Exploring the Munchies: an online survey of users’ experience of cannabis effects on appetite, and the development of a Cannabinoid Eating Experience Questionnaire (CEEQ).

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**Abstract**

**Background:** Cannabis intoxication is commonly reported to increase appetite and enhance appreciation of food (“the munchies”). These effects are attributed to activation of the endocannabinoid system. However, the psychological changes that underlie these phenomena are under-researched. We report here the results of an extensive online survey of cannabis users with an exploratory Cannabinoid Eating Experience Questionnaire (CEEQ).

**Method:** Frequent cannabis users completed a 46-item, questionnaire about their eating behaviour under the influence of cannabis. An English-speaking sample (N=591) provided data for the initial exploratory validation of the scale. A second, Dutch language survey (N=163) was used for confirmatory factor analysis (CFA). Test-retest reliability was based on a third, English-speaking sample (N=40) who completed the revised, 28-item CEEQ twice across 2 weeks.

**Results:** Principal components analysis (PCA) provided a two-factor solution. Factor 1 (Hedonic) comprised 14 items which related primarily to the enjoyment and altered sensory aspects of eating. Factor 2 (Appetitive) comprised a further 14 items related to motivational factors that instigate or promote eating. The two-factor structure was supported by CFA. Both the hedonic and appetitive subscales had good internal reliability (α=0.92 for each subscale, in two independent samples). Good test-retest reliability was obtained for the revised 28-item questionnaire (*ps*<.01 for Total CEEQ and each subscale).

**Conclusion:** The CEEQ provided a valid, reliable assessment of the psychological features of cannabis -induced alterations to appetite. Our data confirm that cannabis principally influences the motivational factors which lead to the initiation of eating, and the hedonic factors implicated in maintaining eating.

**INTRODUCTION**

It is widely accepted that acute cannabis intoxication commonly results in the “munchies”, a behavioural phenomenon exemplified by increased appetite, overconsumption, and an enhanced appreciation of food and the eating experience. This hyperphagic effect of the drug is attributed largely to the action of the cannabinoid Δ⁹-tetrahydrocannabinol (THC), and is understood to reflect the ability of THC to stimulate the endocannabinoid system (ECS) – effectively mimicking the actions of anandamide and 2-arachidonoyl glycerol (2-AG; Kirkham, 2005; Kirkham 2009).

Although hypotheses about the role of endocannabinoids in appetite control have been informed by awareness of cannabis effects in people, most of our current knowledge about cannabinoid actions is based on experiments in animal models. These have demonstrated close similarities between the actions of THC, anandamide, 2-AG and other ECS agonists, and confirmed the motivational effects that are familiar to cannabis users (Kirkham, 2005). Thus, THC and endocannabinoids produce effects that are consistent with increased hunger: activating naturalistic eating behaviours, promoting food seeking, and stimulating consumption even in animals that are already fully satiated (Williams, Rogers & Kirkham, 1998; Williams & Kirkham, 1999; Williams & Kirkham, 2002). Additionally, these substances affect ingestive behaviour in ways that are entirely consistent with a specific action to enhance the palatability, or reward, of ingesta (Higgs et al., 2005; Jarrett et al., 2005; Di Patrizio & Simansky, 2008; Kirkham 2009).

Studies have also shown that brain regions classically associated with appetite control and food reward are sensitive sites for the actions of cannabinoids on eating motivation (Jamshidi & Taylor, 2001; Kirkham et al, 2002; Mahler et al., 2007). Moreover, these different effects are mediated by activation of cannabinoid CB1 receptors, since they can be reversed by selective antagonists of CB1 agonists (e.g., Williams & Kirkham, 1999; 2002; Kirkham et al., 2002).

Based on the animal data, the ECS appears to constitute an important component of brain systems controlling appetite, as well as the coordinated central and peripheral mechanisms that ultimately act to promote positive energy balance and storage (Cota et al., 2007; Kirkham, 2009). The reported actions of cannabis on eating are thus consistent with stimulation of the ECS. However, inferences from animal studies about the specific psychological actions of cannabis in people are necessarily problematic, and more detailed investigation of individual differences and variation in the subjective effects of the drug remains a priority.

