Eating Behaviors 21 (2016) 18–23

Contents lists available at ScienceDirect

Eating Behaviors

The reinforcing value of palatable snack foods and its relationship to subtypes of behavioural and self-report impulsivity

Aaron Brace *, Martin R. Yeomans

School of Psychology, University of Sussex, Brighton BN1 9QH, UK

ARTICLE INFO

Article history:
Received 28 April 2015
Received in revised form 15 November 2015
Accepted 16 December 2015
Available online 19 December 2015

Keywords:
Impulsivity
Appetite
Behavioural economics
Reward

ABSTRACT

Data collected over the last decade has begun to implicate behavioural impulsivity in overeating behaviour. However, recent work has suggested that the reinforcing value of food may be associated with impulsive choice (a sub-type of impulsivity), but to date no study has examined how the reinforcing value of food relates to other aspects of impulsivity. To examine these inter-relationships, 80 women completed measures of eating (a snack intake test and the Three-Factor Eating Questionnaire and then in a separate test session an inhibitory control task, a delay discounting task, a reflection impulsivity task, and a measure of the reinforcing value of their chosen snack foods. Participants also completed the Behavioural Inhibition System/Behavioural Activation System (BIS/BAS) questionnaire to examine self-report and behavioural parallels between measures. In regression models, only Behavioural Inhibition System subscales of the BIS/BAS predicted increased responding on the reinforcing value of food task. The reinforcing value of food task predicted and trended to predict calorie and grams intake of snack foods in regression models, supporting RRV as a predictive measure of short-term snack intake. Likewise, impulsive choice and inhibitory control was not related to eating measures. Methodological implications are discussed.

1. Introduction

In eating behaviour, the pleasurable (hedonic) and nutritional consequences of eating a particular food shape the extent to which we find these foods reinforcing, thus influencing our motivation to obtain and consume them. In some cases, the nature of the reinforcement and subsequent motivation is elastically 'biologically pre-determined' (Epstein, Salvy, Carr, Dearing, & Bickel, 2010), in the sense that bodily changes modify the strength of the reinforcer depending on physiological need (e.g. hunger, Cabanac, 1971). For example, when acutely deprived of access to food, the reinforcing value of food will be increased in a state of hunger, thus leading to greater motivation to obtain food.

The reinforcing value of food (RRVfood) refers to the extent to which someone is willing to work or allocate resources, in terms of time or effort, for food, and it has been suggested (e.g. Epstein, 2013) that RRVfood may be a useful behavioural measure of 'wanting' as defined in the 'wanting vs. liking' distinction from the incentive salience model of motivation (Berridge, 1996). The reinforcing value of food, as related to Berridge's neurobiological 'wanting', is considered as a behavioural and motivational willingness to attain reward, as opposed to the subjective pleasure of experiencing it or 'liking'. As discussed at length by Berridge, Robinson, and Aldridge (2010), dopaminergic activity is a core neurobiological mechanism in the motivational acquisition of reward-seeking activities. There is a wealth of literature building on these core foundations of dopamine as an active agent in motivational behaviour, despite some remaining uncertainty about the underlying behavioural mechanisms.

The reinforcing value of a reward, in this case food, is conceptualised behaviourally as the extent to which our motivation drives us to obtain that reward. Existing reinforcing-value tasks using progressive variable (Ouwens, Van Strien, & Van der Staak, 2003) or more commonly progressive-ratio scheduling tasks aim to examine the extent to which an individual is willing to allocate time or resources to obtain rewards: in the case of the present study palatable snack foods. The way that progressive-ratio tasks work is to ask the participant to work progressively harder to obtain reward, usually using a simple response such as pressing the keyboard spacebar or clicking a computer mouse. For example, participants might at first be required to make 20 clicks to obtain the food reward, then 40 clicks. Critically, the amount of clicks doubles following each receipt of a reward. The critical measure is the point at which the participant is no longer willing to work for the reward, the break-point. This value has been shown to have predictive value in eating research: Epstein's group and others have shown higher break-points using RRVfood tasks predict aspects of eating implicated in poor control: higher measures on RRVfood were related to higher ad libitum intake (Epstein et al., 2010, Epstein & Leddy, 2006 and Epstein, Carr, Lin, & Fletcher, 2011), and has been associated with obesity (e.g. Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008: Giesen, Havermans, Douven, Tekelenburg, & Jansen, 2010).

* Corresponding author.
E-mail address: a.brace@sussex.ac.uk (A. Brace).

http://dx.doi.org/10.1016/j.eatbeh.2015.12.001
1471-0153/

One key question is how individual differences in RRVfood relate other factors that also may pre-dispose people to react to the opportunity for reinforcement, such as impulsivity. Although some studies have discussed this relationship, no study to date has systematically examined the relationship between RRVfood and the three main subtypes of behavioural impulsivity: inhibitory control, impulsive choice and reflection impulsivity. Epstein et al. (2010) suggest that delayed discounting (impulsive choice) and RRVfood, although fundamentally different behavioural models, could be integrated and developed into a model that encapsulates critical risk factors for understanding weight gain. There is an emerging body of evidence linking RRV to delayed discounting preferences. The work of Rollins, Dearing, and Epstein (2010) suggests that there is a moderating relationship between delayed discounting and RRV on increased weight gain in nonobese individuals.

