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Research report

Levels of craving influence psychological challenge and physiological reactivity

Daniel Frings *, Guleser Eskisan, Marcantonio M. Spada, Ian P. Albery

Department of Psychology, London South Bank University, London, 102 Borough Road, SE1 0AA, UK

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ABSTRACT

Behavioural and cognitive pathways that lead to the activation and escalation of craving have been studied extensively. Conversely, limited efforts have been directed towards understanding how craving relates to motivational systems and neuroendocrine responses. These can be understood using the biopsychosocial model of challenge and threat. In the current study, forty participants with varying levels of chocolate craving undertook two word searches, with the prospect of winning a piece of chocolate. Amongst those with high levels of craving, participation in this task led to motivational states of challenge relative to those with lower levels. This was reflected by changes in cardiac reactivity driven by differences in sympathetic-adrenal-medullar and hypothalamic–pituitary-adrenal axis activation. This finding suggests that craving can be associated with states of motivational challenge and thus affect cardiac reactivity.

Introduction

Craving is often referred to as an automatic, powerful and subjective experience which encourages individuals to achieve a given desired target in order to experience its rewarding effects (Marlatt, 1987). Central to this view is the idea that craving is an epiphenomenon of addictive conditioning processes (e.g. Stewart, Dewit, & Eikelboom, 1984). More recently it has been argued that craving is unlikely to be a purely automatic process. For example, van Dillen, Papies, and Hofmann (2013) have shown that cognitive load can reduce the impact of craving and Kavanagh, Andrade, and May (2005) have suggested that the intensity and frequency of craving reflect voluntary cognitive elaboration including mental imagery.

Although much research has investigated the behavioural and cognitive pathways that lead to the activation and escalation of craving, limited efforts have been directed towards elucidating how craving is linked to motivational states. One way of understanding how craving relates to motivational states is to investigate how it affects associated psychophysiological markers. A particular framework which may be relevant in understanding this is the biopsychosocial model of challenge and threat (BPSM; Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). The BPSM argues that in situations where individuals are motivated to perform, they can undergo motivational states of either *challenge* or *threat* which guide goal fulfilment intentions. States of challenge and threat have been linked to a variety of cognitive and behavioural outcomes. For instance, challenged individuals focus their attention more on areas of the visual field associated with gains (Frings, Rycroft, Allen, & Fenn, 2014), have short and long term improvements in sports performance (e.g. Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; Moore, Wilson, Vine, Coussens, & Freeman, 2013), score higher on word games (e.g. Mendes, Blascovich, Lickel, & Hunter, 2002) and may experience more positive affect (see Blascovich & Mendes, 2000). A significant body of research has identified a pattern of neuroendocrine responses (reflected in changes in the cardiovascular system). The links between these markers and challenge/threat have been validated in numerous studies from a number of research groups, which differentiate individuals in states of challenge and threat (see for instance; Blascovich & Tomaka, 1996, Moore, Vine, Wilson, & Freeman, 2014; Scheepers, de Wit, Ellemers, & Sassenberg, 2012). When an individual engages in a performance motivated task (one which requires effort for material gain, or for the purposes of positive self-presentation) they demonstrate increased sympathetic-adrenal-medullary (SAM) activation, leading to increased heart rate (HR; number of beats per minute) and increased vasodilatation (i.e. decreased total peripheral resistance; TPR). In threat states, simultaneous activation of the hypothalamic-pituitary-adrenal system inhibits vasodilatation leading to (relatively) increased TPR. As both challenge and threat are differentiated by changes in TPR, they are conceived of as relative states on a bi-polar continuum (where someone more challenged can also be seen as less threatened and vice-versa).

* Corresponding author.
E-mail address: fringsd@lsbu.ac.uk (D. Frings).

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States of challenge and threat are thought to be the result of an appraisal of both the demands present in a task and the resources one has to face it. Demands can include risk, uncertainty and high effort. Resources can include expertise, knowledge and external support. The potential gains a situation presents may also act as a resource. For instance, Elliot and Harackiewicz (1996) suggest that individuals evaluate a goal-setting task as a challenge provided they have enough resources to meet the demands. Similarly, Kozlowski and Wilkinson (1987) have suggested that craving activates motivational states, producing positive outcomes when the desired object is consumed. Exposure to drug related cues can also lead to an anticipation that craving can be fulfilled, and subsequent behaviours/cognitions. For instance, Droungas, Ehrman, Childress and O'Brien (1995) showed that telling smokers they could smoke (e.g. presenting them with an opportunity to fulfil craving) leads to greater feelings of withdrawal and desire to smoke when presented with a smoke related cue (seeing others smoke). Such behaviours are likely to be automatic, and reflect activation in the ventral striatum, amygdala and orbitol-frontal cortex (see Chase, Eickhoff, Laird, and Hogarth, 2011).

Direct evidence for links between future gains and motivational states can also be found in the challenge and threat literature. For instance, Seery, Weisbuch, and Blascovich (2009) have shown that participants primed to view a task as being gain-orientated (e.g. framed as having a potential to win money) showed states of challenge relative to those with a loss-orientation condition (e.g. framed in terms of potential money loss). Similarly, Chalabaev, Major, Cury and Sarrazin (2009) have shown that participants who believed a task would identify them as high performers (providing an approach related goal) experienced challenge relative to those who believed the task would identify them as weak performers (providing an avoidance related goal).

