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Research report

Combined effects of cognitive bias for food cues and poor inhibitory control on unhealthy food intake ☆

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ABSTRACT

The present study aimed to investigate the combined effects of cognitive bias (attentional and approach biases) and inhibitory control on unhealthy snack food intake. Cognitive biases reflect automatic processing, while inhibitory control is an important component of controlled processing. Participants were 146 undergraduate women who completed a dot probe task to assess attentional bias and an approach-avoidance task to assess approach bias. Inhibitory control was measured with a food-specific go/no-go task. Unhealthy snack food intake was measured using a so-called "taste test". There was a significant interaction between approach bias and inhibitory control on unhealthy snack food intake. Specifically, participants who showed a strong approach bias combined with low inhibitory control consumed the most snack food. Theoretically, the results support contemporary dual-process models which propose that behaviour is guided by both automatic and controlled processing systems. At a practical level, the results offer potential scope for an intervention that combines re-training of both automatic and controlled processing.

Introduction

During the last three decades, the global prevalence of overweight and obesity has doubled, with 35% of adults classified as overweight and 11% as obese (World Health Organization (WHO), 2013). One important contributor to chronic health problems such as overweight and obesity is unhealthy eating (National Health and Medical Research Council (NHMRC), 2013). The contemporary Western diet is characterised by unhealthy eating, in particular consuming too much fat, salt and sugar. Given the potential negative health consequences of unhealthy eating, it is important to investigate the cognitive mechanisms that underlie such behaviour. Specifically, recent theoretical perspectives and empirical evidence suggest that automatic and controlled cognitive processing make important contributions to unhealthy behaviour.

Dual-process models (e.g., Strack & Deutsch, 2004) propose that our behaviour is determined by two different information processing systems, i.e., automatic and controlled processing. Automatic processing is fast, implicit and effortless, and includes affective (i.e., attitudes, preferences) and motivational (i.e., attending to, approaching) responses to relevant stimuli, such as unhealthy food cues. In contrast, controlled processing is effortful, slow, and explicit, and involves conscious decisions based on personal goals and standards (e.g., health and weight loss). These two processing systems elicit conflicting signals, and the outcome is determined by the relative strength of each processing system. According to dual-process models, behaviour is guided by automatic processing and regulated by controlled processing (if cognitive resources are available). For example, the presence of unhealthy food cues may elicit a conflict between the two systems, i.e., automatically attending to and approaching such cues while maintaining incompatible goals related to health and weight. Thus, a strong automatic system (an attentional or approach bias for food cues) and a weak controlled system (poor inhibitory control or working memory capacity) may result in unhealthy eating.

Automatic and controlled processing systems have given rise to two separate lines of research. Support for the role of automatic processing in eating behaviour generally comes from research investigating cognitive biases for food cues. A cognitive bias refers to "systematic selectivity in information processing that operates to favour one type of information over another" (MacLeod & Matthews, 2012, p. 191). Most research has focused on attentional bias, which refers to the automatic allocation of attention to food cues in preference to other cues (MacLeod & Matthews, 2012). More recently, researchers have turned their focus towards approach bias, which is the automatic behavioural tendency to move towards rather than avoid food cues (Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013). Studies have demonstrated biased attentional

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processing of high-caloric food cues in relation to neutral (non-food) cues in healthy weight participants (Nijs, Franken, & Muris, 2010; Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). Both attentional and approach biases for food cues have also been documented in populations with eating-related issues. Specifically, restrained (Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010; Veenstra & de Jong, 2010) and external eaters (Brignell, Griffiths, Bradley, & Mogg, 2009; Hou et al., 2011; Nijs, Franken, & Muris, 2009), as well as overweight and obese individuals (Castellanos et al., 2009; Havermans, Giesen, Houben, & Jansen, 2011; Nijs et al., 2010; Nijs, Muris, Euser, & Franken, 2010), are faster to detect and approach high-caloric food cues relative to neutral cues.

Furthermore, research has demonstrated a positive correlation between attentional biases for unhealthy food cues (e.g., cake, salted peanuts) and the subsequent consumption of snack foods during a laboratory taste test in both healthy weight and obese participants (Nijs et al., 2010; Werthmann et al., 2011). Research from our laboratory (Kakoschke, Kemps, & Tiggemann, 2014; Kemps, Tiggemann, Martin, & Elliott, 2013; Kemps, Tiggemann, Orr, & Grear, 2014), as well as others (Werthmann et al., 2014), has also found that experimentally reducing an attentional bias for unhealthy food cues decreases unhealthy food intake. This evidence is consistent with the idea that cognitive biases for food cues play a causal role in consumption (Berridge, 2009). Similar findings have also been shown for alcohol (Field & Eastwood, 2005) and cigarettes (Attwood, O'Sullivan, Leonards, Mackintosh, & Munafo, 2008). Nevertheless, the evidence is mixed as some studies have found no such link between attentional bias and consumption of food (Hardman, Rogers, Etchells, Houstoun, & Munafò, 2013), alcohol (Field et al., 2007; Fadardi & Cox, 2009), and cigarettes (Field, Duka, Tyler, & Schoenmakers, 2009). In contrast, the smaller amount of research on approach bias shows a more consistent link between approach bias and consumption of alcohol (Wiers, Rinck, Dictus, & Van Den Wildenberg, 2009; Wiers, Rinck, Kordts, Houben, & Strack, 2010) and cannabis (Cousijn, Goudriaan, & Wiers, 2011). One possible explanation for these contradictory findings is that attentional and approach biases behave differently, as has been evidenced by research in the alcohol domain. Specifically, Sharbanee, Stritzke, Wiers, and MacLeod (2013) demonstrated that these two cognitive biases are distinct mechanisms that can make independent contributions to consumption. Another potential explanation for the overall mixed evidence is that the previous research has not taken into account the role of controlled processing in consumption.

