	Average daily amount used over the last 3 months for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*AmtPur	Average amount purchased at one time over the last 3 months for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*PurFreq	Categorical variable capturing the frequency of purchase for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*Daily	Dummy variable identifying users who do not have enough cannabis to use over the next 24 hours and use daily	Visceral events
Used	Dummy variable identifying participants who used cannabis in the last 8 hours	Visceral events
Used*Crim	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in criminalised choice environment	Visceral events

Table 16 presents the variable description and Table 17 the summary statistics for the continuous variables introduced in sub-hypothesis 1e.

Table 17: Summary statistics for Sub-hypothesis 1e

	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
No24*Dly_amt	0.986 [0.864]	0.25	0.25	0.5	0.5	1.5	2	2.5
No24*AmtPur	6.962 [7.718	1	1	2	3.5	7	14	28
No24*PurFreq	4.136 [1.703]	2	2	3	4	6	6	7

Table 18: Hypothesis 1e - Running out					
	(1) δ_cash	(2) β_cash	(3) δ_cannabis	(4) β_cannabis	(5) Cravings
No24	-0.332	-0.240	-0.233	0.266	-0.335
	[0.220]	[0.258]	[0.215]	[0.303]	[1.792]
No24*Crim	0.203	0.155	0.043	-0.104	-0.528
	[0.127]	[0.144]	[0.125]	[0.178]	[0.855]
No24*Dly_amt	-0.174**	-0.097	0.061	0.065	0.986*
	[0.079]	[0.112]	[0.082]	[0.147]	[0.593]
No24*AmtPur	0.012	0.026**	0.006	-0.030**	0.043
	[0.010]	[0.013]	[0.008]	[0.012]	[0.091]
No24*PurFreq	0.039	0.016	0.026	-0.018	0.010
	[0.046]	[0.054]	[0.046]	[0.056]	[0.353]
No24*Daily	-0.137	-0.431***	-0.002	0.330*	0.996
	[0.118]	[0.141]	[0.115]	[0.173]	[0.858]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 18 explores the association between the time preferences, cravings and running out of cannabis, which is measured by whether users report having enough cannabis to use over the next 24 hours. Running out of cannabis appears to be associated with lower impatience and impulsivity towards cash, however this is not significant when looking only at No24. In contrast, running out of cannabis for user who consume higher levels of cannabis is significantly associated with higher cravings strength and lower impatience towards cash. The cravings scores report craving intensity over the last three months and in practice should not be associated with running out of cannabis, however the results suggest that running out of cannabis is associated with an increase in the perceived strength of cravings over the last three months. It is plausible that when running out of cannabis users start focusing on past cravings and perceive them as worse than when they are secure about their supply of cannabis. Interestingly, this is not carried over to the parameters for cannabis, which are both insignificant and positive. Running out of cannabis for users who use daily is highly and substantially negatively associated with impulsivity towards cash and surprisingly positively and significantly associated with reduced impulsivity towards cannabis, while both the impatience coefficients do not appear correlated. The amount purchased is significantly associated with both the impulsivity coefficients but in opposite directions. This is the same pattern observed in the coefficients of No24_crim, which once again could be due to individuals in criminalised environments

buying larger amounts. The association between purchasing frequency and time preferences does not appear to change when users are running out of cannabis, which suggests that these associations are more stable and less affected by visceral influences.

Table 19: Hypothesis 1e - Under the influence

	(6) δ_cash	(7) β_cash	(8) δ_cannabis	(9) β_cannabis	(10) Cravings
Used	0.035	0.094	0.000	-0.039	-0.292
	[0.070]	[0.077]	[0.079]	[0.092]	[0.398]
Used*Crim	-0.086	-0.168	-0.053	0.012	0.850
	[0.093]	[0.112]	[0.101]	[0.127]	[0.565]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

On the other hand, there is little evidence that having used cannabis in the last 8 hours affects the time preferences of users, as illustrated in Table 19. While, there is weak evidence that having recently used cannabis in a criminalised environment is associated with higher craving intensity than having used in a practically decriminalised choice environment, as the difference between the coefficient is substantial (-1.14) approaches significant (p-value=0.200).

In line with the sub-hypothesis, running out of cannabis for certain users is predicted to increase impatience and impulsiveness towards cash. However, it does not appear to be the case for impatience and impulsivity toward cannabis, as there is even some evidence that running out can decrease impulsiveness for cannabis. The effect of 'running out' on time preferences is complicated to disentangle, but it appears that running out does increase cravings for the users who consume more often and higher amounts. While having used does not appear to be associated with time preferences and only weakly with cravings.

SH1f: Living in a criminalised choice environment compared to living in a practically decriminalised choice environment is associated with higher time discounting by frequent cannabis users, moderated by institutional differences in price structure, accessibility and other unidentified differences across countries.

Table 20 - Variable description Sub-Hypothesis 1f

Variable name	Description	Category
Disc	Average decrease in price per gram associated with an increase in quantity purchases from 1 gram to 28 grams	Institutional features
Disc*Crim	Average decrease in price per gram associated with an increase in quantity purchases from 1 gram to 28 grams for users residing in criminalised choice environment	Institutional features
LenPur	Categorical variable capturing the amount of time taken to procure cannabis	Institutional features
LenPur*Crim	Categorical variable capturing the amount of time taken to procure cannabis for users residing in criminalised choice environment	Institutional features
Australia	Dummy variable identifying participants residing in Australia	Institutional features
Netherlands	Dummy variable identifying participants residing in the Netherlands	Institutional features
Canada	Dummy variable identifying participants residing in Canada	Institutional features
PracIllegal	Dummy variable identifying participants residing in a criminalised choice environments	Institutional features
Used*Aus	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in Australia	Visceral events
Used*NL	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in the Netherlands	Visceral events

Table 20 presents the variable description and Table 21 the summary statistics for continuous variables introduced in sub-hypothesis 1f.

Table 21: Summary statistics for Sub-hypothesis 1f								
	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
Disc	0.544	0	0	0.248	0.41	0.625	1	1.44
	[0.682]							
Disc*Crim	0.485	0.121	0.182	0.28	0.401	0.56	0.768	1.269
	[0.413]							
LenPur	4.513	2	2	3	4	6	8	9
	[2.207]							
LenPur*Crim	5.122	1	2	4	5	7	9	9
	[0.265]							

Table 22 explores the associations between institutional features, which includes living in a certain country, and the core measures. The quantity-based discounts faced by users and accessibility to cannabis, measured how long it takes to procure cannabis, do not appear to be meaningfully associated with time preferences or experienced cravings. Systematic differences in revealed time preferences are observed both at the country level and according to whether users reside in a criminalised choice environment or not.

Table 22: Hypothesis 1f - Institutional differences					
	(1)	(2)	(3)	(4)	(5)
	δ_cash	β_cash	δ_cannabis	β_cannabis	Cravings
Disc	0.025	0.042	-0.010	-0.007	-0.071
	[0.031]	[0.029]	[0.034]	[0.039]	[0.142]
Disc*Crim	-0.023	-0.025	0.045	0.020	0.088
	[0.078]	[0.077]	[0.073]	[0.091]	[0.385]
LenPur	0.006	0.007	-0.018	0.025	-0.064
	[0.017]	[0.021]	[0.018]	[0.023]	[0.102]
LenPur*Crim	-0.002	0.022	0.032	-0.019	0.206
	[0.022]	[0.029]	[0.024]	[0.030]	[0.135]
Australia	0.079	0.029	-0.052	-0.002	-0.981
	[0.085]	[0.099]	[0.090]	[0.114]	[0.609]
Netherlands	0.042	0.105	0.192	0.287	-0.522
	[0.110]	[0.125	[0.126]	[0.184]	[0.716]
PracIllegal	0.347*	0.305	-0.134	-0.230	0.479
	[0.194]	[0.235]	[0.204]	[0.261]	[1.107]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 23 – Estimated difference between Australia and the Netherlands
*From model excluding the Used*Aus and Used*NL interaction term*

Dependent variable	Coefficient	P>|t|
δ_cash	0.037	0.759
β_cash	-0.076	0.614
δ_cannabis	-0.244	0.066
β_cannabis	-0.29	0.114
Cravings	-0.459	0.566

These results were obtained by using the command: lincom Australia - Netherlands

The results in Table 23 reveal that Australian residents are both more impatient and impulsive with regards to cannabis, than Dutch residents. But do not differ in their impatience and impulsivity toward cash. Additionally, the residents of criminalised choice environments appear to be more patient with cash than the residents of practically decriminalised environment. The coefficient for δ_{cash} is weakly significant, which suggests that the impatience toward cash of users in criminalised choice environments is approximately 0.35 higher than that of their counterparts. This potentially indicates that they find cash less desirable than their counterparts. Overall, there is only minimal evidence that users in criminalised societies are more impatient and impulsive with regards to cannabis than their counterpart. However, the results in Table 23 show that Australian residents are on average more impatient and impulsive with cannabis than Dutch residents. The estimated differences between the Australian and Dutch δ and β for cannabis are over 0.2, which is a considerable difference.