So far, there is relatively little empirical data on cannabis or THC actions on human appetite, with only a handful of studies reporting acute drug effects on food intake (Abel, 1971; Hollister, 1970; Greenberg et al., 1976; Foltin et al., 1986, 1988; Haney et al., 1999a,b; 2007; Hart et al., 2002; Wachtel et al., 2002; de Bruijn et al., 2017). In the majority of cases, orally administered THC or smoked cannabis induced significant increases in food and energy intake, which was sometimes mediated by increased hunger (Hart et al., 2002), increased meal frequency (Foltin et al., 1988; Hart et al., 2002) and, in some instances, specific consumption of sweet snack foods (Abel, 1971; Foltin et al., 1988).

Other than measures of hunger, laboratory studies have provided few insights into the psychological adjustments that underlie cannabinoid-induced eating. For these aspects, we are almost wholly dependent on a small number of anecdotal accounts obtained from limited questioning of cannabis users. For example, an early survey of cannabis users in India (Chopra & Chopra, 1939) concluded that small doses of cannabis can sharpen appetite and improve taste. Later, Tart (1970) reported on common subjective effects of cannabis in a US sample of predominantly young, male, frequent users. Of the many factors surveyed, “taste effects” were amongst the most commonly experienced. More specifically, the majority of users reported: “Taste sensations take on new qualities” (93%); “I enjoy eating very much and eating a lot” (93%); “If I try to imagine what something tastes like, I can do so very vividly” (69%); “I crave sweet things to eat, like chocolate, more than other foods” (57%). These accounts were supported by Haines & Green (1970) in a similar US sample. When asked about cannabis effects on eating, 91% of respondents reported eating every time they smoked, and 85% ate more than normal when intoxicated. Notably, the majority (67%) indicated that their eating continued voraciously after any hunger had subsided, and “even when bloated”. Specific reasons given for their excessive eating included: being hungrier (30%), liking the tastes and textures of food (27%) or the sensation of chewing and swallowing (37%), or that eating was regarded as enjoyable and sensual (17%).

With almost five decades having passed since those accounts were collected, there has been little empirical work exploring the subjective effects of cannabis on human appetite. Therefore, more detailed interrogation and observation of cannabis users is required to pinpoint the specific consequences of the drug on eating motivation and experience. More comprehensive data are necessary to inform both our understanding of the involvement of the ECS in the psychological, behavioural and physiological regulation of energy balance, generate testable hypotheses for controlled human laboratory experiments, and so open opportunities to exploit greater understanding of cannabinoid actions for the development of improved therapies for disorders related to appetite and body weight (Kirkham, 2004).

In the light of recent advances in cannabinoid pharmacology, the characterization of the ECS, and burgeoning interest in medicinal applications of cannabis, more detailed investigation of the psychological components of the munchies is timely.

Using an online survey, focusing specifically on appetite- and eating-related aspects of cannabis self-administration, we aimed to obtain the most comprehensive analysis so far of these phenomena, in order to create a scale that can reliably measure the psychological components of the munchies. Questions were informed by previously reported accounts of cannabis users, our own focus group discussions, and the existing literature. The survey was particularly aimed at characterizing the cannabis-induced, psychological changes respectively associated with the initiation, maintenance and termination of eating – including the motivational, emotional, and sensory factors that determine when, what and how much is eaten when intoxicated.

