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Exposure to food cues moderates the indirect effect of reward sensitivity and external eating via implicit eating expectancies

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ABSTRACT

Previous research has suggested that the expectancy "eating is rewarding" is one pathway driving the relationship between trait reward sensitivity and externally-driven eating. The aim of the current study was to extend previous research by examining the conditions under which the indirect effect of reward sensitivity and external eating via this eating expectancy occurs. Using a conditional indirect effects approach we tested the moderating effect of exposure to food cues (e.g., images) relative to non-food cues on the association between reward sensitivity and external eating, via eating expectancies. Participants ($N = 119$, $M = 18.67$ years of age, $SD = 2.40$) were university women who completed a computerised food expectancies task (E-TASK) in which they were randomly assigned to either an appetitive food cue condition or non-food cue condition and then responded to a series of eating expectancy statements or self-description personality statements. Participants also completed self-report trait measures of reward sensitivity in addition to measures of eating expectancies (i.e., endorsement of the belief that eating is a rewarding experience). Results revealed higher reward sensitivity was associated with faster reaction times to the eating expectancies statement. This was moderated by cue-condition such that the association between reward sensitivity and faster reaction time was only found in the food cue condition. Faster endorsement of this belief (i.e., reaction time) was also associated with greater external eating. These results provide additional support for the proposal that individuals high in reward sensitivity form implicit associations with positive beliefs about eating when exposed to food cues.

In recent years there has been a growing interest in why individuals make poor food choices. One of the greatest challenges to addressing individuals' eating behavior and food choice is lack of understanding of processes that lead some people to over-eat more than others, despite exposure to the same environment. A growing avenue of enquiry in this area has focused on a personality trait referred to as 'Reward Sensitivity.' Reward sensitivity is a biologically-based, predisposition to seek out rewarding substances and to experience enjoyment in situations with high reward potential (Gray & McNaughton, 2000). This trait is often measured using self-report questionnaires. Such measures typically correlate with activation of the dopaminergic pathways when participants are exposed to appetitive substance (e.g., Beaver et al., 2006) and other behaviors with an appetitive approach response (e.g., Bijttebier, Beck, Claes, & Vandereycken, 2009; Loxton & Tipman, in press).

The brain's dopamine "reward" pathways have been proposed as the key biological basis of this trait and have long been associated with pleasure seeking behavior and the reinforcing effects of drugs of abuse in human and animal studies of addiction (Koob, 1992; Olds & Milner, 1954; Wise, 2004). Highly palatable foods also activate this region of the brain in similar patterns to more potent drugs of abuse (Volkow et al., 2010). Given the biological links between individual differences in reward sensitivity and neural response to substances of abuse and palatable foods, a core theme of recent research has been the proposal that highly reward-sensitive individuals are more attuned to the rewarding properties of drugs that are abused and to the reinforcing properties of high fat/high sugary "tasty" food (Dawe & Loxton, 2004; Hennegan,

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Loxton, & Mattar, 2013; Loxton & Tipman, in press). Using self-report measures in community and university female samples, heightened reward sensitivity has been consistently associated with binge-eating, self-induced vomiting, being overweight, meeting diagnosis for bulimia nervosa, having a preference for foods high in fat and sugar, and a preference for colorful and varied food (Davis & Carter, 2009; Guerrieri, Nederkoorn, & Jansen, 2008; Loxton & Dawe, 2001, 2006, 2007).

Reward pathways have been implicated in forming strong memories and associations between the act of eating and the pleasure that comes with eating (Nijs, Franken, & Muris, 2009). In particular, smells and images associated with tasty foods (e.g., the smell of hot chips, pictures of chocolate cake) activate the reward pathways (Van Strien, Herman, & Verheijden, 2009). Most notably, reward-related cues have been found to activate the reward pathways even more strongly than the consumption of the rewarding substance itself (Schultz, 1998). One possible reason for this activation in some individuals is the reward *hyper*sensitivity hypothesis, in which heightened reward responsiveness may motivate individuals to over-consume food (Dawe & Loxton, 2004; Stice, Spoor, Bohon, Veldhuizen, & Small, 2008).