Interestingly, as illustrated by the results in Table 25, the differences between the cannabis parameters of Australian and Dutch residents disappears when interaction terms for having used in Australia and having used in the Netherlands are introduced. It indicates that the differences observed over discounting of cannabis between Australian and Dutch resident occurs when users are under the influence and not when they are sober. The introduction of the interaction terms also appears to increase the difference between the cash parameters. Where Australian residents now appear less impatient and impulsive toward cash than Dutch resident, this is in line with the findings (in Table 22 & 24) that users in criminalised societies are more patient with cash outcomes than users in practically decriminalised societies. This difference could be the results of framing, as all participants were aware that the survey was related to cannabis consumption and this itself could

impact the attractiveness of cash, especially for users who do not have easy access to cannabis. The results in Table 24 indicate that being under the influence of cannabis for Australian residents reduces impatience for cash and reduces impatience for cannabis, however this result is only approaching significance (P-value=0.130). While the opposite pattern is observed for Dutch residents.

Table 24 Hypothesis 1f - Institutional differences for model which additional includes country interaction terms for Used variable

	(1) δ_cash	(2) β_cash	(3) δ_cannabis	(4) β_cannabis	(5) Cravings
Used*Aus	0.278*	0.123	-0.252	-0.287	-0.215
	[0.148]	[0.184]	[0.157]	[0.179]	[0.998]
Used*NL	-0.136	-0.164	0.227	0.285	0.455
	[0.155]	[0.162]	[0.171]	[0.211]	[0.873]
Australia	-0.089	-0.047	0.103	0.176	-0.841
	[0.119]	[0.129]	[0.126]	[0.150]	[0.867]
Netherlands	0.111	0.154	0.044	0.133	-0.802
	[0.133]	[0.147]	[0.148]	[0.223]	[0.834]
PracIllegal	0.412**	0.320	-0.242	-0.371	0.311
	[0.201]	[0.241]	[0.208]	[0.261]	[1.116]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 25 – Estimated difference between Australia and the Netherlands
*Including the Used*Aus and Used*NL interaction term*

Dependent variable	Coefficient	P>|t|
δ_cash	-0.200	0.248
β_cash	-0.201	0.264
δ_cannabis	0.059	0.750
β_cannabis	0.051	0.833
Cravings	-0.039	0.971

These results were obtained by using the command: lincom Australia - Netherlands

Sub-hypothesis 1f predicts that living a criminalised society is linked with higher impatience and impulsivity and the evidence is mixed, as residing appears to be associated with lower impatience and impulsivity for cash outcomes and higher impatience and impulsivity for cannabis outcomes. However, it is clear that residing in a criminalised choice environment is associated with systematic differences in discounting of delayed outcomes. It appears that systematic differences in time preferences appear across countries and this is particularly true when users are under the influence of cannabis. While cravings do not appear to be strongly associated with institutional features or residing in a specific country.

SH2a: The presence of visual cues on choice lists increases the impatience and impulsivity of decision makers, compared to the same choice lists without the visual cues

Table 26 - Variable description Sub-Hypothesis 1f

Variable name	Description	Category
Pic	Dummy variable identifying participants who had a picture of the outcomes on their choice lists	Treatment varibles
Pic*Crim	Dummy variable identifying participants who had a picture of the outcomes on their choice lists and reside in criminalised choice environment	Treatment variables
NoPic*Crim	Dummy variable identifying participants who did not have a picture of the outcomes on their choice lists and reside in criminalised choice environment	Treatment variables
Pic*Decrim	Dummy variable identifying participants who had a picture of the outcomes on their choice lists and reside in practically decriminalised choice environment	Treatment varibles
NoPic*DeCrim	Dummy variable identifying participants who did not have a picture of the outcomes on their choice lists and reside in practically decriminalised choice environment	Treatment variables

Table 26 presents the variable description for the variables introduced in hypothesis 2.

Table 27: Hypothesis 2a - Picture - Treatment					
	(1)	(2)	(3)	(4)	(5)
	δ_cash	β_cash	δ_cannabis	β_cannabis	Cravings
Pic	0.028	0.058	0.056	0.082	0.871**
	[0.064]	[0.074]	[0.068]	[0.082]	[0.362]
Pic*Crim	-0.090	-0.227**	-0.080	-0.026	-1.083**
	[0.086]	[0.106]	[0.090]	[0.112]	[0.524]
N	950	950	950	950	950

*Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*
All regressions include the following unreported controls: age, gender, income, employed dummy, student dummy, residing location, cannabis_sub dummy, Res_less1 dummy, Res_more3 dummy, pic dummy, practically legal dummy.

Table 27 explores the causal effect of adding a visual cue to a choice lists on time preferences and reported craving strength over the previous 3 months period. The only coefficient which appears significantly different as a result of adding a visual cue is the coefficient for β_{cash} for users in criminalised environments. The effect appears to be primarily driven by users residing in the USA. This result demonstrates that visual cues can incite more impulsive behaviour in individuals. However, this impact is not automatic, as there is little evidence that visual cues impacted any of the other parameters. Surprisingly, the visual cues have impacted the reported craving intensity experienced over the last three months. This indicates that an individual's evaluation of their past experience or remembered utility can be influenced by visual cues which was visible only before the questions about craving strength were answered and not while the questions about cravings were being answered. The effect of the picture appears to have increased the perceived cravings of users in practically decriminalised environment and decreased the cravings of individuals in criminalised environments.

In line with the sub-hypothesis, the results illustrate that visual cues present at the point of decision can decrease the discounting of delayed outcomes. However, this outcome is only observed once, and the parameters do not appear to have been affected by the visual cues.

SH2b: Visual cues increase impatience and impulsivity for rewards more in users residing in criminalised societies than in users residing in non-criminalised societies.

Table 28 - Estimate difference between the causal effect of the treatment on frequent cannabis users residing in criminalised choice architectures and the causal effect of the treatment on frequent cannabis users residing in practically decriminalised choice environments

Dependent variable	Coefficient	P>|t|
δ_cash	-0.090	0.295
β_cash	-0.227	0.033
δ_cannabis	-0.080	0.376
β_cannabis	-0.026	0.816
Cravings	-1.083	0.039

*These results were obtained by using the command: lincom (Pic*Crim - NoPic*Crim) - (Pic*Decrim - NoPic*Decrim)*

The results in Table 28 indicate that the presence of a visual cue on the choice lists had more of an effect on individuals living in practically decriminalised societies than their counterpart. This is significant for impulsivity towards cash and experienced cravings over the last 3 months. These results are surprising and in the opposite direction to what sub-hypothesis H2b predicted, as it appears that visual cues had less of an effect on the criminalised users than on their counterpart. These results provide evidence that visual cues can impact individuals residing in different choice environment differently.

10.2 Robustness checks

The core analysis in this thesis relies on parametric testing, while the distributions of the error terms of the dependent variables are not necessarily normal or symmetric. To ensure that the results observed hold without the assumption of normality, the main results are verified using a nonparametric test, the two-sided Fisher exact test. This is only possible for the findings which do not rely on a large number of variables and controls, which are found in sub-hypotheses 1a and are the findings which underpin the rest of the results explored.

Main findings of SH1a:

- δ_cash is significantly lower for current users compared to former user in both the full and the Aus_NL samples. The two-sided Fisher exact test confirm the results: Full sample = 0.039 and Aus_NL= 0.025.

- There is no significant difference in δ_choc within both samples. This is confirmed by the Fisher exact test: Full =0.846 and Aus_NL: 0.830

- Former daily users are not more impatient but are more impulsive with cash than former users who did not use daily. Fisher exact test: $\delta\_cash = 0.558$ and $\beta\_cash = 0.223$. The results are in line with the main findings but β_cash is not found to be significantly different. This could also be due to there being no controls.

- Daily users are both more impatient and more impulsive with cannabis than non-daily users. Fisher exact test: $\delta\_cannabis = 0.050$ and $\beta\_cannabis = 0.257$. The evidence for the $\delta\_cannabis$ results found is solid, while evidence for $\beta\_cannabis$ is in line with the findings for former users.