Taking a behavioural economic approach to human food choice and acquisition, and with much focus on impulsive choice through delayed discounting tasks, Carr, Daniel, Lin, and Epstein (2012) describe a model of 'reinforcement pathology'. This concept refers to the interaction between motivational and executive systems, or top down and bottom up, with RRVfood indexing the motivational system, and executive referring to constructs of impulsivity, specifically inhibitory control. Extrapolating the link between preferences on delayed discounting tasks and RRV; this model proposes an interaction between RRV and impulse or inhibitory control. The authors suggest that dopamine reward pathway activation is associated with RRV (as discussed previously), and suggest that this activation may also in part be linked to reduced impulse control (Volkow, Wang, Fowler, Tomasi, & Baler, 2012).

Although this provides a relatively interesting mechanism for understanding a possible relationship between RRV and inhibitory control as mediators of short-term overeating, that dopamine dependent incentive mechanisms may drive impulsive behaviour, there has been little behavioural work carried out directly examining this idea. The primary aim of the present study is therefore to investigate the interrelationship between RRV and behavioural impulsivity as predictors of increased snack food consumption. Notably, most prior work using the RRV methodology has been conducted in a paediatric setting, often with obese children (Temple et al., 2008). The present study therefore also examines for the first time how RRV (as measured by progressive-ration procedures), impulsivity and uncontrolled eating were inter-related in a normal weight, healthy adult population.

Additionally, although the association between RRV, inhibitory control and delayed discounting has been discussed and tested, the relationship between RRV and a third subtype of impulsivity, reflection impulsivity – the ability to reflect adequately on the available evidence before making a decision – has yet to be explored to our knowledge. Thus the present experiment was the first attempt to examine the relationship between behavioural motivation (as measured by RRV) and the three main behavioural constructs of impulsivity, in relation to increased snack consumption and scores on the disinhibition scale of the Three Factor Eating Questionnaire (TFEQ-D). TFEQ-D was included since it was previously found to moderate the relationship between RRVfood and 12-month weight gain (Carr, Lin, Fletcher, & Epstein, 2014). Given the literature suggesting that those high in both disinhibition and restraint (TFEQ-R) are characterised as most likely to overeat or are 'unsuccessful dieters' (Van Strien et al., 1986), this investigation aims to assess the interaction between these two components TFEQ-R and TFEQ-D, and their interactive product on RRV and other subtypes of impulsivity, not just disinhibition alone.

We hypothesized that higher scores on the RRV will be associated with faster delayed discounting and weaker inhibitory control, and given the association between TFEQ-D and reflection impulsivity (Leitch, Morgan, & Yeomans, 2013), we also predicted RRV to relate to this third component of impulsivity. We also hypothesize that dietary attitudes, RRV, delayed discounting and subtypes of impulsivity will be related to ad libitum intake. In terms of the models themselves, we anticipate that impulsivity and RRV will be additive in their effects on snack intake, in the sense that both sets of variables will independently contribute to ad libitum snack intake.

2. Method

2.1. Participants

Participants were 80 women between the ages of 18–35 who were students or staff at the University of Sussex. All approached participants had previously completed a recruitment questionnaire, which contained the TFEQ and dietary requirements and allergies. Participants were told that the study was about 'snacking behaviour and cognitive performance'. Participants were ineligible to take part if they smoked (>5 cigarettes per week), did not meet the BMI requirements (between18 and30), were taking regular medication, or were allergic to any ingredients in the snack foods used. All participants gave their written informed consent and were paid either £6 or 6 course credits for their participation. The University of Sussex ethical review committee approved the study. Participants were excluded based on either not responding throughout the GoStop task, or for non-systematically erroneous responding on the DDT in accordance with Epstein (2009).

2.2. Materials

2.2.1. RRV slot-machine task

The relative reinforcement task (RRV) was in the form of a slot machine style game with 3 shapes that rotate on the screen. A point was earned each time the three shapes match in shape and colour. For every five points earned, the subject received a 15 g portion of his or her preferred snack food in a translucent cup selected in the ad libitum task as the one which was rated as most pleasant or 2 min of reading time, depending on which reward they chose to work for (participants could choose to work for food or reading time (a copy of general interest magazines and newspapers), or could alternate according to choice on separate windows of the software on the same monitor). The programmed reinforcement schedules for food and reading were progressive fixed-ratio schedules with response requirements of 4, 8, 16, 32, 64, 128, 256, 512 and so forth for each point, and 5 points were required to obtain a reward. This meant that in the FR 4 schedule, participants earned a point every 4 responses, meaning that they needed 20 responses to progress to the next schedule, and therefore earn a reward. Whenever participants were informed by the software when a reward was won, they were required to alert the experimenter using an external light activation switch from inside the cubicle, who provided the participant with the allocated reward portion (14-20 g, 100 kcal). Participants could end the task when they no longer wanted to earn either reward by contacting the researcher. Water was provided ad libitum.

The last reinforcement schedule (Pmax, the dependent variable) was the last schedule at which subjects met requirements for 1 point towards either reward, and the proportion of responses for food compared with the alternative (RRVprop) was calculated (Pmax food)/(Pmax food + Pmax reading) as the dependent variable to have a metric for understanding the reinforcing nature of food versus and non-food alternative, the RRVfood vs RRV reading.

2.3. Snack foods used in taste test and in RRVfood task

The snack foods used in the taste test and RRVfood task were Walker's ready salted crisps (Walkers, UK), cheese corn tortilla chips (Sainsbury's, UK), M&M's (Mars, USA) and chocolate buttons (Sainsbury's, UK), see Table 1 for nutritional information.