



Alterations in taste perception due to recreational drug use are due to smoking a substance rather than ingesting it



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ABSTRACT

Two studies explored the differences in tastant (salt, sour, bitter, sweet and spicy) concentration preference between recreational drug users and abstainers. In study 1, 250 opportunistically recruited abstainers, cannabis only users and multiple-drug users completed psychometric questionnaires and a concentration preference tastant test. In study 2, 76 participants purposefully recruited abstainers, daily tobacco users, recreational cannabis users and daily cannabis users completed the same protocol as study 1. Study 1 demonstrated that both multiple drug users and cannabis users had a higher preference for salt and sour tastants than abstainers. Study 2 showed that daily cannabis and tobacco users had a higher preference for sweet and spicy tastants than recreational cannabis users and abstainers. As predicted, recreational drug users scored higher on both sensation-seeking and impulsivity compared to abstainers. Participants who habitually smoke tobacco or cannabis daily have different concentration preference for specific tastants. The aim of the current study was to provide an explanation for the inconsistency in published results on taste preferences in recreational drug users. The data offered in this paper indicate that variation in recruitment strategy, definition of 'drug users', and mode of drug delivery, as well as multiple drug use, may explain the preference for stronger tastants in habitual drug users. Future research exploring the psychobiological underpinnings of the impact of drug use on food preferences should carefully define recreational drug user groups.

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1. Introduction

A number of studies have demonstrated that taking recreational drugs, particularly those that activate the opioid and endocannabinoid systems, affects appetite regulation (Kirkham, 2009; Tallett, Blundell, & Rodgers, 2008; Yeomans, 1998). Many studies have reported that the use of recreational drugs, usually cannabis, resulted in a higher appreciation for, or uncontrolled cravings to consume, foods (Abel, 1971; Green, Kavanagh, & Young, 2003; Mattes, Shaw, & Engelman, 1994; Nail, Richard, Gunderson, & Kolb, 1974). One explanation for this has been that cannabis alters users' perceptions of sweet tastants (Cooper, 2004; Jager & Witkamp, 2014; Tart, 1970); although both preferences for higher sour and bitter tastants have also been associated in the use of other

recreational drugs (Mata, 1963; Spitzer, 1988). Moreover, at least one study has reported null findings in regards to the effects of recreational drugs on taste perception (Mattes et al., 1994). A prevailing view within the literature suggests that recreational drugs, such as cannabis, increase appetite through non-taste-related mechanisms (Jager & Witkamp, 2014). The mechanisms that have been implicated are olfactory processing (Soria-Gómez et al., 2014), reward (specifically 'liking' processing e.g. Mahler, Smith, & Berridge, 2007), and attention and memory (Mattes et al., 1994).

Unlike animal models, human participants' drug use cannot always be precisely controlled. Individuals often use multiple recreational drugs sequentially and concurrently, making multiple drug use the norm rather than the exception (DuRant, Rickert, Ashworth, Newman, & Slavens, 1993; Jones & Heaven, 1998; Suris, Akre, Berchtold, Jeannin, & Michaud, 2007), but this is rarely accounted for. Therefore, on the basis of current evidence it is difficult to disentangle the potential effects of individual

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recreational drugs on appetite or taste perception. Moreover, laboratory designed studies examining the impact of recreational drug use on taste perception have operated on a paradigm of administering the drug in question and then performing a taste test (e.g. Foltin, Fischman, & Bryne, 1988, 1986; Mata, 1963; Mattes et al., 1994). This administration paradigm does not assess the effects of long-term habitual use of the drug and therefore tolerance, dosage and participants' weight are not considered. Differences in taste perception observed with this method could be explained by variation within the participant's habitual use, lifestyle or level of intoxication rather than by drug use directly.

Personality characteristics that predict drug taking, such as sensation-seeking, could also provide an explanation of the differences in taste perception reported. The interaction between personality and drug use has been consistently shown (Cloninger, Sigvardsson, & Bohman, 1988; Conner, Hellemann, Ritchie, & Noble, 2010; Deas & Thomas, 2002), with impulsivity frequently being identified as a key determinant (Allen, Moeller, Rhoades, & Cherek, 1998; Hayaki, Stein, Lassor, Herman, & Anderson, 2005). Consistent with the neophilic characteristics of impulsiveness, people with comparatively high levels of this personality attribute have been shown to have difficulties with healthy food choices (Kakoschke, Kemps, & Tiggeman, 2015) and have a higher preference for sweeter tastants (Saliba, Wragg, & Richardson, 2009). Interactions between personality and drug use on taste preference must be considered in order to uncover the specific impact of habitual use of a recreational drug on taste perception.

