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Research report

To eat or not to eat. The effects of expectancy on reactivity to food cues ☆

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ABSTRACT

Cue reactivity may be determined by the ability of cues to evoke expectations that a reward will be imminently received. To test this possibility, the current study examined the effects of manipulating expectations about the receipt of food (pizza) on self-reported and physiological responses to pizza cues, and attentional bias to pizza pictures. It was predicted that expecting to eat pizza would increase salivation, self-reported measures of motivation and attentional bias to pizza cues relative to conditions where there was no eating expectancy. In a within-subjects counterbalanced design, 42 hungry participants completed two pizza-cue exposures in a single experimental session during which their expectation of consuming the pizza was manipulated (*i.e.*, expectancy of eating imminently *vs.* no eating expectancy). They also completed a computerised attentional bias task during which the probability of receiving pizza (0%, 50% or 100%) was manipulated on a trial-by-trial basis. Participants showed reliable increases in hunger and salivation in response to the pizza cues, as well as a bias in attentional maintenance on pizza pictures. However, these responses were not influenced by eating expectancy. Contrastingly, expectancy did influence early attentional processing (initial orientation of attention) in that participants directed their first gaze towards pizza pictures more often on 100% and 50% probability trials relative to 0% trials. Overall, our findings indicate that exposure to food cues triggers appetitive responses regardless of explicit expectancy information. Methodological features of the study that may account for these findings are discussed.

Introduction

The consumption of food is highly rewarding and therefore supports the development of conditioned responses. Initially, food acts as an unconditioned stimulus (US) that elicits unconditioned responses (URs). Through a Pavlovian conditioning process, the rewarding properties of food become associated with external cues that are present at the time of consumption, such as the sight and smell of food. These external cues become conditioned stimuli (CS) that influence eating initiation and meal size and evoke a number of conditioned responses (CRs) (Weingarten, 1985). Accordingly, exposure to food cues in humans has been shown to reliably elicit CRs such as changes in subjective state (increased hunger, desire to eat and craving), physiological readiness to eat (increased salivation and heart rate) and cognitive changes, such as food-related attentional bias (Fedoroff, Polivy, & Herman, 1997; Ferriday & Brunstrom, 2011; Nederkoorn, Smulders, & Jansen, 2000; Rogers & Hill, 1989; Smeets, Roefs, & Jansen, 2009). There is also evidence that food cue exposure increases the amount of food that is subsequently consumed (Fedoroff et al., 1997; Ferriday & Brunstrom, 2008).

Expectancy theory (Bolles, 1972) holds that experience of Pavlovian contingencies gives rise to explicit knowledge of the predictive relationships between environmental stimuli and reward. In this way, the cue (CS) signifies the availability of the reward and elicits an expectation that it will be imminently received. Expectancy may therefore be critical for the initial development of CRs (Field & Cox, 2008; Hogarth & Duka, 2006; Jedras, Jones, & Field, in press). This prospect is supported by human conditioning studies with addictive substances which indicate that nicotine CRs, such as salivary responses, attentional bias and subjective craving, depend on participants having explicit knowledge of, and hence an expectation about, the CS-US contingency (Field & Duka, 2001; Hogarth & Duka, 2006). Further evidence is provided by studies that experimentally manipulated participants' expectations about substance availability and observed effects on cue reactivity (*e.g.*, Carter & Tiffany, 2001). In one study, the probability that participants would receive beer (100%, 50%, or 0%) was manipulated on a trial-by-trial basis in an attentional bias eyetracking task (Field et al., 2011). Results indicated that, in light drinkers, attentional

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bias towards alcohol-related pictures was seen only on 100% probability trials (*i.e.,* when alcohol was expected imminently), whereas heavy drinkers' attentional bias was insensitive to alcohol expectancy. These findings were replicated using both chocolate and alcohol rewards (Jones et al., 2012) and, intriguingly, effects were not outcome-specific; that is, the expectation of receiving alcohol increased attentional bias for both alcohol and chocolate cues, and vice versa. This general transfer effect might reflect an increase in arousal when rewards are anticipated, which enhances attentional bias for a variety of motivationally-salient cues (Jones et al., 2012).

