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Psychological predictors of opportunistic snacking in the absence of hunger

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Abstract

Increased frequency of eating in the absence of homeostatic need, notably through snacking, is an important contributor to overconsumption and may be facilitated by increased availability of palatable food in the obesogenic environment. Opportunistic initiation of eating snacking is likely to be subject to individual differences, although these are infrequently studied in laboratory-based research paradigms. This study examined psychological factors associated with opportunistic initiation of snacking, and predictors of intake in the absence of homeostatic need. Fifty adults (mean age 34.5 years, mean BMI 23.9 kg/m^2, 56% female) participated in a snack taste test in which they ate a chocolate snack to satiation, after which they were offered an unanticipated opportunity to initiate a second eating episode. Trait and behavioural measures of self control, sensitivity to reward, dietary restraint and disinhibited eating were taken. Results showed that, contrary to expectations, those who initiated snacking were better at inhibitory control compared with those who did not initiate. However, amongst participants who initiated snacking, intake ~~in the laboratory~~(kcal) was predicted by higher food reward sensitivity, impulsivity and BMI. These findings suggest that snacking initiation in the absence of hunger is an important contributor to overconsumption. Consideration of the individual differences promoting initiation of eating may aid in reducing elevated eating frequency in at-risk individuals.

Overconsumption; eating initiation; eating frequency; reward; inhibitory control

1. Introduction

Overconsumption can be defined as energy intake that is superfluous to energy needs (Fay et al., 2013), with excessive portion size or consumption of energy-dense foods often implicated (Duffey and Popkin, 2011; French et al., 2014; Piernas and Popkin, 2011). However, research increasingly suggests that elevated eating frequency is a significant contributor to overconsumption and weight gain (Berteus Forslund et al., 2005; la Fleur et al., 2014; Mattes, 2014). Initiation of eating is likely to be an important driver of eating frequency, in that a higher propensity to initiate eating, especially in the absence of hunger, may be associated with overconsumption associated with greater frequency of eating episodes. This may be facilitated by increased snack food availability (la Fleur et al., 2014). It is hypothesised that individual differences exist in opportunistic snacking, and the psychological drivers of eating initiation in the absence of metabolic need are therefore of interest. However, laboratory-based research has tended to overlook initiation of eating, in favour of overconsumption as amount consumed, or portion size, during a single mandatory eating episode.

Research has shown that overconsumption within an eating episode is related to increased sensitivity to food reward (Davis et al., 2007; Epstein et al., 2011), reduced inhibitory self control (Allan et al., 2010; Haws and Redden, 2013; Jasinska et al., 2012), or an interaction of these factors (Nederkoorn et al., 2010; Redden and Haws, 2013; Rollins et al., 2010), with eating behaviour traits such as dietary restraint and disinhibition (Batra et al., 2013; Carr et al., 2014; Hofmann et al., 2007) also implicated. It is unclear whether these factors, implicated in delayed termination of an eating episode, may also be predictive of the decision to initiate eating. Much research investigating eating initiation has relied on self-report (e.g. Tuomisto et al., 1998), despite issues with under-reporting of eating frequency (McCrory et al., 2011). The aims of this study were to examine differential ~~factors~~ levels of sensitivity to food reward, inhibitory self control, dietary restraint and disinhibition between individuals who opportunistically initiated intake in the laboratory and those who did not; and secondly to examine predictors of overconsumption in this context.

2. Methods

2.1 Participants

Fifty adults (mean age 34.5 years [SD = 12.9], mean BMI 23.9 kg/m^2 [SD = 3.1,], 56% female) were recruited from the staff and student population of the Queensland University of Technology to take part in a study investigating 'differences in taste perceptions of chocolate snack food' during which they ate chocolate snack food to self-determined satiation. Participants were then invited to take part in a further, unanticipated taste test. Acceptance of this further opportunity to initiate eating having recently eaten to satiation, and resultant energy intake, was the main focus of the present study.

2.2 Measures

2.2.1 Self control

Trait self control was measured using the 30-item Barratt Impulsiveness Scale, Version 11 (BIS-11) (Patton et al., 1995), which measures general impulsivity as well as three sub-factors: motor, attentional and non-planning impulsivity (example item: 'I act on the spur of the moment'. It is generally found to have good test-retest reliability and high correlation with other self-report measures of impulsiveness (Stanford et al., 2009).