Overall the nonparametric results do not differ significantly from the main results but tend to be less significant.

11. Discussion

11.1 Main findings

An important question posed by addiction experts is whether addiction is in-born or learnt. The results appear to support both explanations, impatience for cash is associated with current use and not former use, which suggests that it is contextual and thus more likely to be developed over time or learnt. While impulsivity toward cash is associated with more frequent use in both current and former users. This supports the view that certain traits associated with real-life drug behaviour or other self-defeating behaviours with similar benefit and costs structure, are somewhat in-born.

The results provide clear evidence that both impatience and impulsivity are tied to the outcome type and thus that individuals do not apply a single rate of impatience and impulsivity to all outcome types. This appears logical, as being able to control yourself with chocolate is not necessarily linked with how much cannabis one uses or how one spends money. Additionally, there is evidence that δ and β are influenced by visceral events, experienced and remembered utility, self-stigma and visual cues. Cues can also influence remembered utility directly. As predicted by Kahneman, Wakker and Ravin (1997) subjective experienced and revealed preferences are linked. It also appears that visual cues can impact the recall of global subjective experience, which indicates that subjective experience is influenced unconsciously. Understanding the influence of these factors on decision making is particularly important when trying to model the decision of individuals who are potential highly sensitised to certain rewards, as described by Incentive-Sensitization Theory of Addiction.

Individuals across criminalised and practically decriminalised societies appear to experience the same intensity of cravings when using the same daily amount, yet the same users within criminalised choice environments appear both more impatient and impulsive toward cannabis. A similar trend appears with purchasing habits, where its link with craving intensity is stable across both types of choice environments but the positive link to impatience and impulsivity, this time towards cash, appears only in criminalised societies. Another perplexing observed difference across different countries are the differences in time preferences associated with being under the influence of cannabis. Lastly, the influence of visual cues on both time preferences and remembered cravings also appears to be country specific. These findings are in line with the expectation that time preferences are linked with choice environment and framing of decisions.

Quasi-hyperbolic models allow for meaningful distinction between δ, rational or stable discount, and β a form of impulsive or present biased discounting. Throughout the analysis both components of the quasi-hyperbolic model are found to be predictive of different aspects of the experience and real-life behaviour of frequent cannabis users. This suggests that considering both impatience and impulsivity separately is useful and informative to the study of self-defeating behaviours.

11.2 Policy implications

Thaler & Sustein (2008) highlight the importance of developing considered choice architectures, which examine the challenges faced by decision makers. Delaying gratification, or exerting self-

control is a challenge faced by all, but it is most relevant for individuals who expose themselves to excessive risk and report feeling 'out of control'.

The results in this thesis provide evidence that both levels of impatience and impulsivity vary according to whether someone lives within a criminalised or a practically decriminalised choice environment. Additionally, these differences appear to be mediated by the visceral events and cues which users face. In line with Lundenberg and Levine's (2006) dual-self model, impulsivity implies that individuals are influenced by temptations and thus need to exert self-control in order to delay rewards. This is evidence that a government's approach to drug policy and regulation over drug markets results, not only in externalities on their society, but also in internalities on frequent substance users. Governments are tasked with minimising harm within their societies and this should motivate further research into the internalities associated with their approach to drug policy. These internalities could be explored by shifting the focus from counting the number of users and individuals seeking medical support, to the exploring the systematic differences in the way users behave and interact within different types of environment across different societies. This is especially important for cannabis as a significant number of governments are currently reconsidering their approach to policy or are already in a position where they can make changes to their choice environment, which could result in a reduction of the societal harms experienced within societies. Additionally, cannabis offers a wide range of choice environments across the world to explore the impact of different approaches on behaviour and thus the opportunity to better understand the formation and duration of harmful and maladaptive behaviours.

11.3 Limitations

The analysis in this thesis faced a number of limitations, which bring up potential areas for further research:

- The time preferences were elicited by using hypothetical multiple price lists over small outcomes. It is hard to understand how this impacted the results without investigating how the results would differ with incentive compatible choice scenarios.

- All time preferences measures are estimate with a quasi-hyperbolic model and they are not compared to other models, such as exponential or hyperbolic discount models. This limits the analysis' ability to evaluate the validity of the estimates, especially for the estimate which

have not been captured in previous studies. This includes time preferences over very small amounts of cannabis and for individuals under the influence of cannabis.

- Throughout the data collection process some users reported finding it difficult to accurately report their purchasing and consumption habits. This is due to the great variety of products available on the market, especially in practically decriminalised societies. For example, cannabis cartridge and wax are more concentrated than the standard plant, making comparison across products difficult. This issue could be remedied by asking a few additional questions to better understand how cannabis is purchased and consumed

- The price and discount information included in the analysis are incomplete. The discount variable is only a rough estimation of the discount faced by individuals and it is possible that drove the insignificance of discounts within the analysis. Additionally, prices faced by users were not included in the analysis due to incomplete information. Asking additional questions and ensuring the information is available for all observations would strengthen the analysis

- The results around self-stigma are interesting but only cover one aspect of stigma, the other being perceived public stigma. It is possible that individuals do not experience or report self-stigmatisation but are still influenced by social norms and public stigma in their decision making. Exploring stigma and social norms further could help explain the observed and unattributed differences between the time preferences and experienced cravings across different societies

- The impact of visual cues related to cannabis was explored and not found to have an effect on the time preferences of users. It is likely that other cues, such as the smell of cannabis or cannabis paraphernalia, would be more triggering to current users. Therefore, the investigation of other cannabis related cues would provide a more complete picture.

- The connection between purchasing behaviour and consumption behaviour was not explored explicitly, gaining a better understanding of the links between the amount purchased and stored at home would be valuable, as it is not yet clear, how buying smaller amount affects consumption.

- Experienced cravings are a form of retrospective experienced utility or remembered utility, which is recognised by Kahneman, Wakker and Ravin (1997) as informative to the study of self-defeating behaviours. Instant utility is the other kind of experienced utility and it has been shown that it is also associated with real-life behaviours. Exploring the links between instant utility and remembered utility would allow for a better understanding of how remembered utility is formed and transformed through instant utility.

11. Conclusion

Heyman's three principles proved to be useful guidelines to explore the real-life behaviours and decision-making process of frequent cannabis use. Firstly, past consumption is clearly associated with both time preferences and craving intensity. Secondly, the frame within which decisions are being made is linked with both time preferences and experienced cravings. The potential changes in framing range wide; from the introduction of visual cues, the impact of social stigma and the criminalisation of behaviour. Finally, time preferences and by consequence decisions made are linked to a point in time, and changes in visceral influences and context can affect the decisions being made. The findings in this report are high level and only indicative but provide strong motivation for further exploring the impact of choice environment and by extension choice architecture on the decision-making process of frequent cannabis users and other individuals who engage in self-defeating behaviours, through the lens of revealed preferences and subjective experience.

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13. Appendix:

Appendix Table 1: Question and summary of answers to the survey

	Australia	Netherlands	All observations
1.1 Demographics			
What is your age?	Less than 18 (3%), 18 to 24 (21%), 25 to 34 (47%), 35 to 44 (18%), 45 to 54 (9%), 55 to 64 (1%), 65 to 74 (0%), Above 75 (0%)	Less than 18 (1%), 18 to 24 (39%), 25 to 34 (47%), 35 to 44 (10%), 45 to 54 (1%), 55 to 64 (2%), 65 to 74 (0%), Above 75 (0%)	Less than 18 (4%), 18 to 24 (48%), 25 to 34 (35%), 35 to 44 (9%), 45 to 54 (3%), 55 to 64 (1%), 65 to 74 (0%), Above 75 (0%)
What is your gender?	Male (77%), Female (22%), Other (2%)	Male (82%), Female (18%), Other (0%)	Male (80%), Female (18%), Other (1%)
What is your current employment status?	Employed full time (49%), Employed part-time (13%), Retired (0%), Self-employed (7%), Student (16%), Unable to work through illness/disability (6%), Unemployed (9%)	Employed full time (33%), Employed part-time (13%), Retired (0%), Self-employed (6%), Student (41%), Unable to work through illness/disability (4%), Unemployed (3%)	Employed full time (46%), Employed part-time (13%), Retired (0%), Self-employed (5%), Student (28%), Unable to work through illness/disability (3%), Unemployed (5%)
What is your yearly income?	1 (24%), 2 (14%), 3 (23%), 4 (33%), 5 (6%)	1 (37%), 2 (25%), 3 (22%), 4 (12%), 5 (4%)	1 (31%), 2 (20%), 3 (22%), 4 (19%), 5 (8%)
How long have you been residing in this country?	Less than 1 year (0%), 1 to 3 years (2%), Over 3 years, but not most of my life (4%), Most or all of my life (93%)	Less than 1 year (10%), 1 to 3 years (9%), Over 3 years, but not most of my life (8%), Most or all of my life (72%)	Less than 1 year (2%), 1 to 3 years (3%), Over 3 years, but not most of my life (4%), Most or all of my life (91%)
How stressful is your life currently?	Far below average (3%), Moderately below average (4%), Slightly below average (10%), Average (22%), Slightly above average (24%), Moderately above average (10%), Far above average (10%)	Far below average (6%), Moderately below average (8%), Slightly below average (19%), Average (17%), Slightly above average (24%), Moderately above average (25%), Far above average (11%)	Far below average (4%), Moderately below average (7%), Slightly below average (10%), Average (23%), Slightly above average (22%), Moderately above average (27%), Far above average (7%)
1.2 Consumption habits All questions were prefaced by: *'During the past three months'* for current users and, *'Towards the end of the time (e.g. the last 3 months) you were using cannabis frequently'* for former users			
How did you typically use cannabis?	Eat it (1%), Smoke it (82%), Vaporise it (16%)	Eat it (2%) Smoke it (93%) Vaporise it (5%)	Eat it (2%) Smoke it (76%) Vaporise it (22%)
Did you use cannabis with tobacco?	Yes (38%) Sometimes (20%) No (42%)	Yes (73%) Sometimes (13%) No (14%)	Yes (26%) Sometimes (23%) No (51%)
How often did you use cannabis?	3 - 4 days (28%) 5 -6 days (20%) Every day (53%)	3 - 4 days (34%) 5 -6 days (25%) Every day (40%)	3 - 4 days (24%) 5 -6 days (23%) Every day (54%)
On a typical day of use, approximately	1.002 grams [1.023]	0.649 grams [0.782]	0.837 grams [0.865]

how much cannabis did you use?			
At what time of the day did you typically first use cannabis?	When I woke up (13%), During the morning (10%), During the afternoon (21%), At night (57%)	When I woke up (5%), During the morning (17%), During the afternoon (38%), At night (50%)	When I woke up (10%), During the morning (12%), During the afternoon (27%), At night (51%)
What percentage of the time did you use cannabis with others?	Never (6%), Rarely (16%), Sometimes (32%), About half the time (15%), Most of the time (22%), Always (9%)	Never (6%), Rarely (16%), Sometimes (19%), About half the time (22%), Most of the time (25%), Always (11%)	Never (4%), Rarely (16%), Sometimes (27%), About half the time (24%), Most of the time (23%), Always (6%)
How often did you try to limit or restrict the amount of cannabis in your possession to reduce your use?	Never (56%), Once or twice (15%), Occasionally (20%), Regularly (7%), Every day (1%)	Never (53%), Once or twice (23%), Occasionally (18%), Regularly (5%), Every day (1%)	Never (59%), Once or twice (18%), Occasionally (16%), Regularly (6%), Every day (1%)
1.3 Purchasing habits All questions were prefaced by: *'During the past three months'* for current users and, *'Towards the end of the time (e.g. the last 3 months) you were using cannabis frequently'* for former users			
Approximately, how often did you purchase cannabis?	Every day (0%), 5-6 times a week (1%), 2 -4 days a week (7%), Once a week (19%), Every 10 days (6%), Every 2 weeks (22%), Once a month (36%), I did not typically purchase cannabis (8%)	Every day (4%), 5-6 times a week (5%), 2 -4 days a week (24%), Once a week (25%), Every 10 days (9%), Every 2 weeks (17%), Once a month (10%), I did not typically purchase cannabis (6%)	Every day (1%), 5-6 times a week (1%), 2 -4 days a week (8%), Once a week (17%), Every 10 days (7%), Every 2 weeks (26%), Once a month (35%), I did not typically purchase cannabis (6%)
How long did it typically take you to purchase cannabis, from initiating the transaction (e.g. from leaving the house to go to coffeeshop or first texting a dealer) to finishing the transaction?	Less than 15 minutes (7%), Between 15 minutes and 30 minutes (8%), Between 30 minutes and 1 hour (18%), Between 1 hour and 2 hours (18%), Between 2 hours and 4 hours (12%), About half the day (10%), An entire day (4%), More than a day (13%)	Less than 15 minutes (38%), Between 15 minutes and 30 minutes (35%), Between 30 minutes and 1 hour (15%), Between 1 hour and 2 hours (3%), Between 2 hours and 4 hours (2%), About half the day (2%), An entire day (0%), More than a day (0%)	Less than 15 minutes (14%), Between 15 minutes and 30 minutes (18%), Between 30 minutes and 1 hour (21%), Between 1 hour and 2 hours (14%), Between 2 hours and 4 hours (8%), About half the day (7%), An entire day (3%), More than a day (9%)
How many grams of cannabis did you typically purchase at once?	14.38 grams [11.50]	4.041 grams [17.62]	11.55 grams [11.55]

What are the most common prices you faced for the amounts of cannabis described below? (Medium prices)	0.5 grams: 10 AUD, 1 gram: 20 AUD, 3.5 grams: 50 AUD, 7 grams: 90 AUD, 14 grams: 160, 28 grams: 300 AUD	0.5 grams: €5 , 1 gram: €10 , 2 grams: €20, 5 grams: €48	USA: 0.5 grams: 5 USD 1 gram: 10 USD, 3.5 grams: 30 USD, 7 grams: 60 USD, 14 grams: 100 USD, 28 grams: 180 USD Canada: 0.5 grams: 5 CAD, 1 gram: 10 CAD, 3.5 grams: 30 CAD, 7 grams: 55 CAD, 14 grams: 95 CAD, 28 grams: 160 CAD
Where did you typically purchase cannabis?	A dealer came to me (9%), I arranged it through a friend (27%), I grew my own (4%), I met a dealer at a random location (20%), I went to a dealer's house (32%),I went to a licensed retailer (0%), My dealer came to my house (2%), Online (5%), Other (1%)	A dealer came to me (1%), I arranged it through a friend (3%), I grew my own (2%), I met a dealer at a random location (2%), I went to a dealer's house (0%), I went to a licensed retailer (87%), My dealer came to my house (1%), Online (0%), Other (6%)	A dealer came to me (9%), I arranged it through a friend (16%), I grew my own (2%), I met a dealer at a random location (12%), I went to a dealer's house (23%), I went to a licensed retailer (27%), My dealer came to my house (1%), Online (5%), Other (4%)
How many different cannabis dealers did you interact with in the last year?	0 (8%), 1 (22%), 2 (25%), 3 (17%), 4 to 5 (15%), Over 5 (12%)	0 (4%), 1 (12%), 2 (25%), 3 (41%), 4 to 5 (56%), Over 5 (44%)	0 (4%), 1 (15%), 2 (23%), 3 (21%), 4 to 5 (16%), Over 5 (22%)
1.4 Craving strength All questions were prefaced by: 'During the past three months' for current users and, 'Towards the end of the time (e.g. the last 3 months) you were using cannabis frequently' for former users			
How often did you use cannabis when you had not planned to use, or after you had planned to stop using?	Never (39%), Once or twice (26%), Occasionally (22%), Regularly (13%), Every day (1%)	Never (28%), Once or twice (30%), Occasionally (26%), Regularly (14%), Every day (2%)	Never (40%), Once or twice (27%), Occasionally (23%), Regularly (8%), Every day (2%)
How often did you find yourself spending money on cannabis/marijuana over other things that you need?	Never (65%), Once or twice (15%), Occasionally (13%), Regularly (7%), Every day (0%)	Never (68%), Once or twice (16%), Occasionally (11%), Regularly (3%), Every day (2%)	Never (67%), Once or twice (16%), Occasionally (11%), Regularly (4%), Every day (1%)
How often did you worry if you had no cannabis at home?	Never (36%), Once or twice (21%), Occasionally (23%), Regularly (15%), Every day (4%)	Never (38%), Once or twice (32%), Occasionally (21%), Regularly (8%), Every day (2%)	Never (35%), Once or twice (28%), Occasionally (24%), Regularly (10%), Every day (2%)