**METHODS**

***Participants:*** Three samples of participants were recruited, in order to conduct an initial exploratory factor analysis and internal reliability analysis (Sample 1, N = 591), a confirmatory factor analysis (Sample 2, N = 167) and a test-retest reliability analysis (Sample 3, N = 40). Sample sizes for Samples 1 and 2 were based on recommendations of a minimum of 5-10 participants per item included in a factor analysis (Comrey & Lee, 2013), for test-retest a sample of 40 is able to identify a Pearson r of .5+ with 90% (assuming an error probability of .25 (as one tailed). Samples 1 and 3 completed an English version of the survey; Sample 2 completed a Dutch version, translated from the original by a native Dutch speaker (G.J.). We conducted the second sample in Dutch in order to provide cross-language stability for confirmatory factor analysis. Participants were recruited by advertising a link to the survey on cannabis- or drug-related social media pages, forums of websites that provide information about recreational drug use (e.g., www.bluelight.org, [www.drugs-forum.com](http://www.drugs-forum.com), [www.reddit.com](http://www.reddit.com)), an online research survey participation website ([www.callforparticipants.com](http://www.callforparticipants.com)), web sites that promote research into cannabinoid medicines ([www.maps.com](http://www.maps.com), www.IACMbulletin.com), and internal web pages of the University of Liverpool, UK (Samples 1 and 3) and Wageningen University, The Netherlands (Sample 2). The study was advertised as an investigation into cannabis use and eating experiences, and was open only to adults (> 18 years of age) who reported using cannabis at least once in the previous six months.

In exchange for their participation, respondents were given the option of entering a prize draw for online shopping vouchers. The study was approved by the University of Liverpool Research Ethics Committee, and participants were required to provide informed consent prior to undertaking the survey.

**Measures**

***Cannabis Eating Experience Questionnaire (CEEQ)***

An initial pool of 46 items for inclusion in the CEEQ was generated, to specifically target characteristics of eating behaviour and eating experience that might be influenced by acute cannabis intoxication. These items were derived by assessing responses obtained from cannabis users in previous surveys (Haines & Green, 1970; Tart, 1970), focus groups conducted in Liverpool and Wageningen, known cannabinoid effects on appetite in animal models (Kirkham, 2009), and recent literature on motivational aspects of eating behaviour (e.g., Ruddock et al., 2015). In order to capture as broad a range of “munchies” related phenomena as possible, items were devised that related to each of six identified themes: 1) *eating for pleasure, rather than need* (e.g., “I start to eat even though I feel full”); 2) *loss of control over eating* (e.g., “when I start to eat I can’t stop”); 3) *increased salience of food* (e.g., “if someone mentions food, I want to eat”) 4) *taste* (e.g., “Foods taste different to me”); 5) *increased hunger* (e.g., “I feel hungrier”), and 6) *increased sensory pleasure* (e.g., “the sensation of chewing and swallowing food is enhanced”). For each item, participants were required to indicate how much they agreed with the statement, or with what frequency a particular experience occurred, when they use cannabis. Responses were recorded using a 5-point Likert scale, ranging either from “Strongly Agree” to “Strongly Disagree”, or “Always” to “Never”.

***Procedure:*** All participants completed the survey online at [www.qualtrics.com](http://www.qualtrics.com). After giving informed consent, participants provided demographic information (age, gender, country of residence, weight and height). They were then asked questions about their cannabis use (last use, age of first use, type and strain of most frequently used cannabis, frequency of use, medicinal use). Additional questions addressed food choice and preference and the impact of cannabis (e.g., “What food is most appealing after using cannabis?”; “Is your favourite food under the influence of cannabis different to your normal favourite food?”; “If yes, how is it different?”). Participants then completed the CEEQ to address their eating experiences and behaviour under the influence of cannabis. Finally, participants were presented with a debrief statement about the goals of the study. All responses were anonymized with no identifying information was requested or collected with the questionnaires. Participants who wished to be entered into the prize draw could provide their email address. Participants recruited to Sample 3 were required to provide an email address to enable the test-retest reliability analysis, with a revised, 28-item survey completed on two occasions, separated by a 2-week interval. In neither case were email addresses associated with individual data sets.

**Data Analysis**

***Data Reduction and Statistical analyses***

Data were analysed using SPSS (and AMOS) version 22. Preliminary data screening involved removal of participants who did not respond to all items. The CEEQ items were assigned a value of 1 – 5 (1 = strongly disagree/never, 2 = disagree/rarely, 3 = neither agree or disagree/sometimes, 4 = agree/most of the time, 5 = strongly agree/always). A higher score indicated a stronger cannabis effect, therefore some items were reverse-scored in order to maintain positive inter-item correlations.