Behavioural inhibitory control was measured using a computerised GoStop task (Dougherty et al., 2005), which assesses ability to inhibit a prepotent ‘go’ response when a ‘stop’ signal is presented. Participants were required to attend to a series of five-digit numbers presented in quick succession and respond via mouse-click when a number matched the previous onenumber displayed (the ‘go’ signal). If the colour of the number changed from black to red (the ‘stop’ signal), participants were required to withhold the response. Following White et al. (2009), the parameters were set as two blocks with seven stop trials, 28 no-stop trials and 56 novel trials. Stimuli were presented for 500 milliseconds (ms) with a 600ms washout between presentations. Four intervals between the ‘go’ and ‘stop’ signals were used: 50ms, 150ms, 250ms and 350ms, presented in a randomised order throughout the trials. Percentage correct inhibition on the ‘stop’ trials was averaged over the four intervals and two blocks to produce a mean response inhibition value per session. The task has been shown to have good validity (Ledgerwood et al., 2009).

2.2.2 Sensitivity to food reward

Sensitivity to food reward was measured using the Leeds Food Preference Questionnaire (LFPQ) (Finlayson et al., 2007), measuring motivation to eat foods according to their taste and fat properties (i.e. sweet-high fat, savoury-high fat, sweet-low fat and savoury-low fat categories). Each of the four food categories was represented by four photographs of ready-to-eat foods that were matched for familiarity and palatability. Explicit sensitivity to food reward within each category was measured using visual analogue scales (VAS) with the question ‘How much do you want to eat this food right now?’. Here, data from the high-fat sweet category only were used in line with because as the test food were also high-fat sweet.fell into this category. The LFPQ is a validated predictor of food selection and intake and demonstrates reliable sensitivity to nutritional manipulations (Dalton and Finlayson, 2014).

2.2.3 Dietary restraint

The 10-item restraint subscale of the Dutch Eating Behaviour Questionnaire (DEBQ-R) (van Strien et al., 1986) was used to measure restrained eating tendency (sample item: ‘Do you try to eat less at mealtimes than you would like to eat?’). The restraint subscale has been shown to have good test-retest reliability and validity (Allison et al., 1992).

2.2.4 Dietary disinhibition

The 16-item disinhibition subscale of the Three Factor Eating Questionnaire (TFEQ-D) (Stunkard and Messick, 1985) was used to measure disinhibited eating tendency, or the tendency to eat opportunistically (sample item: ‘I usually eat too much at social occasions, like parties and picnics’). The TFEQ-D has good reliability (Stunkard and Messick, 1985) and discriminatory validity with regards to BMI (Harden et al., 2009).

2.2.5 Assessment of appetite, mood and palatability

Subjective appetite and mood sensations were measured using computerised 100-point visual analogue scales (VAS) 100mm long word anchored at each end (‘Not at all’ and ‘Extremely’). Questions were: ‘How hungry do you feel right now?’, ‘How full do you feel right now?’, ‘How stressed do you feel right now?’, ‘How alert do you feel right now?’, and ‘How content do you feel right now?’. -VAS measures of appetite have been shown to have excellent test-retest reliability (Arvaniti et al., 2000) and to correspond to levels of circulating appetite hormones (Heini et al., 1998).

2.2.6 Test food

The opportunistic taste test food was a milk chocolate snack (M&Ms; Mars) with an energy density of 4.9 kcal/g. -150g M&Ms (the size of a snack bag) was presented in a white ceramic bowl in a taste test paradigm. Participants who accepted the snack were allocated 10 minutes to participate in the taste test and complete VAS measures of mood, appetite and food palatability, together with a series of sensory ratings of the test food (not included in analysis). Participants were instructed to eat as much as they wished during the taste test, and that any leftover food would be thrown away. Amount consumed was calculated by weighing the food before and after the taste test.

The mandatory taste test chocolate snack food was Maltesers (Mars) (150g provided), of which participants self-selected the amount eaten. Sweet snack foods were chosen in accordance with the majority of previous research on laboratory-based snacking, with specific test foods chosen to be comparable in terms of taste, sensory characteristics (confirmed via self-report; data not presented here) and macronutrient composition.

2.3 Procedure

Self-report measures (BIS-11, DEBQ-R and TFEQ-D) were completed by online survey at least one week prior to the laboratory test visit, while baseline appetite and mood VAS measurements and computerised behavioural measures (GoStop and LFPQ) preceded the mandatory taste test. ~~The mandatory taste test chocolate snack food was Maltesers (Mars), of which participants self-selected the amount eaten.~~ Following this taste test, each participant was shown the opportunistic chocolate snack food (M&Ms) and told that a new taste test opportunity was available, which was optional and unrelated to the experiment. If they accepted the snack, another 10-minute taste test was administered in an identical format. Post-consumption VAS measures of appetite and mood were taken following the final taste test (either the mandatory or the opportunistic, if accepted). Finally, height (in centimetres) and weight (in kilograms) were measured while the participant was wearing light indoor clothing, and used to calculate body mass index (BMI). After the session, participants were fully debriefed. Research was approved by the Queensland University of Technology Human Research Ethics Committee.