How often did you think 'I must stop or cut down'?	Never (23%), Once or twice (24%), Occasionally (26%), Regularly (22%), Every day (5%)	Never (20%), Once or twice (30%), Occasionally (26%), Regularly (15%), Every day (9%)	Never (24%), Once or twice (32%), Occasionally (28%), Regularly (12%), Every day (3%)
Did you need to use more cannabis than you used to in order to get high?	The same (41%), A bit more (42%), A lot more (14%), It was hard for me to get high at all (3%)	The same (39%), A bit more (46%), A lot more (13%), It was hard for me to get high at all (6%)	The same (34%), A bit more (49%), A lot more (14%), It was hard for me to get high at all (3%)
Have you ever felt irritable, restless and unable to sleep if you have not used cannabis for a few days?	Never (33%), Once or twice (21%), Occasionally (20%), Regularly (18%), I didn't stop for a few days (8%)	Never (41%), Once or twice (25%), Occasionally (13%), Regularly (12%), I didn't stop for a few days (8%)	Never (36%), Once or twice (24%), Occasionally (17%), Regularly (12%), I didn't stop for a few days (10%)
How often did you end up using cannabis instead of going out to see friends/family or taking part in hobbies?	Never (37%), Once or twice (22%), Occasionally (25%), Regularly (14%), Every day (2%)	Never (40%), Once or twice (27%), Occasionally (24%), Regularly (8%), Every day (1%)	Never (46%), Once or twice (24%), Occasionally (21%), Regularly (8%), Every day (1%)
How often did you feel an overwhelming desire or craving to use cannabis?	Never (31%), Once or twice (26%), Occasionally (21%), Regularly (15%), Every day (6%)	Never (25%), Once or twice (29%), Occasionally (29%), Regularly (9%), Every day (7%)	Never (29%), Once or twice (29%), Occasionally (26%), Regularly (12%), Every day (5%)
How did you imagine your life would be different if you didn't use cannabis? *Current users only*	It would be a lot worse (12%), It would be a bit worse (36%), It would be the same (34%), It would be a bit better (17%), It would be much better (2%)	It would be a lot worse (5%), It would be a bit worse (30%), It would be the same (41%), It would be a bit better (18%), It would be much better (7%)	It would be a lot worse (15%), It would be a bit worse (41%), It would be the same (31%), It would be a bit better (11%), It would be much better (2%)
How do you imagine your life would be different today, if you hadn't stopped using cannabis frequently? *Former users only*	It would be a lot worse (22%), It would be a bit worse (23%), It would be the same (35%), It would be a bit better (16%), It would be much better (4%)	It would be a lot worse (35%), It would be a bit worse (24%), It would be the same (33%), It would be a bit better (17%), It would be much better (2%)	It would be a lot worse (20%), It would be a bit worse (23%), It would be the same (36%), It would be a bit better (16%), It would be much better (5%)
1.5 Stigma All questions were prefaced by: 'During the past three months' for current users and, 'Towards the end of the time (e.g. the last 3 months) you were using cannabis frequently' for former users			
Did many people in your life know that you use cannabis frequently?	No one (1%), A few people (58%), Most people (31%), Pretty much everyone (10%)	No one (2%), A few people (48%), Most people (37%), Pretty much everyone (12%)	No one (2%), A few people (47%), Most people (37%), Pretty much everyone (15%)

How often did you feel ashamed by the amount of cannabis you use?	Never (56%), Once or twice (15%), Occasionally (21%), Regularly (7%), Every day (2%)	Never (40%), Once or twice (25%), Occasionally (21%), Regularly (9%), Every day (4%)	Never (53%), Once or twice (21%), Occasionally (21%), Regularly (4%), Every day (1%)
How often did you try to hide the extent of your smoking?	Never (41%), Once or twice (14%), Occasionally (26%), Regularly (11%), Every day (9%)	Never (34%), Once or twice (24%), Occasionally (21%), Regularly (13%), Every day (7%)	Never (37%), Once or twice (19%), Occasionally (23%), Regularly (14%), Every day (7%)
1.6 Consumption history			
How long has it been since you first started using cannabis frequently?	Less than 1 year (9%), 1 to 2 years (16%), 2 to 5 years (25%), 5 to 10 years (27%), 10 to 20 years (12%), Over 20 years (12%)	Less than 1 year (8%), 1 to 2 years (26%), 2 to 5 years (27%), 5 to 10 years (18%), 10 to 20 years (15%), Over 20 years (5%)	Less than 1 year (3%), 1 to 2 years (23%), 2 to 5 years (31%), 5 to 10 years (18%), 10 to 20 years (12%), Over 20 years (4%)
How long did you use cannabis regularly for?	Less than 1 year (7%), 1 to 2 years (16%), 2 to 5 years (33%), 5 to 10 years (29%), 10 to 20 years (9%), Over 20 years (6%)	Less than 1 year (15%), 1 to 2 years (15%), 2 to 5 years (44%), 5 to 10 years (15%), 10 to 20 years (9%), Over 20 years (2%)	Less than 1 year (13%), 1 to 2 years (26%), 2 to 5 years (33%), 5 to 10 years (18%), 10 to 20 years (7%), Over 20 years (3%)
Since you first started using cannabis frequently, have you attempted to stop using?	Yes (57%), No (43%)	Yes (47%), No (53%)	Yes (47%), No (53%)
How many times have you attempted to stop using cannabis? (Each attempt being at least 3 months from each other)	1 (17%), 2 (21%), 3 to 5 times (33%), 5 to 10 times (15%), Over 10 times (14%)	1 (11%), 2 (36%), 3 to 5 times (42%), 5 to 10 times (7%), Over 10 times (4%)	3 (17%), 2 (21%), 3 to 5 times (33%), 5 to 10 times (15%), Over 10 times (14%)
During the time you were using cannabis regularly, how many times did you attempt to stop using cannabis (excluding the last time)?	0 - 1 (55%), 2 (10%), 3 to 5 times (23%), 5 to 10 times (7%), Over 10 years (4%)	0 - 1 (69%), 2 (9%), 3 to 5 times (13%), 5 to 10 times (5%), Over 10 times (4%)	0 - 1 (64%), 2 (13%), 3 to 5 times (17%), 5 to 10 times (4%), Over 10 times (2%)
How long has it been since you stopped using cannabis frequently?	Less than 1 year (33%), 1 year to 2 years (22%), 2 years to 5 years (25%), 5 years to 10 years (10%), 10 years to 20 years (10%)	Less than 1 year (40%), 1 year to 2 years (19%), 2 years to 5 years (20%), 5 years to 10 years (7%), 10 years to 20 years (15%)	Less than 1 year (52%), 1 year to 2 years (19%), 2 years to 5 years (16%), 5 years to 10 years (6%), 10 years to 20 years (6%)

Since you stopped using cannabis frequently, how often do you still use cannabis?	Never (28%), Very rarely (23%), 1 to 3 times a week (12%), 4 to 8 times a week (7%), About once a month (14%), A few times a month (14%), About once a week (6%), 1 to 2 times a week (1%)	Never (22%), Very rarely (22%), 1 to 3 times a year (9%), 4 to 8 times a year (11%), About once a month (6%), A few times a month (20%), About once a week 11%), 1 to 2 times a week (0%)	Never (21%), Very rarely (20%), 1 to 3 times a year (9%), 4 to 8 times a year (8%), About once a month (11%), A few times a month (18%), About once a week (9%), 1 to 2 times a week (4%)
Do you regularly take other substances (including both alcohol, or other legal or illegal highs)?	Yes, both alcohol and legal or illegal highs (6%), Yes, just alcohol (30%), Yes, just legal or illegal highs (3%), No (61%)	Yes, both alcohol and legal or illegal highs (8%), Yes, just alcohol (37%), Yes, just legal or illegal highs (3%), No (52%)	Yes, both alcohol and legal or illegal highs (6%), Yes, just alcohol (27%), Yes, just legal or illegal highs (3%), No (65%)
1.7 Control			
Do you smoke tobacco (without cannabis)?	Yes (17%), Sometimes (21%), No, never have (30%), I quit (31%)	Yes (31%), Sometimes (23%), No, never have (21%), I quit (25%)	Yes (15%), Sometimes (18%), No, never have (41%), I quit (25%)
Do you like chocolate?	It's my favourite food (5%), I like it a lot (42%), I like it a little (48%), I don't like it at all (5%)	It's my favourite food (5%), I like it a lot (42%), I like it a little (48%), I don't like it at all (6%)	It's my favourite food (4%), I like it a lot (46%), I like it a little (44%), I don't like it at all (5%)
Do you currently use cannabis frequently (i.e. at least 3 times a week)?	Yes (67%), No (33%)	Yes (74%), No (26%)	Yes (83%), No (17%)
Which country do you reside in?	Australia (100%)	Netherlands (100%)	Australia (12%), Canada (7%), European excluding the Netherlands (13%), USA (53%), Other (15%)
Where you live, do you have the opportunity to obtain cannabis in a legal way or a practically legal way (e.g., medical license, official policy of tolerance)?	Yes (0%), No (Yes%)	Yes (100%), No (0%)	Yes (45%), No (55%)
Have you ever sought assistance to address your cannabis use from medical professional (e.g. counselling,	Yes (11%), No (89%)	Yes (9%), No (11%)	Yes (7%), No (93%)