Sampling adequacy of the CEEQ was determined using the Kaiser-Meyer-Olkin measure, whereby values between 0.5 and 0.7 are considered acceptable and values > 0.7 are considered good to excellent (Hutcheson and Sofroniou, 1999). Bartlett’s test of sphericity was performed to ensure adequate correlations between items for principal components analysis (PCA).

***Exploratory Factor Analysis (EFA) – Sample 1.***

Firstly, we used a Monte-Carlo simulation to give an upper estimate of the number of factors likely to be present in the data set: this is the most statistically robust method of estimating a starting point for factor structure, as it does not rely on arbitrary cut offs such as Kaiser’s rule. Specifically, we conducted a principal components analysis using a raw data permutation in which we compared 1000 raw data permutations to actual eigenvalues derived from the data set. In order to be assumed to be statistically significant factors, the raw data eigenvalues had to exceed the 95th percentile eigenvalues derived from the simulated data. Subsequently, we conducted a PCA with a varimax rotation, with items removed if they had factor loadings of <0.4 (Osbourne, 2009) or >0.35 on more than one factor (Kiffen-Petersen & Cordery, 2003). Items were also removed following reliability analysis (Cronbach’s alpha), if they had low item-total correlation <0.7 (Gleim & Gleim, 2003), or were not conceptually similar to other items associated with each factor (O’Rourke & Hatcher, 2013).

***Internal reliability and descriptives – Samples 1 and 2***

Internal reliability of each CEEQ subscale (the two subscales which comprise the CEEQ relate to the two factors derived from factor analysis) was assessed with Cronbach’s alpha, with a lower bound of α = 0.7 considered acceptable (Nunnally & Bernstein, 1994). Total CEEQ and subscale scores were calculated by summing each participant’s response scores (1 – 5) on each item. For Samples 1 and 2, independent t-tests assessed gender differences on the CEEQ and subscales. Pearson correlations assessed the relationship between CEEQ scores, BMI and age for each sample.

Multiple regression analyses were conducted to observe whether frequency of cannabis use was associated with total and subscale CEEQ scores. In this model, BMI, gender and age were entered in step 1, and CEEQ total score and subscale scores were entered in step 2. Frequency of cannabis use (times per week) was entered as the dependent variable.

***Confirmatory Factor Analysis (CFA) – Sample 2***

The CFA was conducted in AMOS (version 22), using the maximum likelihood parameter estimation, on Sample 2 data. Model fit was assessed using a normed χ2 statistic (χ2/df), the Tucker Lewis Index (TLI), and the standardized root mean residual (SRMR) absolute fit index (Hu & Bentler, 1999). A χ2/df score <2 and TLI > 0.9, together with SRMR <0.08 represent a good model fit. Additionally, two non-centrally based indices of model fit were assessed: comparative fit index (CFI) which assumes a good fit with values ≥ 0.95 (Hu & Bentler, 1999); root mean square error of approximation (RMSEA) for which a value <0.06 is accepted as a good fit, and values between <0.06 and <0.08 are deemed acceptable (Browne & Crudeck, 1993).

***Test-retest Reliability – Sample 3 (revised 28-item scale)***

Following data-reduction, we arrived at a 28-item scale. Test-retest reliability was assessed with correlations between CEEQ total and subscale scores obtained between time 1 and time 2 in Sample 3. Values >0.6 indicate good test-retest reliability (Cicchetti, 1994).