2.4 Data analysis

Independent samples t-tests were conducted to investigate any differences between participants who accepted and those who declined the opportunistic snack. Relationships between opportunistically initiated snack intake and appetite and psychological variables of interest (eating behaviour traits, self control and sensitivity to food reward) were examined via Pearson's correlational analysis and linear regression (enter method).

3. Results

3.1 Opportunistic snacking initiation

Thirty-eight participants from the sample (76% of total sample) accepted the opportunistic taste test. Those who initiated snacking ~~following satiation~~ had consumed more at the previous, mandatory taste test than those who declined it (M = 236.1 kcal acceptors vs. M = 210.0 kcal non-acceptors), but this difference was not significant ~~($t(24.87) = -0.41$, $p = .69$)~~. There were no significant differences between those who accepted and those who declined, with the exception of inhibitory control (see Table 1). Participants who initiated snacking demonstrated significantly better inhibitory control than those who did not.

[Table 1 here]

3.2 Opportunistically initiated snack intake

VAS appetite scores confirmed that participants who initiated snacking were not hungry following the mandatory taste test (M fullness = 57 mm, 61% increase from baseline; M hunger = 44 mm, 11% decrease from baseline). Correlation analyses showed that opportunistic snack intake was not correlated with any measure of appetite (hunger: r = -.26, p = .12; fullness: r = .14, p = .40). Opportunistic snack intake was positively correlated with ~~previous intake~~amount eaten at the mandatory taste test (r = .84, p < .001).

At the opportunistic taste test, ~~M~~mean snack intake was 115.7 (SD = 151.0) kcal. The snack food was rated as moderately palatable (M palatability = 60 mm); however, intake was not significantly correlated with palatability (r = .28, p = .10). Mean opportunistic snack intake was positively correlated with sensitivity to food reward (r = .40, p = .004), motor impulsivity (r = .39, p = .006) and BMI (r = .30, p = .02). All three variables when entered into a regression model emerged as significant predictors of intake (F(3, 46) = 8.38, p < .001; see Table 2).

[Table 2 here]

4. Discussion

This study aimed to examine psychological predictors of initiation of snacking in the absence of homeostatic need, and amount eaten in an opportunistically initiated episode. The use of a community sample of adults is a strength of this study, as is the use of carefully matched test

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foods. We found that initiation of snacking was associated with higher inhibitory control. This is contrary to previous research associating overconsumption and overweight with poor inhibitory control (Houben et al., 2014; Jasinska et al., 2012; Wirt et al., 2014). However, much research has demonstrated this in the context of amount eaten within a mandatory~~n~~ eating episode, ~~relating~~ where inhibitory control may be required to terminate ~~to~~ eating when food is presented 'ad libitum' ~~termination;~~ rather than in the context of initiation of an eating episode as in the present study (Allan et al., 2010; Houben, 2011). Higher inhibitory control may reflect more conscious cognitive control and it is interesting that while this was associated with the decision to initiate snacking, it was not associated with the amount consumed in that snacking episode. It is therefore possible that this finding is indicative of a more conscious decision to initiate snacking given an opportunity, possibly coupled with the intention to later compensate for intake. The mechanism underlying increased eating initiation with increased self control is unknown, but it is possible that snacking may be initiated for reasons such as curiosity or sensation-seeking, which is satisfied by tasting a food without necessitating prolonged consumption. Higher self control may then allow successful termination of the eating episode. However, this speculation requires further investigation and would benefit from the addition of self-report. Amongst participants who did initiate snacking, greater trait motor impulsivity was associated with greater intake. This suggests that a tendency to act on motor impulses may be more strongly associated with failure to terminate eating episodes, in line with previous research. Motor control in particular may be especially pertinent to intake of bite-size snack foods, where intake involves repetitive hand-to-mouth movements (Castiello, 1997).