medical doctor, rehabilitation centre,...)?			
Have you used cannabis in the last 8 hours?	Yes (48%), No (52%)	Yes (38%), No (62%)	Yes (52%), No (48%)
How long has it been since you last used cannabis? *Only asked if participants answered yes to the previous question*	Less than 1 hour (45%), Around 1 hour (3%), Around 2 hours (13%), Around 3 hours (9%), Around 4 to 5 hours (13%), Around 6 to 8 hours (17%)	Less than 1 hour (48%), Around 1 hour (9%), Around 2 hours (15%), Around 3 hours (6%), Around 4 to 5 hours (19%), Around 6 to 8 hours (13%)	Less than 1 hour (37%), Around 1 hour (11%), Around 2 hours (12%), Around 3 hours (8%), Around 4 to 5 hours (11%), Around 6 to 8 hours (22%)
Do you currently have enough cannabis to last you the next 24 hours?	Yes (87%), No (13%)	Yes (84%), No (16%)	Yes (88%), No (12%)
Do you currently have enough cannabis left to get high (at least one)? *Only asked if participants answered no to the previous question*	Yes (48%), No (52%)	Yes (53%), No (47%)	Yes (64%), No (36%)

Appendix Table 2: List of subreddits

Subreddit	Date posted	Cannabis Subreddit	Number of responses
r/Australia	9/06/2019	No	135
r/trees	9/06/2019	Yes	1283
r/ausents	9/06/2019	Yes	42
r/AmsterdamEnts	12/06/2019	Yes	88
r/Dutch	12/06/2019	No	14
r/LearnDutch	12/06/2019	No	15
r/Groningen	12/06/2019	No	29
r/Utrecht	12/06/2019	No	69
r/Leiden	17/06/2019	No	19
r/TheHague	17/06/2019	No	10
r/Netherlands	17/06/2019	No	28

Appendix Table 3a:

Choice lists - block 1 - A smaller reward **today** versus a larger reward in **1 month** time - **βδ**							
Number of small sooner rewards chosen over larger later rewards	Discount associated	Choice list 1: Cash Number of observations	Choice list 2: Cash Percentage	Choice list 2: Chocolate Number of observations	Choice list 2: Chocolate Percentage	Choice list 3: Cannabis Number of observations	Choice list 3: Cannabis Percentage
11	0.500	107	6%	488	28%	251	17%
10	0.513	76	4%	69	4%	92	6%
9	0.541	11	1%	9	1%	20	1%
8	0.572	38	2%	40	2%	60	4%
7	0.607	36	2%	30	2%	44	3%
6	0.646	111	6%	88	5%	106	7%
5	0.690	516	30%	244	14%	321	22%
4	0.742	114	7%	58	3%	62	4%
3	0.801	110	6%	67	4%	93	6%
2	0.871	97	6%	65	4%	64	4%
1	0.955	458	26%	336	19%	277	19%
0	1.000	46	3%	204	12%	34	2%
Multiple switch points (excluded)		12	1%	22	1%	11	1%
Violate monotonicity assumption		0	0%	12	1%	1	0%
Total		1732		1732		1436	

Appendix Table 3b:

Choice lists - Block 2 - A smaller reward in **1 month** time versus a larger reward in **2 month** time - **δ**							
Number of small sooner reward chosen over larger later reward Sooner: Today Later:	Discount associated Today vs In 1 month (βδ)	Choice list 1: Cash Number of observations	Choice list 2: Cash Percentage	Choice list 2: Chocolate Number of observations	Choice list 2: Chocolate Percentage	Choice list 3: Cannabis Number of observations	Choice list 3: Cannabis Percentage
11	0.5	172	10%	444	26%	254	18%
10	0.513157895	120	7%	74	4%	100	7%
9	0.540935673	20	1%	22	1%	22	2%
8	0.571895425	77	4%	50	3%	65	5%
7	0.606617647	61	4%	32	2%	54	4%
6	0.645833333	116	7%	109	6%	105	7%
5	0.69047619	389	22%	221	13%	255	18%
4	0.741758242	81	5%	68	4%	57	4%
3	0.801282051	76	4%	51	3%	73	5%
2	0.871212121	89	5%	59	3%	58	4%
1	0.954545455	452	26%	369	21%	326	23%
0	1	68	4%	196	11%	55	4%
Multiple switch points (excluded)		11	1%	29	2%	12	1%
Violate monotonicity assumption		0	0%	5	0%	0	0%
Total		1732		1729*		1436	

Appendix Table 4:

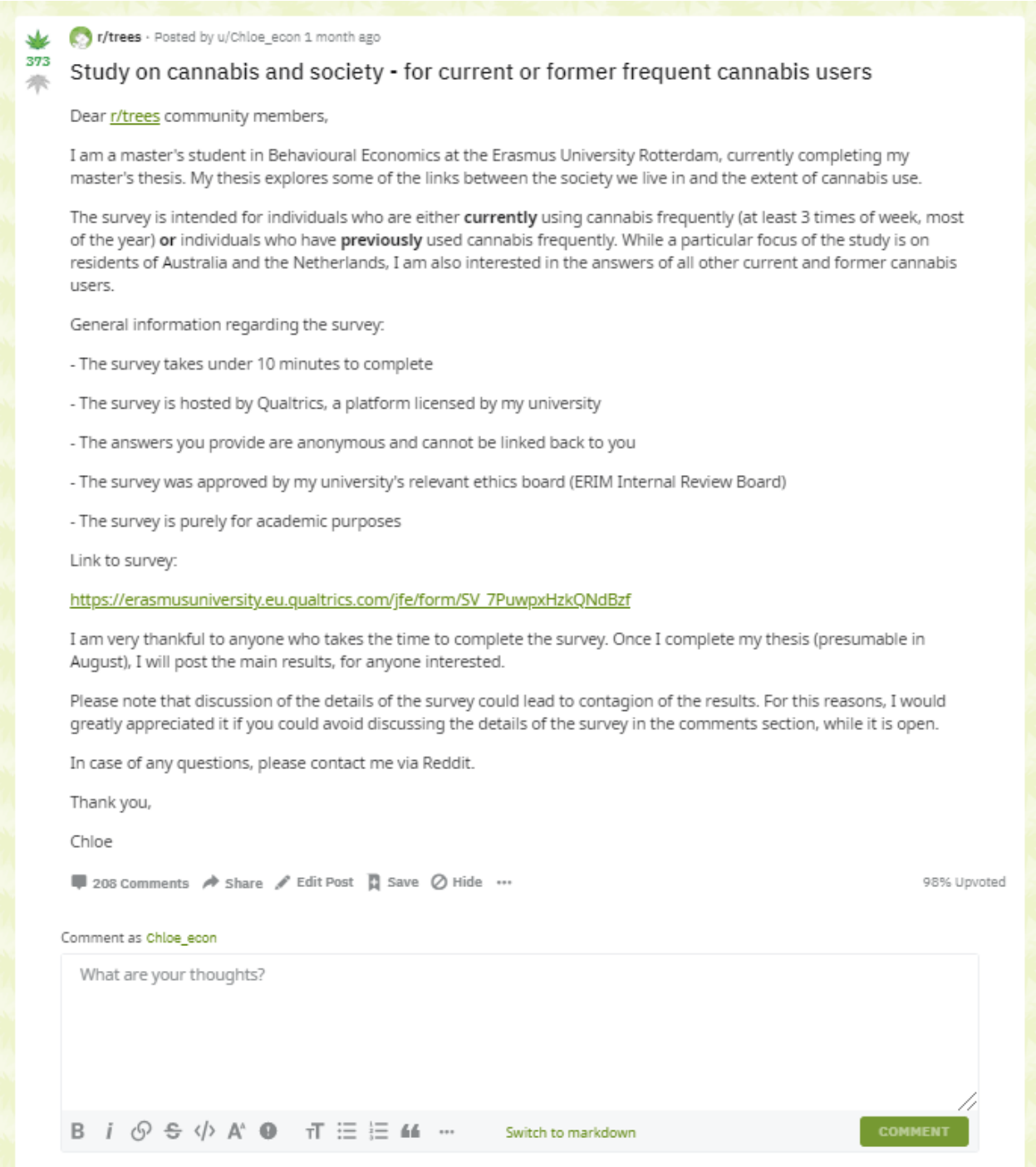
Measure	Average	Percentiles						
	[St. Error]	5th	10th	25th	50th	75th	90th	95th
δ_cash	0.744 [0.169]	0.5	0.513	0.607	0.69	0.955	0.955	0.955
β_cash	1.047 [0.2]	0.723	0.801	1	1	1.096	1.298	1.381
δ_chocolate	0.728 [0.196]	0.5	0.5	0.5	0.69	0.955	1	1
β_chocolate	1.017 [0.231]	0.624	0.774	1	1	1	1.241	1.382
δ_cannabis	0.718 [0.176]	0.5	0.5	0.541	0.69	0.955	0.955	0.955
β_cannabis	1.007 [0.179]	0.723	0.777	1	1	1.054	1.194	1.297
Craving strength scale	7.435 [4.94]	1	2	4	7	10	15	17