Whilst the association between reward sensitivity and problematic eating is now well-established, the aim of current research is to examine possible mechanisms by which individual differences in traits such as reward sensitivity affect eating behavior. Previous studies with college age students, predominately female, have found reward sensitivity to be associated with the desire to eat and greater self-reported external eating (i.e., eating when externally cued) when exposed to external food cues (Hennegan et al., 2013; Hou et al., 2011; Van Strien et al., 2009). Individuals higher in reward sensitivity pay more attention to the processing of food related cues and allocate a greater amount of cognitive resources given to food-related cues (Hennegan et al., 2013). However, the mechanism by which this trait may result in this specific eating style has not been determined. One proposal has been that reward sensitive individuals form stronger implicit beliefs regarding the rewarding and pleasurable outcomes of eating (Hennegan et al., 2013).

Beliefs regarding the positive outcomes from eating highly palatable, high calorie food offer additional pathways from reward sensitivity and cue-exposure to eating behavior. Used extensively in the study of addiction, expectancy theory proposes that individuals form strong beliefs regarding the outcomes associated with specific behaviors; such beliefs guide future behavior (e.g., Bruce, Mansour, & Steiger, 2009). Eating expectancies relate to the positive effects of food consumption, e.g., “eating is a good way to pass the time”, “eating is a great way to celebrate” (Hohlstein, Smith, & Atlas, 1998). Thus, the formation of strong expectations about the positive outcomes of eating high calorie food may be one mechanism that drives food cravings and problematic-eating in reward sensitive individuals.

1. Aims of the study

In a previous study, it was found that reward-sensitive university women showed stronger associations (e.g., faster reaction times to the belief that eating is a good way to celebrate) than less reward-sensitive women when presented with pictures of (appetitive and healthy) food on a computerised reaction time “Expectancies task” (E-TASK). The E-TASK was initially developed to measure implicit alcohol expectancies (Read & Curtin, 2007), but has been adapted to measure food expectancies (Hennegan et al., 2013). The E-TASK measures the speed at which participants are able to access such eating expectancies. Additionally, faster reaction times on the E-TASK between the food pictures and positive beliefs about food was, in turn, associated with greater external eating (Hennegan et al., 2013). The current study aims to extend previous research through explicitly testing exposure to food cues as moderating the pathways from heightened trait reward sensitivity to external eating via implicit expectancies to the rewarding properties of palatable foods. Previous research has focused on general exposure to food cues during the E-TASK without a non-food cue condition (Hennegan et al., 2013). As such, this previous study could not address whether the activation of implicit expectancies was due to food-cue per se, or the passage of time during the experiment. Thus, this study will attempt to address this shortcoming by exposing participants to either an appetitive food cue or neutral cue (i.e., colors), in addition to replicating the effect of the E-TASK. Only women were recruited in keeping with previous research investigating reward sensitivity and eating behavior (Hennegan et al., 2013; Loxton & Dawe, 2006; Loxton & Tipman, in press). It was hypothesised that 1) women higher in reward sensitivity (and thus more likely to notice and approach appetitive stimuli) would score higher on a self-report measure of external eating, 2) that high reward sensitivity would be associated with faster responding to eating expectancies in the E-TASK, when appetitive food images are embedded with the task (but not when non-food images are embedded), 3) that faster reaction time to the eating expectancy ‘eating is rewarding’ would mediate the relationship between reward sensitivity and external eating for those in the food-cue E-TASK condition. This moderated mediation model is shown in Fig. 1.

2. Method

2.1. Participants

Participants were 119 psychology undergraduate women who received course credit for participation. The sample was almost entirely Caucasian (98%) with a mean age of 18.67 ($SD = 2.40$). Two participants did not endorse any of the “eating is rewarding” E-TASK items and thus were not included in the test of indirect effects, leaving a total sample of 117. The study received ethical approval from the University‘s Human Ethics board.

2.2. Experimental design

A 2 way between subjects design was employed. Participants were randomly allocated to one of two E-TASK cue (food cue embedded, non-food cue) conditions. The dependant variable was reaction time to the E-TASK “eating is rewarding expectancy” statements, controlling for reaction time to self-description items. Urge to eat was measured pre- and post- E-TASK to check the food cue condition was an effective manipulation.

2.3. Procedure

Participants completed the procedure in groups of one to eight at computers separated by partitions in a university computer lab under the supervision of a research assistant. Measures were completed via an online survey system which contained instructions and safeguards to ensure participants could not skip ahead of the experimental task. Initially participants completed demographic items and baseline urge to eat scale. Participants then completed the E-TASK with approximately half of the participants ($n = 59$) randomly exposed to appetitive food images throughout the task (as used in Hennegan et al., 2013), whilst the other half ($n = 60$) in the neutral condition were exposed to screens of various colors in place of food images. After completing the E-TASK, participants completed another urge to eat visual analogue scale. Self-