**RESULTS**

Demographic information and cannabis use indices for each participant sample are displayed in Table 1. The types of cannabis used and data on medicinal cannabis use are summarized in Tables 2 and 3, respectively. Kruskal-Wallis tests suggested that there were no differences in BMI and age of first use of cannabis between the samples. There were small differences in age (H(2)=10.48, *p*=.005, η2 = .013) and weekly frequency of cannabis use (H(2)=10.87, *p*=.004, η2 = .014). Pairwise comparisons show that Sample 1 was somewhat older (*p*=.001) and smoked cannabis more frequently than Sample 2 (*p*=.001). Regardless of these differences, each sample can be considered to comprise frequent users: the percentage of respondents reporting use less than once per week was 11.68% (n=69) in Sample 1, 17.96% (n=30) in Sample 2, and 12.5% (n=5) in Sample 3. In each sample, respondents predominantly reported using herbal cannabis (Table 2).

Kruskall-Wallis test indicated that there was a significant difference between groups in respondents reporting use for medicinal reasons, H(2)=45.57, *p*<.001, η2 = .006 (Table 3). Pairwise comparisons show that Sample 2 had significantly fewer respondents reporting medicinal use than Sample 1 (*p*<.001) and Sample 3 (*p*=.03)

<<Insert Tables 1, 2 and 3 here>>

***Exploratory Factor Analysis (Sample 1)***

The sampling adequacy was determined to be excellent (KMO = 0.93), and Bartlett’s test of sphericity indicated that correlations between items were sufficient for EFA (χ2 (378) = 9856.28, *p*<0.001).

The parallel analysis initially identified a six-factor solution. However, subsequent PCA with varimax rotation revealed no clear six-factor solution. Following removal of items (as described in the Methods section), we arrived at a two-factor solution from 28 items. Eigenvalues for the two factors were 9.81 and 4.53, respectively.

Factor one explained 35% of the overall variance, and consisted of 14 items with factor loadings from 0.48 to 0.8 that related to hedonic aspects of eating – i.e., enhanced pleasure or sensory experience (e.g., “Food tastes better”, “I like food more”). Factor two was responsible for 16% of the overall variance, and comprised 14 items with factor loadings from 0.51 to 0.78 relating to appetitive motivational factors – i.e., elevated hunger, increased capacity for food, and greater drive to continue eating (e.g., “I eat more than usual”, “I start to eat even though I feel full”), as well as increased responsivity to food cues (e.g., “If I see food, I want to eat it”). Items within the hedonic and appetitive factors, and item-factor loadings are summarized in Table 3. The full 28-item CEEQ and scoring criteria are included in the supplementary material.

<<insert table 4 here>>

***Internal reliability and descriptives – Sample 1***

Mean CEEQ total and subscale scores are summarized in Table 4. Cronbach’s alpha confirmed a high internal consistency for both the hedonic (α = .92), and appetitive (α = .92) subscales. There were significant negative correlations between age and Total CEEQ score (*r* = -.30, *p*<.001), and between hedonic (*r* = -.23, p<.001) and appetitive subscales (*r* = -.26, *p*<.001). BMI did not correlate significantly with Total CEEQ or either subscale. There were no differences between males and females on total CEEQ, or either of the subscales (*p*s> .05).

***Internal reliability and descriptives –Sample 2***

For Sample 2, Cronbach’s alpha indicated a high internal consistency for both hedonic eating (α=.92) and appetitive (α=.92) subscales (Table 4). Age was significantly (negatively) correlated with Total CEEQ (*r* = -.26, *p*=.001) and the hedonic (*r* = -.25, *p*=.001) and appetitive (*r* = -.21, *p*=.006) subscale scores. BMI did not correlate with total CEEQ or subscale scores. No differences between males and females were observed for total CEEQ or either of the subscales (*p*s> .05).

***Confirmatory Factor Analysis (CFA) – Sample 2***

Fourteen items were free to load on the hedonic latent factor, and a further fourteen items on to the appetitive latent factor. After inclusion of covariance pathways based on modification indices (see Figure 1), the two-factor model provided an acceptable fit to the data on all measures bar the TLI, which was under the .9 threshold (χ2/df = 1.92; SRMR = 0.08; TLI = 0.88; CFI = 0.9; RMSEA = 0.07, 90% CI [0.066-0.083]).