Appendix Table 5:

Variable name	Description	Category
Current vs Former	Binary variable which classifies participants as either current frequent cannabis users or former frequent cannabis users. Frequent cannabis use is defined as using cannabis at least 3 times a week for most of the year	Real life drug behaviour
Freq of use	Ordered categorical variable which classifies frequency of use within the following three categories: 3-4 days, 5-6 days and every day.	Real life drug behaviour
δ_cash	Standardised time-consistent discount factors for cash	δ parameter
β_cash	Standardised time-inconsistent discount factors for cash	β parameter
δ_cannabis	Standardised time consistent discount factors for cannabis	δ parameter
β_cannabis	Standardised time-inconsistent discount factors for cannabis	β parameter
δ_chococolate	Standardised time-consistent discount factors for chocolate	δ parameter
β_chocolate	Standardised time-inconsistent discount factors for chocolate	β parameter
Dly*amt	Average daily amount used over the last 3 months	Consumption habits
Dly_amt*Crim	Average daily amount used over the last 3 months for users residing in criminalised choice environment	Consumption habits
Daily	Dummy variable identifying daily users	Consumption habits
Daily*Crim	Dummy variable identifying daily users residing in criminalised choice environment	Consumption habits
Tobacco	Dummy variable identifying users who mix cannabis with tobacco	Consumption habits
AmtPur	Average amount purchased at one time over the last 3 months	Purchasing habits
AmtPur*Crim	Average amount purchased at one time over the last 3 months for users residing in criminalised choice environment	Purchasing habits
PurFreq	Categorical variable capturing the frequency of purchase	Purchasing habits
PurFreq*Crim	Categorical variable capturing the frequency of purchase for users residing in criminalised choice environment	Purchasing habits
No24	Dummy variable identifying users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*Crim	Dummy variable identifying users who do not have enough cannabis to last the next 24 hours for users residing in criminalised choice environment	Visceral events
No24*Dly_amt	Average daily amount used over the last 3 months for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*AmtPur	Average amount purchased at one time over the last 3 months for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*PurFreq	Categorical variable capturing the frequency of purchase for users who do not have enough cannabis to last the next 24 hours	Visceral events
No24*Daily	Dummy variable identifying users who do not have enough cannabis to use over the next 24 hours and use daily	Visceral events

Used	Dummy variable identifying participants who used cannabis in the last 8 hours	Visceral events
Used*Crim	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in criminalised choice environment	Visceral events
Used*Aus	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in Australia	Visceral events
Used*NL	Dummy variable identifying participants who used cannabis in the last 8 hours for users residing in the Netherlands	Visceral events
Pic	Dummy variable identifying participants who had a picture of the outcomes on their choice lists	Treatment varibles
Pic*Crim	Dummy variable identifying participants who had a picture of the outcomes on their choice lists and reside in criminalised choice environment	Treatment variables
NoPic*Crim	Dummy variable identifying participants who did not have a picture of the outcomes on their choice lists and reside in criminalised choice environment	Treatment variables
Pic*Decrim	Dummy variable identifying participants who had a picture of the outcomes on their choice lists and reside in practically decriminalised choice environment	Treatment varibles
NoPic*DeCrim	Dummy variable identifying participants who did not have a picture of the outcomes on their choice lists and reside in practically decriminalised choice environment	Treatment variables
Disc	Average decrease in price per gram associated with an increase in quantity purchases from 1 gram to 28 grams	Institutional features
Disc*Crim	Average decrease in price per gram associated with an increase in quantity purchases from 1 gram to 28 grams for users residing in criminalised choice environment	Institutional features
LenPur	Categorical variable capturing the amount of time taken to procure cannabis	Institutional features
LenPur*Crim	Categorical variable capturing the amount of time taken to procure cannabis for users residing in criminalised choice environment	Institutional features
Australia	Dummy variable identifying participants residing in Australia	Institutional features
Netherlands	Dummy variable identifying participants residing in the Netherlands	Institutional features
Canada	Dummy variable identifying participants residing in Canada	Institutional features
PracIllegal	Dummy variable identifying participants residing in a criminalised choice environments	Institutional features

Appendix Item 1: Reddit post



r/trees · Posted by u/Chloe_econ 1 month ago

373

Study on cannabis and society - for current or former frequent cannabis users

Dear r/trees community members,

I am a master's student in Behavioural Economics at the Erasmus University Rotterdam, currently completing my master's thesis. My thesis explores some of the links between the society we live in and the extent of cannabis use.

The survey is intended for individuals who are either **currently** using cannabis frequently (at least 3 times of week, most of the year) **or** individuals who have **previously** used cannabis frequently. While a particular focus of the study is on residents of Australia and the Netherlands, I am also interested in the answers of all other current and former cannabis users.

General information regarding the survey:

- The survey takes under 10 minutes to complete

- The survey is hosted by Qualtrics, a platform licensed by my university

- The answers you provide are anonymous and cannot be linked back to you

- The survey was approved by my university's relevant ethics board (ERIM Internal Review Board)

- The survey is purely for academic purposes

Link to survey:

https://erasmusuniversity.eu.qualtrics.com/jfe/form/SV_7PuwpxHzkQNdBzf

I am very thankful to anyone who takes the time to complete the survey. Once I complete my thesis (presumable in August), I will post the main results, for anyone interested.

Please note that discussion of the details of the survey could lead to contagion of the results. For this reasons, I would greatly appreciated it if you could avoid discussing the details of the survey in the comments section, while it is open.

In case of any questions, please contact me via Reddit.