The current study examines the links between craving towards one of the most popular snacks in the world, chocolate, and motivational changes expressed through neuroendocrine system reactivity. Chocolate consumption is widely associated with enjoyment and pleasure and has been found to provide its own hedonistic reward by satisfying craving (Parker, Parker, & Brotchie, 2006). Rozin, Levine, and Stoess (1991) suggest chocolate craving stems from a perceived need to restore physiological deficiencies, such as energy loss. Individuals may thus prefer to indulge in chocolate than other foods, due to its high calorie content in fat, sugar and carbohydrates (Hill & Heaton-Brown, 1994), along with the pleasurable effect of a melt-in-the-mouth sensation (Rozin et al., 1991).

Given the operation of states of challenge and threat through appraisals, and the likelihood that craving will influence appraisals of subsequent gains, a prediction can be made that states of challenge will vary as a function of momentary levels of craving for the desired object, with higher craving linked to increased challenge. The current study tested this prediction by measuring changes in physiological indexes associated with states of challenge and threat amongst participants with various levels of chocolate craving whilst they took part in a task aimed at winning chocolate.

Method

Participants

Forty-eight participants aged between the ages of 18 and 30 were recruited from a London University. Forty participants (27 female and 13 male, Mean age = 21.75 years, SD = 2.73) completed the study. Complete data from the remaining eight participants was not collected due to equipment malfunction (e.g. sensors detaching during the study leading to poor quality/absent signals or automatic recalibrations of the blood pressure monitoring equipment occurring mid-study) and also experimenter error (e.g. failing to note start and end times of recordings).

Design

A correlational design was employed.[1] The critical variables measured included levels of chocolate craving prior to the tasks being undertaken, and levels of challenge/threat states experienced during each of the two word searches. Performance and perceived task difficulty were also recorded.

Measures

Craving

States of chocolate craving were measured using a chocolate craving scale modelled on (but not replicating directly) the Alcohol Craving Questionnaire Short Form-Revised (see Singleton, Tiffany, & Henningfield, 2004). The scale comprises eight items ('I have a desire for chocolate right now', 'Nothing would be better than eating a chocolate bar now', 'If it were possible I would eat a bar of chocolate now', 'All I want right now is a bar of chocolate', 'A bar of chocolate would taste good now', 'I would do almost anything for a chocolate bar now', 'Eating chocolate would make me less depressed' and 'I am going to eat chocolate as soon as possible') scored on 5 point scale (1 = *strongly disagree*, 5 = *strongly agree*). Internal reliability of the scale was good (Cronbach $\alpha = .86$) and no item removal was found to improve reliability.

Challenge and threat

Measures of challenge and threat were obtained via impedance cardiography (ICG), electrocardiography (ECG) and continuous blood pressure monitoring.

ECG measures were obtained using a Standard Lead II configuration via a BIOPAC ECG100C amplifier, whilst ICG measures were recorded using a BIOPAC NICO100C amplifier via electrodes to provide basal transthoracic impedance (ZO) and its first derivative (dZ/Dt). Continuous blood pressure was measured using a CNSsytems CNAP monitor connected to a BIOPAC DA100c amplifier. Samples were taken at 1 kHz. Data were collected, filtered and complied using Acknowledge 4.2 'ICG Analysis' function (with default calculation methods and filtering methods retained).

Measures derived from ICG, ECG, blood pressure and heart rate readings formed various indexes including cardiac output (CO), heart rate (HR), pre-ejection period (PEP), left ventricular ejection time (LVET) and total peripheral resistance (TPR). Challenge-threat indexes were calculated by converting TPR and CO reactivity of each participant into z-scores. These indexes allowed comparisons of: (a) resting baseline and practice phase; (b) resting baseline and task phase; and (c) practice and task phase to be made. Since TPR and CO both relate to SAM and HPA activation and share variance, a single index was generated for each of these challenge-threat comparisons (see Blascovich et al., 2004; Frings, Hurst, Cleveland, Blascovich, & Abrams, 2012). zTPR values were subtracted from zCO values creating a challenge-threat index. Higher values of this index indicate relative states of challenge, whilst lower scores indicate relative states of threat (typically interpreted as scores above 0 indicating relative challenge within a sample, and below 0 relative threat).

[1] Two version of the practice word search were used in an attempt to vary task difficulty. An independent *t* test was conducted to compare practice phase word search scores in the easy word search and difficult word search conditions. There was no significant difference in the performance between the 'easy' ($M = 5.00$, $SD = 2.77$) and 'difficult' ($M = 4.85$, $SD = 2.99$) word search conditions; $t(38) = 0.164$, $p = 0.87$. Nor did the perceived difficulty of the easy ($M = 7.10$, $SD = 1.91$ and difficult ($M = 7.20$, $SD = 1.88$) conditions differ, $t(38) = .17$, $p = .87$. Thus, these conditions were collapsed.