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***Test-retest Reliability – Sample 3***

Table 4 summarizes the mean CEEQ scores (total and each subscale) for Sample 3, employing a revised 28-item CEEQ (comprising the 14 hedonic and 14 appetitive items ascertained in the CFA, described above), administered to the same participants on two occasion, separated by a 2-week interval. Intra-class (Pearson’s) correlations suggest good test-retest reliability for each subscale (hedonic *r* = .91, *p*<.001; appetitive *r* = .92, *p*<.001) and for Total CEEQ scores (*r* = .95, *p*<.001).

<<insert table 4 here>>

***CEEQ scores and frequency of cannabis use***

Regression analyses (Table 5) indicated that in both Sample 1 and Sample 2, a higher frequency of cannabis use was associated with lower scores on the appetitive subscale, after controlling for age, gender and BMI. In Sample 2, greater frequency of use was associated with higher hedonic eating scores. Frequency of use was greater in older participants in both Samples 1 and 2, and also greater in males in Sample 1.

<<insert tables 5 and 6 here>>

***Comparison of CEEQ responses between medicinal and recreational cannabis users***

We ran MANOVA on CEEQ scores in Sample 1, using whether participants reported using cannabis for a medical reason (2 levels: yes/no) as the independent variable, and subscales of the CEEQ as the dependent variables (hedonic and appetitive). There was an overall effect of group F(2, 588)=17.10, p<.001, ηp2 = .06. The individual ANOVAs showed that there was a significant effect of group on the appetitive subscale F(1, 589)=27.55, p<.001, ηp2 = .05, whereby those who reported using cannabis for medical conditions had a lower mean appetitive score (39.14±9.93) than those who did not (43.50±10.13). There were no differences between the two groups on the hedonic subscale score.

The same MANOVA in Sample 2 also suggested there was an overall effect of medicinal use F(2, 164)=5.44, p=.005, ηp2 = .06. Individual ANOVAs in this sample suggested that there was a significant effect of group on the appetitive subscale F(1, 165)=10.45, p=.001, ηp2 = .06, whereby those who reported using cannabis for medical reasons had lower mean appetitive scores (39.44 ± 12.69) than those who did not (45.30 ± 9.42), with an identical effect size as Sample 1. Interestingly, in Sample 2 there was also a significant difference on the hedonic drive subscale F(1, 165)=6.04, p=.015, ηp2 = .04, whereby those who reported using cannabis for medical reasons had lower hedonic subscale score (43.40±13.66) than those who did not (47.93 ± 9.21).

**DISCUSSION**

This study describes the development and validation of a novel tool to investigate the effects of cannabis on human appetite; the Cannabinoid Eating Experience Questionnaire (CEEQ). To our knowledge, this is the most extensive attempt to survey and characterize cannabis effects on the subjective psychological components of eating behaviour and food evaluation that accompany the drug’s acute action to induce food intake.

The CEEQ has a 2-factor scale structure, which was verified by confirmatory factor analysis in a second, Dutch-speaking sample, suggesting cross-language stability. The items included in the first factor relate to hedonic aspects of eating, while the second factor items relate to what we refer to as appetitive – i.e., the stimulation of appetite and food consumption. Both sub-scales showed excellent internal reliability and test-retest reliability. Our data confirm that cannabis principally influences the motivational factors which lead to the initiation of eating, and the hedonic factors implicated in maintaining eating.

Neither total CEEQ scores or subscale scores differed significantly between males and females. There was no correlation between BMI and total CEEQ score or scores on either subscale. However, age was negatively correlated with total CEEQ, and with hedonic and appetitive subscale scores – potentially reflecting reduced cannabis effects on appetite with increasing age. After controlling for age, gender and BMI, we found that increased frequency of use was associated with reduced appetitive drive. Taken together, the effects on appetitive drive may therefore be more related to frequency of use than to age *per se*. Conversely, there was a positive association between frequency of use and hedonic subscale scores. These data may thus reflect selective tolerance to drug effects on eating initiation, while actions on the maintenance of eating and food reward remain intact, or are enhanced, with increased use. This possibility is in line with investigations into the efficacy and tolerability of dronabinol (a synthetic form of Δ9THC approved for HIV-related anorexia) which observed tolerance to initially increased caloric intake following repeated high doses (Bedi et al., 2010). However, as our frequency of use measure is crude, the regression analysis needs to be interpreted with caution.

