



Review

Whether or not to eat: A controlled laboratory study of discriminative cueing effects on food intake in humans



Thomas L. Ridley-Siegert^a, Hans S. Crombag^{a,b}, Martin R. Yeomans^{a,*}

^a School of Psychology, University of Sussex, Falmer, Brighton BN1 9QH, UK

^b Sussex Neuroscience, University of Sussex, Falmer, Brighton BN1 9QH, UK

HIGHLIGHTS

- Participants associated novel cues with the chance of winning snacks
- The presence of these cues in a snack test modified actual intake
- Highest consumption for snacks labelled with cues paired with winning chocolate
- Cues associated with winning no snacks tended to inhibit snack intake

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ABSTRACT

There is a wealth of data showing a large impact of food cues on human ingestion, yet most studies use pictures of food where the precise nature of the associations between the cue and food is unclear. To test whether novel cues which were associated with the opportunity of winning access to food images could also impact ingestion, 63 participants participated in a game in which novel visual cues signalled whether responding on a keyboard would win (a picture of) chocolate, crisps, or nothing. Thirty minutes later, participants were given an ad libitum snack-intake test during which the chocolate-paired cue, the crisp-paired cue, the non-winning cue and no cue were presented as labels on the food containers. The presence of these cues significantly altered overall intake of the snack foods; participants presented with food labelled with the cue that had been associated with winning chocolate ate significantly more than participants who had been given the same products labelled with the cue associated with winning nothing, and in the presence of the cue signalling the absence of food reward participants tended to eat less than all other conditions. Surprisingly, cue-dependent changes in food consumption were unaffected by participants' level of contingency awareness. These results suggest that visual cues that have been pre-associated with winning, but not consuming, a liked food reward modify food intake consistent with current ideas that the abundance of food associated cues may be one factor underlying the 'obesogenic environment'.

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* Corresponding author.

E-mail address: martin@sussex.ac.uk (M.R. Yeomans).

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1. Introduction

A common view of appetite is that regulation is dependent on homeostatic control of nutrient availability; if one loses or uses nutrients through metabolism then internal cues trigger a state of hunger which leads to eating as a compensatory response (e.g. [1]). However, the number of people who are overweight or obese has doubled since 1980 [2], and simple homeostatic-based appetite models cannot readily explain this rapid increase in obesity. This has led to suggestions that external, non-homeostatic mechanisms, such as the impact of cues associated with food, may play a more prominent role in the development and maintenance of obesity (e.g. [3–5]).

In studies with non-human animals, environmental cues associated with food have been shown to increase food consumption compared to cues not associated with food [6–11]. For example, a cue signalling food availability increased consumption by 20% compared to another cue presented at the midpoint of an intermeal interval (thus not predictive of food: [12]). The effects of these food cues were almost instantaneous; in the presence of the food cues rats instigated intake with a mean latency of less than 5 s, compared to the non-food-associated cues to which animals responded much slower. Additionally, the effects of these food cues have been shown to be highly specific to the cue-associated food and do not generalise to other equally familiar foods [13].

There is a long history of research into the impact of food cues on human ingestion, notably encapsulated in the classic externality theory where the presence of food cues in the environment was seen as a key driver of over-eating [14]. Amongst the wealth of experimental studies examining the effect of food cues on eating, humans have been shown to overeat in response to the sight of food [15–18], smell of food [19–22] or a small taste of the food itself [23]. However, these studies use stimuli that people have come to associate with food from their everyday experience. This is most notable in studies which use pictures of preferred foods which is now a common method for examining neural responses to food-related stimuli [24–27]. All of these studies rely on each person's past history of associating these pictures with eating. Consequently, these types of cues could be differentially associated with different aspects of the rewarding effects of eating both depending on an individual's past experience and on the specific cue. One way of starting to explore how different cue–food associations impact the effects of cues on ingestion is to associate a novel cue with a specific aspect of food reward and then examine how that cue alters subsequent eating, and that was the aim of the study reported here.

To date only one study in humans has used a novel cue–food training paradigm to explore cue-potentiated eating in humans [28]. In that experiment children associated snack food availability with the presence of one cue, and the chance to play with toys with the presence of another cue. Children who were explicitly aware of the cue–food association ate significantly more in the presence of the food cue than the toy-associated cue. Those unaware of the association did not significantly differ in intake in the presence of either cue. This finding demonstrates that neutral cues associated with eating can impact subsequent behaviour, in line with animal studies of cue-potentiated feeding. However, Birch et al. [28] did not investigate the specificity of the eating response. One aim of the present study was to extend these findings to investigate

the level of the specificity of the effects of food cues on eating in humans. Specifically, using a snack–intake paradigm, we investigated whether novel visual cues associated with either a sweet (chocolate) or savoury (potato crisp) reward would lead to subsequent potentiation of intake of the associated food category when the cue was subsequently experienced alongside a variety of test snack foods.

Additionally, Birch et al. [28] did not investigate the psychological processes underlying this cue-potentiated eating. The incentive salience theory [29–31] postulates that incentive salience is a property of a cue associated with a reward, such as food, that makes the cue wanted and the target of consummatory behaviours. According to Robinson and Berridge [29] incentive salience is made up of three parts; firstly, the US produces hedonic activation ('liking'). Secondly, one learns the association between the CS and the US ('learning'). Lastly, incentive salience is attributed to the CS ('wanting'). However, the incentive salience theory has not been investigated in human cue-potentiated feeding. This study seeks to investigate whether increased 'wanting', elicited by cues associated with food, underlies potentiated feeding and whether this increased 'wanting' is specific to cue-associated food or generalises to all food rewards.

In the present study participants had the opportunity to associate one stimulus with one response to view pictures of a sweet reward (chocolate) whereas another stimulus required a different response leading to pictures of a savoury reward (potato crisp). Other stimuli predicted nothing (*DS* –). The key test was responses in a free-feeding test with the snacks labelled with the sweet-associated stimulus, or the savoury-associated stimulus, or the *DS* –, or *No Cue* stimulus present. It was predicted that when the sweet (*DSchoc*)- or savoury (*DScrisp*)-associated cues were present in the free feeding situation participants would eat more overall, and in particular more of snacks in the category associated with the trained cue, compared to those participants presented with the same snacks labelled with the cue associated with not earning a food reward (*DS* –), or when no cue was present (*No Cue*).

2. Materials and methods

2.1. Design

A between-participants design contrasted the effects of visual cues on measures of food-related intake following prior association of de novo cues with the chance to earn food rewards. Four conditions were tested: two where these cues had been associated with winning either a sweet (chocolate, *DSchoc*) or savoury (chips/crisps, *DScrisp*) reward, one where cues were associated with the absence of food (*DS* –) and a *No Cue* control.

2.2. Participants

Sixty-four healthy men and women consented to take part in a study described as 'cognitive performance on sensory evaluations'. However, data from one participant were excluded due to computer error during the snack intake test. The 63 remaining participants (31 male) had a mean age of 21.6 years (range: 18–51) and BMI of 23.3 ± 0.5 .

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