Thank you,

Chloe

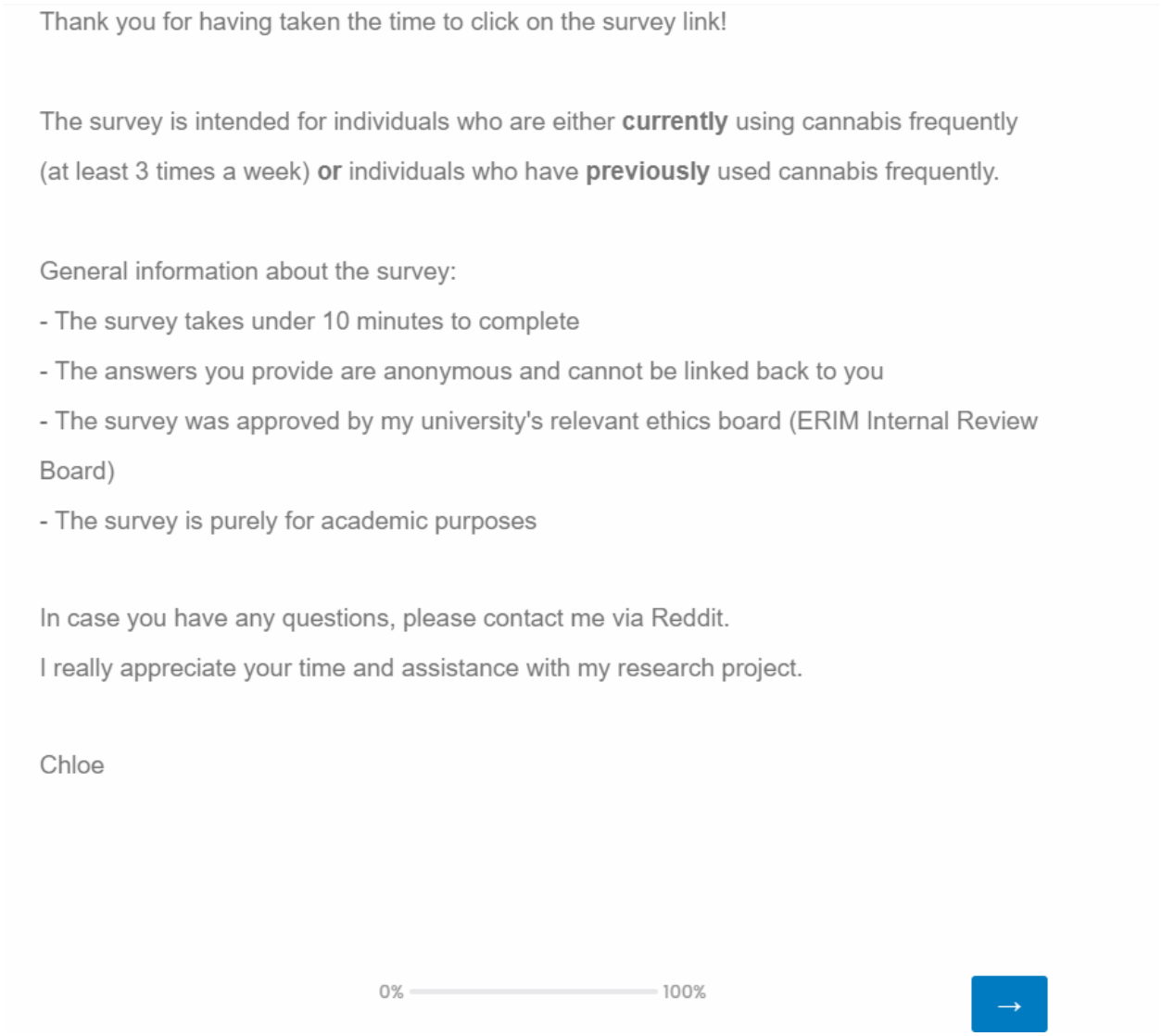
208 Comments Share Edit Post Save Hide ••• 98% Upvoted

Comment as Chloe_econ

What are your thoughts?

Switch to markdown COMMENT

Appendix Item 2: Intro message for the survey


Thank you for having taken the time to click on the survey link!

The survey is intended for individuals who are either **currently** using cannabis frequently (at least 3 times a week) **or** individuals who have **previously** used cannabis frequently.

General information about the survey:

- The survey takes under 10 minutes to complete
- The answers you provide are anonymous and cannot be linked back to you
- The survey was approved by my university's relevant ethics board (ERIM Internal Review Board)
- The survey is purely for academic purposes

In case you have any questions, please contact me via Reddit.

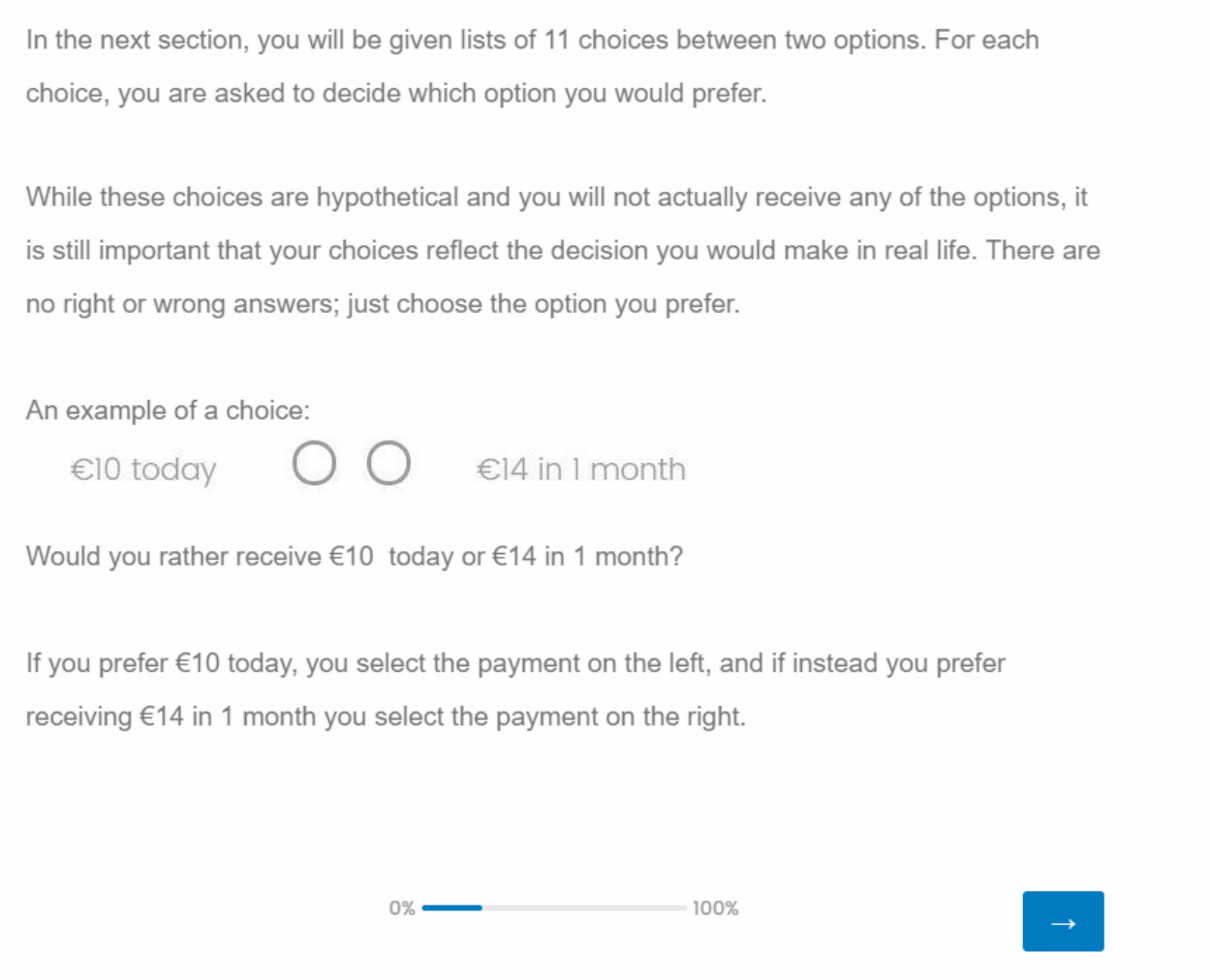
I really appreciate your time and assistance with my research project.

Chloe

0% 100%

→

Appendix Item 3: Intro to choice lists and examples of choice lists with and without the picture



Please indicate for each of the 11 choices, which option you would prefer receiving

*You are choosing between different amounts of **cannabis** at different times*

	Or	
1 gram of cannabis today	○ ○	1 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.1 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.2 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.3 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.4 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.5 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.6 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.7 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.8 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.9 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	2 grams of cannabis in 1 month

0% 100% →

Please indicate for each of the 11 choices, which option you would prefer receiving

*You are choosing between different **cash** amounts at different times*


	Or	
€10 today	○ ○	€10 in 1 month
€10 today	○ ○	€11 in 1 month
€10 today	○ ○	€12 in 1 month
€10 today	○ ○	€13 in 1 month
€10 today	○ ○	€14 in 1 month
€10 today	○ ○	€15 in 1 month
€10 today	○ ○	€16 in 1 month
€10 today	○ ○	€17 in 1 month
€10 today	○ ○	€18 in 1 month
€10 today	○ ○	€19 in 1 month
€10 today	○ ○	€20 in 1 month

0% 100% →

Please indicate for each of the 11 choices, which option you would prefer receiving

*You are choosing between different amounts of **mini chocolate bars (of your choice)** at different times*

	Or	
10 mini chocolate bars, today	○ ○	10 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	11 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	12 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	13 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	14 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	15 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	16 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	17 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	18 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	19 mini chocolate bars, in 1 month
10 mini chocolate bars, today	○ ○	20 mini chocolate bars, in 1 month

Please indicate for each of the 11 choices, which option you would prefer receiving

*You are choosing between different amounts of **cannabis** at different times*

	Or	
1 gram of cannabis today	○ ○	1 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.1 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.2 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.3 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.4 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.5 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.6 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.7 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.8 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	1.9 gram of cannabis in 1 month
1 gram of cannabis today	○ ○	2 grams of cannabis in 1 month