Analyses comparing medicinal and recreational users’ CEEQ scores suggest that those who report using cannabis for medicinal reasons (including to improve appetite) show lower scores on the appetitive subscale in Sample 1, and on both appetitive and hedonic subscales in Sample 2, than those not reporting medicinal use (*de facto* recreational users). Perhaps these differences reflect a lower baseline for these aspects of the eating experience in medicinal cannabis users. This is something which can be explored further in randomised controlled trials with more specific samples of medicinal users, rather than the broad sample of medicinal user types employed in the current analysis.

The appetitive subscale includes items that drive or lead to the initiation of eating, such as increased hunger (e.g. ,“I feel hungrier”), increased incentive salience of food (e.g., “if I see food I want to eat it”), and increased capacity for food (e.g., “No matter how much I eat, I don’t feel full”).

Increased hunger has been reported previously in cannabis users by Haines and Green (1970), and corroborates findings from the animal literature of appetite-related brain endocannabinoid activity (Kirkham et al., 2002). Similarly, increased incentive salience (i.e., food “wanting”) is regularly observed in animal models, whereby CB1 receptor stimulation will lead to energized food seeking, advanced onset of eating (Kirkham & Williams, 2001; Williams & Kirkham, 2002), increased effort to obtain food (Gallate et al., 1999; Jones & Kirkham, 2012), and hyperphagia in pre-fed, satiated rats following oral THC (Williams et al., 1998).

Following on from the psychopharmacological changes that promote the initiation of eating, we describe a factor which relates to multiple hedonic components associated with eating for pleasure, and which maintain eating once initiated. These include: enhanced smell of food; a general increased attractiveness of food (“Foods that I wouldn’t normally eat become more appealing”); enhanced taste and appreciation of flavours (e.g., “food is more delicious”); orosensory and post-oral reward (e.g., “The sensation of chewing and swallowing is enhanced”), and post-prandial evaluation (“Food is more satisfying”).

Enhanced smell potentially reflects endocannabinoid involvement in the modulation of olfactory epithelium (Breunig et al., 2011), and reflects the finding in mice that CB1 stimulation increases odour detection and promotes food intake (Soria-Gómez et al., 2014). Similarly, CB1 receptors have also been implicated in the modulation of taste (Yoshida et al., 2010). The importance of mouthfeel and the sensation of chewing and swallowing corroborate animal data suggesting cannabinoid involvement in sensory pleasure (Smith et al., 2010; Kirkham, 2009; Mahler et al., 2007), and supports cannabinoid modulation of multiple modalities contributing to the pleasure obtained from eating.

The nucleus accumbens shell, has been termed an endocannabinoid hedonic hotspot for sensory pleasure (Mahler et al., 2007). CB1 receptors are widely expressed in the nucleus accumbens (Tsou et al., 1998), and localized injections of anandamide (Mahler et al., 2007) and 2-AG (Kirkham et al., 2002) produce both hyperphagia and increased liking responses in rats. Moreover, CB1 receptor downregulation in the nucleus accumbens has been observed in dietary obese rats fed palatable junk foods (Harrold et al., 2002). The preclinical data suggest a role for the endogenous cannabinoid system in food reward or “liking”, which is reflected in the components that comprise the “hedonic eating” subscale of the CEEQ.

Clearly, endocannabinoid control of appetite is multifaceted (Di Marzo & Matias, 2005) and, as Kirkham et al. (2002) suggest, cannabinoid-associated “wanting” and “liking” are not mutually exclusive. Rather, they confer a general brain-reward activation responsible for feeding initiation, and enhanced appreciation of food while it is being consumed. This assertion is supported by the current results, with the two-factor model suggesting that cannabis has acute effects on both appetitive/motivational and hedonic factors that influence eating behaviour.