Research investigating the role of controlled processing in eating behaviour has primarily focused on inhibitory control (or response inhibition), which has been defined as "the ability to inhibit a behavioural impulse in order to attain higher-order goals, such as weight loss" (Houben, Nederkoorn, & Jansen, 2012, p. 550). A recent study by Loeber et al. (2011) found that both healthy weight and obese participants were less effective at inhibiting behavioural responses to food cues relative to neutral (non-food) cues. Furthermore, studies have shown that obese participants were less effective at inhibiting responses to neutral cues (Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006) as well as to food-related cues (Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006) than healthy weight participants.

Several studies have also demonstrated that poor inhibitory control is associated with increased food intake during a laboratory taste test in both healthy weight (Guerrieri, Nederkoorn, & Jansen, 2007) and overweight or obese women (Appelhans et al., 2011). In addition, poor inhibitory control predicted an increase in weight (BMI) over a one year period in a sample of healthy weight women (Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). Some studies have also shown that experimentally increasing inhibitory control reduces chocolate (Houben & Jansen, 2011) and alcohol (Houben, Nederkoorn, Wiers, & Jansen, 2011) consumption; however, Guerrieri et al. (2007) found that experimentally increasing behavioural inhibition had no effect on milkshake consumption in a laboratory taste test. Furthermore, inhibitory control is related to working memory capacity, which is the ability to store and process goal-relevant information (Conway, Kane, & Engle, 2003). A recent study found that experimentally increasing working memory capacity reduced alcohol intake in a sample of problem drinkers (Houben, Wiers, & Jansen, 2011).

As indicated above, prior research has largely focused on automatic or controlled processing separately. However, it may be their combination that is most important for consumption. In line with dual-process models, recent meta-analyses suggest that a cognitive bias for appetitive cues combined with poor inhibitory control may result in unhealthy behaviour, such as consuming appetitive substances like drugs and alcohol (Coskunpinar & Cyders, 2013; Field & Cox, 2008). Nederkoorn et al. (2010) investigated this theoretical prediction in the food domain and found that automatic and controlled processing interacted in determining an increase in BMI over a one year period in healthy weight women. Specifically, women with strong implicit preferences for food and low inhibitory control gained the most weight. Other studies have shown that the combination of strong implicit preferences and low inhibitory control predicts candy (Hofmann, Friese, & Roefs, 2009) and alcohol (Houben & Wiers, 2009) intake on a laboratory taste test. The above studies measured automatic processing with the implicit association task, which assesses evaluative attitudes for appetitive cues. However, we chose to focus on the motivational bias component of automatic processing. Similarly, in the alcohol domain, Peeters et al. (2012) recently found that the combination of an approach bias for alcohol and low inhibitory control (measured by the Stroop task) predicted alcohol use in adolescent drinkers. To the best of our knowledge, this finding has not been demonstrated in the food domain. In addition, the above studies have all measured inhibitory control in general, not specifically related to food. Yet specific food-related inhibitory control needs to be examined as a more proximal potential mechanism associated with unhealthy eating (Appelhans et al., 2011; Meule et al., 2014).

The aim of the current study was to investigate the combined effects of automatic and controlled processing on unhealthy food intake. Cognitive biases for food cues were assessed as an indicator of automatic processing, and food-specific inhibitory control was assessed as an important component of controlled processing. Both of the two main forms of cognitive bias, namely attentional bias and approach bias were included. Attentional bias was assessed by the often used dot probe task, developed by MacLeod, Matthews and Tata (1986). Approach bias was assessed by the approach-avoidance task of Rinck and Becker (2007). Inhibitory control was assessed using the food-related go/no-go task of Houben and Jansen (2011). A so-called "taste test" was used to measure unhealthy food consumption. It was predicted that a stronger cognitive bias together with lower inhibitory control would lead to increased unhealthy food intake. This was tested for the two different components of cognitive bias (attentional and approach) separately.

Method

Participants

Participants were 146 women recruited from the Flinders University undergraduate student population. They were aged 18–25 years ($M = 20.20$, $SD = 2.64$). Most participants were within the healthy weight range (i.e. 18.5–24.9 kg/m^2) with a mean BMI of 22.9 kg/m^2 ($SD = 5.11$). Only women were recruited as they have shown a greater tendency to overeat (Burton, Smit, & Lightowler, 2007). Participants were included if they spoke English as their first language, liked most foods, and did not have any food allergies or