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Research report

Individual differences in executive function predict distinct eating behaviours ☆

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ABSTRACT

Executive function has been shown to influence the performance of health behaviours. Healthy eating involves both the inhibitory behaviour of consuming low amounts of saturated fat, and the initiatory behaviour of consuming fruit and vegetables. Based on this distinction, it was hypothesised that these behaviours would have different determinants. Measures of inhibitory control and updating were administered to 115 participants across 2 days. One week later saturated fat intake and fruit and vegetable consumption were measured. Regression analyses revealed a double dissociation effect between the different executive function variables and the prediction of eating behaviours. Specifically, inhibitory control, but not updating, predict saturated fat intake, whilst updating, but not inhibitory control, was related to fruit and vegetable consumption. In both cases, better executive function capacity was associated with healthier eating behaviour. The results support the idea that behaviours that require stopping a response such as limiting saturated fat intake, have different determinants to those that require the initiation of a response such as fruit and vegetable consumption. The findings suggest that interventions aimed at improving these behaviours should address the relevant facet of executive function.

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Introduction

Healthy eating can facilitate the maintenance of a healthy weight and reduce the risk of chronic diseases, such as cancer, diabetes and coronary heart disease (Mente, de Koning, Shannon, & Anand, 2009). Specifically, it is recommended that individuals limit saturated fat intake and increase consumption of fruit and vegetables (National Health and Medical Research Council, 2003; World Health Organization, 2000). In Australia, the national guidelines suggest that saturated fat intake should not exceed 24 g per day; and that individuals should consume two servings of fruit and five servings of vegetables each day (National Health and Medical Research Council and New Zealand Ministry of Health, 2006). Similar guidelines exist in other countries (Food Standards Agency, 2007; US Department of Agriculture & US Department of Health and Human Services, 2010).

Despite awareness of the benefits, individuals experience difficulty adhering to guidelines (Australian Institute of Health and Welfare, 2012; McLennan & Podger, 1998). This is reflected in the consistent finding that individuals often fail to carry out their intentions (McEachan, Conner, Taylor, & Lawton, 2011), and suggests that whilst motivation to carry out a goal-directed behaviour is important, the ability to translate this motivation into action is key. A construct that has been implicated in the successful execution of health behaviour is self-regulation (Hagger, 2010; Hofmann, Schmeichel, & Baddeley, 2012). Self-regulation has been defined as the capacity for regulating cognitions and responses in order to support the pursuit of long-term goals (Baumeister, Vohs, & Tice, 2007). Research has found that self-regulation is important for both the initiation of health-enhancing behaviours, such as breakfast consumption (Wong & Mullan, 2009), and the inhibition of health-risk behaviours, such as binge drinking (Mullan, Wong, Allom, & Pack, 2011).

Executive function is a multifaceted construct comprised of several higher-order cognitive processes that are said to subserve the capacity to self-regulate (Gazzaley & D'Esposito, 2007), wherein individual differences in these processes predict the translation of intention into action (Hofmann et al., 2012). Executive function processes can be broadly thought of as falling into three categories: (1) *shifting*, i.e. flexibly altering goals and plans in response to chang-

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ing contingencies; (2) *inhibitory control*, i.e. inhibiting goal-irrelevant information and impulses in order to maintain focus on goals; and (3) *updating*, i.e. updating and monitoring goals (Miyake et al., 2000; Suchy, 2009). Importantly, when measured in early childhood, individual differences in executive function predict a range of important life outcomes, including health and academic performance (Marteau & Hall, 2013; Moffitt et al., 2011), and furthermore, individual differences in these constructs amongst adults have been shown to relate to the performance of numerous health behaviours (Booker & Mullan, 2013; Hall, Fong, Epp, & Elias, 2008).

Executive function and eating behaviour

Limited research has examined whether individual differences in shifting capacity in normal-weight populations relate to eating behaviours, such as saturated fat intake and fruit and vegetable consumption. Whilst Allan, Johnston, and Campbell (2011) demonstrated that superior performance on shifting tasks accounted for variance in both snacking and fruit and vegetable consumption within normal-weight adults, the majority of research appears to suggest that shifting deficits are primarily involved in the eating behaviour of underweight or obese individuals (Gunstad et al., 2007; Roberts, Demetriou, Treasure, & Tchanturia, 2007; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007). Therefore, shifting ability was not the focus of the current study.