Human appetite involves a complex interplay between motivation, reward and behavioural control (Roberts et al., 2017), and it is now clear that the endocannabinoid system is heavily involved in hunger and food reward. Thus, our data suggest that cannabis-induced hyperphagia is produced by natural adjustments in endocannabinoid-mediated hunger, sensory and food-reward processes, leading to enhanced appetite and a heightened appreciation of food.

It is noteworthy that we also asked our cannabis users about their food preferences under the influence of cannabis (Table 7). The modal response from Samples 1 and 2 to the question “what food is most appealing after cannabis” was “anything/everything”, suggesting thatthe (endo)cannabinoids can enable fine tuning of palatability for all food types (Jager & Witkamp, 2014). Contrary to previous reports, it is not only sweet, snack foods which are reported as more rewarding with ‘the munchies’. Historically, research has focused narrowly on THC effects on sweet taste/foods (e.g., De Bruijn et al., 2017), but clearly more work is needed on the effects of THC on other qualities – particularly savoury (umami) and fatty tastes. The capacity of the drug to enhance the desire to eat a variety of foods would be invaluable in a therapeutic context, administering the drug to encourage consumption of a beneficial, nutritionally optimized diet.

Our questionnaire has identified cannabis influences on several aspects of eating experience. Future experiments require laboratory characterisation of the effects of acute cannabis/cannabinoid administration on food intake, food choice, eating microstructure, incentive salience, liking, and examination of the time course of effects and dose-response relationships – particularly taking into account the modulation of THC actions by other cannabinoids, such as CBD.

***Limitations:*** There are several limitations to the current study. The data are based on retrospective accounts of people’s experience whilst on cannabis, which may be problematic if we consider the association between cannabis use and memory function (Bossong et al., 2014). Similarly, we have no specific information about effective or optimal doses necessary to induce the munchies, or how dose or different preparations (e.g., cannabis-tobacco mixtures) or routes of administration (inhalation versus ingestion) affect experiences; no assumptions about these factors can be drawn from the current data. The authors encourage more experimental work in this area, with different modes of administration and cannabinoid content, to define dose-effect relationships and the time-course of cannabis actions on appetite and eating behaviour. Our analysis is restricted to examination of cannabis use in a restricted, generic sense – reflecting the limitations of investigating use of a drug that for many respondents, at the time of the survey, may have been obtained illegally with limited information about cannabinoid content. Future surveys may be able to more usefully exploit the information about specific cannabinoid content of different cannabis strains that is increasingly available to users in regions with legal, commercialized availability of the drug.

Other limitations of the current study relate to issues of potentially biased sampling. For example, while not specifically recruited, it is apparent that our samples predominantly comprised frequent cannabis users, with possible concomitant influences on drug experience related to adaptations to repeated or prolonged drug use. Moreover, it could be that this survey appealed more to cannabis users that do notice an effect of use on their eating experience; or that some respondents were conforming to social desirability, or demand characteristics. Further studies are required to resolve such issues. Moreover, well designed double-blind, placebo-controlled studies are necessary to measure dose-response, latency and duration of drug effects with greater sensitivity, and to assess effects in individuals without prior cannabis experience.

Finally, there was also no assessment of discriminant validity of the CEEQ with other scales that assess motivations for eating in this analysis; this is something which follow-up papers will seek to address.

The CEEQ has provided a valid and reliable quantification of the principal behavioural features of the munchies. Moreover, this is the most detailed, specific survey of subjective experiences of cannabis effects on human appetite to date. In line with anecdotal accounts, our data confirm that cannabis principally influences both the motivational factors which lead to the initiation of eating, and the hedonic factors implicated in encouraging and maintaining eating. The findings should provide further impetus for research in support of the therapeutic application of cannabis for conditions involving loss of appetite and body weight, including clinical and ageing populations.

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