The four aims of the current study were to assess 1) if differences in taste perception were evident in participants who habitually used recreational drugs and those that did not. 2) To explore the relative impact of participant drug use categorisation/grouping on the outcome of taste perception/preference. In particular, we were interested in exploring loose grouping criteria of recreational drug use that simply compared participants who use recreational drugs against complete abstainers. 3) To improve our understanding of drug use categorisation, we also aimed to compare a purposeful sample of individuals recruited based on a history of only consuming a specific recreational drug (cannabis). 4) To assess the interaction between drug use and taste perception with reference to known personality characteristics that have been shown to also independently predict drug use. Due to the nature of the investigation, two separate studies employing different recruitment strategies were offered. Four primary research hypotheses were held based on the previous literature. These hypotheses were: a) Opportunistic sampling would uncover a highly heterogeneous sample of participants who use multiple types of recreational drugs. b) Differences in tastant preference will be observed in individuals who report taking recreational drugs and were grouped together based on loose inclusion criteria. c) No differences will be observed in tastant preferences when a strict inclusion criteria for the drug user group was applied. d) There will be an interaction between sensation-seeking, impulsivity and tastant preference. In particular, individuals with higher sensation-seeking and impulsivity will be more likely to use recreational drugs and prefer stronger sweet tastants than those with lower scores for these characteristics.

2. Method

2.1. Design (study 1)

A mixed-measures design was used to examine differences in preference for five flavours. The first independent between-subject variable was drug group, which had three levels – control, cannabis user and multiple drug user. The second repeated measures

independent variable was tastant, which contained five domains – salty, sweet, sour, spicy, and bitter. The dependent variable was the individual's reported preference for five different strengths of each tastant. Potential personality correlates were added to the analysis to explore if any interactive effects on recreational drug taking were evident. In particular, these correlates were sensation-seeking and its derivative subscales (Zuckerman, 1990) and impulsiveness (Eysenck & Eysenck, 1991), as these have been related to recreational drug use in past research (e.g. Donohew et al., 1999; Ersche, Turton, Pradhan, Bullmore, & Robbins, 2010). Participants were excluded if they reported having any allergies or disliking the test foods.

2.2. Participants

In the current paper, all individuals were deemed to be recreational rather than dependent drug users. We separated the term recreational drug user into three categories of light, moderate and heavy drug user depending on frequency of use. Light drug users were defined as those who had taken at least some form of recreational drug once a week for the last month, as well as having a history of taking recreational drugs on a monthly basis over the last year. Moderate users were defined as individuals who used recreational drugs at least once (but no more than four times) a week over the last month, and had a similar monthly profile of use over the last year. Heavy users were defined as individuals who consumed recreational drugs at least once a day, every day for the last month and reported that this was a typical monthly use profile for the last year. Multiple drug use was defined as habitual use of two or more recreational drugs.

Two hundred and fifty participants (91 male) were recruited using opportunistic sampling. The sample within study 1 were recruited from undergraduate and postgraduate student cohorts and aged between 19 and 24 years old, which was similar to all other published research in this domain. We followed similar recruitment protocols to previous research to explore the impact of the recruitment process on the outcome of the research. Fifteen participants were removed for incomplete data and a further 3 were removed due to errors in their reporting of their habitual drug use. Ten participants from the control group were excluded as they reported having tried at least one substance on at least one occasion in their past. This left a total control sample of 75 participants. Of the remaining participant pool, 147 individuals reported taking recreational drugs habitually and were further separated into multiple drug users ($n = 77$) and cannabis only users ($n = 70$). Therefore, 222 participants (86 male) were included in the analysis of study one. The average age was (20.82 ± 1.29 y), with the average weight of the sample being $67.1 \text{ kg} \pm 13.2 \text{ kg}$ and their average height was $1.71 \text{ m} \pm 0.1 \text{ m}$. The average Body Mass Index (BMI) of the sample was $22.8 \pm 3.6 \text{ kg/m}^2$ with 184 participants falling into the lean ($\text{BMI} > 18.5 \text{ kg/m}^2$), 33 into overweight ($\text{BMI} > 25 \text{ kg/m}^2$) and 5 into the obese categories ($\text{BMI} > 30 \text{ kg/m}^2$). Participants most frequently reported their ethnicity to be white (90%).

2.3. Measures

Food Neophobia and General Neophobia. Levels of food and general neophobia were measured with the Food and General Neophobia Scales (Pliner & Hobden, 1992), which have been shown to be reliable and have high internal consistency (Richey, Frank, Hursti, & Tuorila, 2003; Rigal et al., 2006). The food neophobia scale was used to measure the fear/reluctance to try unfamiliar/new foods. Participants indicated their willingness to try 10 different food items using a 7-point Likert scale (1 *strongly disagree* to 7 *strongly agree*). The general neophobia scale consisted of a

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