There has been much less consideration of the role of expectancy in human eating studies. In the majority of existing food cue reactivity studies, it is not clear whether participants expected to be able to eat the cued foods. This is potentially problematic because, on the basis of the above evidence, eating expectancy would be predicted to strongly influence the magnitude of food cue reactivity. In order to address this important issue, some studies have manipulated expectations about whether the cued foods will be available for subsequent consumption. In a study with dietary restrained women, Higgs (2007) manipulated information about the post-task availability of a cued food (chocolate cake) and examined concurrent performance on a reaction time task. It was predicted that reaction time performance would be impaired when participants expected to subsequently eat the chocolate cake because consumption of a forbidden food would trigger diet-related anxieties. However, there was no evidence for an effect of post-task food availability on reaction time. More recently, Werthmann, Roefs, Nederkoorn, and Jansen (2013) found that the perceived availability of chocolate did not affect chocolate-related attentional bias, craving or chocolate intake in healthy weight female participants. These null findings stand in marked contrast to results from the addiction studies but it is possible that they are explained by methodological differences. For example, in the Werthmann et al. (2013) study, the time delay between giving participants the availability information and the actual opportunity to consume the food (approximately 15–20 min) may have resulted in the availability information losing its motivational impact. This is supported by a study by Field and Duka (2004) in which participants who expected to smoke had to wait around 20 min before being able do so and there were no effects on smoking cue reactivity (craving and physiological reactivity). On the basis of existing studies, it would appear that the effects of reward anticipation on cue reactivity are most prominent when expectancy is manipulated on an immediate, trial-by-trial basis. This ensures that participants expect to receive the reward (or not receive it) at the exact moment that the response is measured (Jedras et al., 2014).

The current study examined the effects of expectancy information about the imminent receipt of an appetizing food (pizza) on reactivity to food cues. In addition to assessing attentional bias and self-reported responses to food cues, we also included a physiological measure of cue reactivity (salivation). Salivary responses are sensitive to food cue exposure (Brunstrom, Yates, & Witcomb, 2004; Ferriday & Brunstrom, 2011; Nederkoorn et al., 2000; Rogers & Hill, 1989), contextual appetitive conditioning (van den Akker, Jansen, Frentz, & Havermans, 2013) and smoking expectancy (Field & Duka, 2001); however, to our knowledge, salivation has not yet been examined in the context of explicit manipulations of eating expectancy. Our primary hypothesis was that expecting to eat pizza would increase salivation, attentional bias to pizza and self-reported measures of cue reactivity relative to comparable no-eating expectancy conditions. We also anticipated that higher levels of cue reactivity as a result of explicit eating expectancy would, in turn, be expressed behaviourally as increased food intake. In this way, our secondary hypothesis predicted that increased cue reactivity during conditions of eating expectancy (relative to conditions of no-expectancy) would be predictive of subsequent *ad libitum* intake of pizza. Our attentional bias task was adapted from that used by Field et al. (2011) and Jones et al. (2012) and critically enabled the manipulation of pizza expectancy on an imminent, trial-by-trial basis. The task also included alcohol-related pictures. This was to determine whether expectancy of receiving pizza would increase attentional bias towards other reward-relevant stimuli thus indicating a general transfer effect, as has recently been reported (Jones et al., 2012).

Finally, divergent findings between the drug and food studies might also be explained by differences in the level of substance exposure. In the nicotine studies for example, participants were daily smokers (*e.g.,* smoking at least 15 cigarettes per day in Field and Duka (2001)) whereas, in the eating studies, habitual consumption of the target food was less frequent (*e.g.,* less than once a day in Werthmann et al. (2013)). This greater exposure might lead to stronger associations between drugs and cues, thus affecting both the magnitude of the CRs themselves and responses to expectancy information. In order to address this possibility, we examined whether individual differences in habitual consumption of pizza (*i.e.,* more-frequent vs. less-frequent consumers) would moderate the effects of the expectancy manipulation on food cue reactivity.

Method

Participants

Forty-two participants were recruited from the University of Liverpool (UK) through email and poster advertisements. A total of 28 females (67%) and 14 males (33%) participated; the average age of participants was 27.83 (*SD* = 8.26) years. Inclusion criteria were regular consumption of pizza (*i.e.,* every 2–3 months, at least), consumption of alcohol (monthly, at least), and normal or corrected-to-normal vision. Participants were excluded if they wore glasses (due to eye-tracking apparatus) or if they had any food allergies or intolerances. The study was approved by the University of Liverpool research ethics committee. Participants were informed that the study was investigating the relationship between cognitive function and eating behaviour.

Measures

Salivation

Total volume of salivation was measured over a period of 30-s. Participants placed a 3.5 cm dental roll horizontally under their tongue. The rolls were weighed before and after being placed in participants' mouths and the difference in weight (g) was recorded as the amount of salivation. This technique is widely used in food studies (Brunstrom et al., 2004; Ferriday & Brunstrom, 2011; Rogers & Hill, 1989), is relatively non-invasive and provides a sensitive measure of whole-mouth saliva volume.

Self-report measures

Hunger, pizza pleasantness and desire to eat pizza were measured using 100-mm visual-analogue scales (VAS). Subjective arousal was measured using VAS ratings of excitedness (''how excited do you feel right now?'') and alertness (''how alert do you feel right now?''). All of the scales were anchored with the phrases ''Not at all'' and ''extremely''.

Attentional bias

Pictorial stimuli. We used 5 pizza-related pictures (*e.g.,* a close-up of a piece of pizza), each of which was paired with a neutral picture (*e.g.,* a close-up of a stationery item). To test for a general