Food reward sensitivity was also positively associated with snack intake, supporting previous laboratory-based studies (Davis et al., 2007; Rollins et al., 2014). However, in the present study there were no differences in reward sensitivity ~~were not apparent~~ between participants who initiated snacking compared with those who did not. This may indicate that food reward sensitivity plays less of a role in initiation of eating, compared with amount eaten during an eating episode. ~~a lesser role of food reward in eating initiation specifically~~. One proposed hypothesis for this derives from the observation in this study that opportunistic snacking initiation was not related to hunger. Evidence suggests that hunger influences reward-driven motivation to eat through increasing the incentive salience of food-related cues (Kroemer et al., 2013; Loeber et al., 2013)~~, which may account for a reduced role in a satiated state~~. Alternative factors implicated in eating initiation in the absence of hunger merit further consideration, such as ~~. –~~a tendency to eat for emotional reasons rather than in response to internal hunger of satiety cues (Tylka, 2006). Another possibility is that some participants may have eaten more than they typically would in order to avoid wasting food (Fay et al., 2011). Participants were asked to self-report any perceived influences on their behaviour at the end of the study, and dislike of food wastage was not mentioned. However, this possibility cannot be ruled out and further research should aim to clarify this issue. ~~In the present study, the similarity of the opportunistic snack food with the previously consumed snack indicates that sensory-specific satiety was unlikely to play a strong role in initiation. Snack foods were comparable in terms of taste, sensory characteristics (confirmed via self-report; data not presented here) and macronutrient composition, which may reduce sensory-specific satiety-related consumption (Griffioen-Roose et al., 2010).~~

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The observed association with BMI and opportunistically initiated snack intake may highlight a link between overconsumption in the absence of hunger and risk for weight gain (Hill et al., 2008; Kral et al., 2012), although to date most research has been conducted in children. Disregard for hunger as a factor in meal termination has been linked to elevated BMI (Wansink et al., 2007), and a link with eating initiation is also likely. Given the relatively modest sample size of the current study, replication would be beneficial, especially to confirm findings in a population with a wide range of BMIs.

The use of a community sample of adults is a strength of this study, as is the use of carefully matched test foods. ~~However, it is subject to a number of limitations, principally the modest sample size. Furthermore, an in-depth exploration of reasons for eating initiation was not possible in the context of this study and additional factors may have contributed to participants' intake. In particular, as participants were informed prior to the taste tests that leftover food would be thrown away, some participants may have eaten more than they would have otherwise in order to avoid wasting food (Fay et al., 2011). Participants were asked to self-report any perceived influences on their behaviour at the end of the study, and dislike of food wastage was not mentioned. However, this possibility cannot be ruled out and further research should aim to clarify this issue.~~

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4.1 Conclusions

This study is one of the first to examine predictors of opportunistically initiated food intake in the laboratory, together with the characteristics of individuals who initiate snacking compared with those who do not. We found that opportunistically initiated intake was associated with sensitivity to food reward, motor impulsivity and higher BMI, which suggests a link with overconsumption in the absence of metabolic need through elevated eating frequency. However, we also found that inhibitory control was higher in those who initiated eating than those who did not, implying that opportunistic initiation may not simply represent uncontrolled eating in response to food availability. The factors associated with opportunistic initiation of snacking therefore merit further study. ~~Opportunistic initiation of snacking in the absence of metabolic need, implicating elevated eating frequency, is an important contributor to overconsumption and the factors predisposing it merit further study.~~ It is important to define overconsumption in order to highlight the diverse pathways to overweight and obesity, which may be a current barrier to obesity treatment and prevention.

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Table 1: Mean (standard deviation) values and t-tests between participants who initiated vs. did not initiate snacking

Variable	Initiators M (SD) n = 38	Non-initiators M (SD) n = 12	t	p
Gender (M:F)	15:23	7:5	-	-
Age	35.08 (12.75)	32.83 (13.69)	-.52	.60
BMI	23.57 (3.23)	24.21 (2.56)	.20	.84
Restraint	2.45(0.75)	2.33 (0.72)	-.89	.38
Disinhibition	5.39 (3.06)	5.00 (3.35)	.53	.60
Attentional impulsivity	16.08 (2.61)	14.27 (4.05)	-1.88	.07
Motor impulsivity	21.14 (3.08)	20.00 (3.52)	-.67	.51
Non-planning impulsivity	22.81 (4.59)	20.46 (4.91)	-1.14	.26
Inhibitory control	45.96 (12.52)	36.53 (10.90)	-2.25	.03
Food reward sensitivity	48.77 (24.95)	45.48 (11.23)	-.23	.82
VAS hunger[1]	43.67 (24.85)	37.17 (16.75)	-.84	.40

[1]Following mandatory snack intake

Table 2: Linear regression model predicting opportunistically initiated snack intake.

	Unstandardised		Standardised	t	p
	B	S.E.	Beta		
(Constant)	-620.47	171.78		-3.61	.001
Sensitivity to food reward	2.47	0.79	.38	3.13	.003
Motor impulsivity	13.41	5.47	.30	2.45	.02
BMI	13.94	5.77	.29	2.42	.02

Model $R^2 = .35$