Conversely, evidence suggests that inhibitory control and updating are influential determinants of eating behaviour amongst normal-weight adults. In order to meet the goal of adhering to a healthy diet, the desire to consume unhealthy palatable foods needs to be inhibited, and information relevant to this goal has to be maintained and updated. Previous research has demonstrated that deficits in inhibitory control are associated with poorer eating behaviour and weight outcomes (Allan, Johnston, & Campbell, 2010; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). Specifically, Allan et al. (2011) demonstrated that individuals with poor inhibitory control were less likely to carry out their healthy eating intentions. Hofmann, Friese, and Roefs (2009) and Hofmann, Gschwendner, Friese, Wiers, and Schmitt (2008) demonstrated that implicit attitudes rather than explicit dietary goals predicted chocolate consumption within individuals who performed poorly on a measure of updating. Conversely, amongst those who performed better on the task, goals rather than implicit attitudes predicted behaviour (Hofmann et al., 2008). These results indicate that having a goal to eat healthily may only be beneficial when an individual has sufficient ability to maintain and update this goal. This assumption is supported by the findings of Allan, Sniehotta, and Johnston (2013) in which goals were only predictive of behaviour amongst those with sufficient planning ability.

Thus poorer inhibitory control and updating ability appear to be associated with increased consumption of unhealthy foods; however, the relationship between executive function and consumption of healthy foods, such as fruit and vegetables, is less clear (Allom & Mullan, 2012). In one study, inhibitory control was found to moderate the relationship between intention and fruit and vegetable consumption, such that intention was more likely to lead to behaviour amongst those with greater inhibitory control (Hall et al., 2008). However, Hall (2012) failed to demonstrate a comparable relationship with non-fatty food consumption. Several other researchers have also struggled to replicate this effect (Allan et al., 2011; Collins & Mullan, 2011), suggesting that inhibitory control may not play a role in the consumption of healthy foods. In contrast, Sabia et al. (2009) found that eating less than two serves of fruit and vegetables a day was associated with poorer updating in later life. As the direction of causality is unclear, it is important to examine whether updating capacity contributes to the prediction of fruit and vegetable consumption.

Avoiding consumption of unhealthy foods versus initiating consumption of healthy foods

Previous research has established that different types of self-control can distinguish between conceptually distinct behaviours (de Boer, van Hooft, & Bakker, 2011; de Ridder, de Boer, Lugtig, Bakker, & van Hooft, 2011). Through a series of confirmatory factor analyses it was demonstrated that the Tangney, Baumeister, and Boone (2004) Self-control Scale consisted of two factors: inhibitory self-control and initiatory self-control. It was found that behaviours which required stopping a response, such as alcohol consumption and cigarette smoking, were predicted by inhibitory self-control, whilst behaviours that required starting a response, such as studying or exercising, were predicted by initiatory self-control (de Ridder et al., 2011). Therefore, it is plausible that tasks that index inhibitory control will be more relevant to the avoidance of unhealthy food consumption than to the initiation of healthy food consumption.

Aims and hypotheses

The aim of this study was to determine whether individual differences in two categories of executive function could predict two healthy eating behaviours: saturated fat intake and fruit and vegetable consumption, amongst participants with healthy eating intentions. As executive function refers to the ability to carry out goal-directed behaviour, it was necessary for participants to already have healthy eating intentions, so that the influence of executive function on the ability to carry out these intentions could be measured. It was hypothesised that those with a superior inhibitory control capacity would consume less saturated fat. However, inhibitory control was not expected to play a role in fruit and vegetable consumption. It was also expected that those with a superior updating capacity would consume less saturated fat and more fruit and vegetables. Based on previous research that demonstrated the importance of controlling for factors such as sex and BMI (Hall, 2012; Hall, Lowe, & Vincent, 2013), and eating style (Brignell, Griffiths, Bradley, & Mogg, 2009; Jansen et al., 2009; Jasinska et al., 2012), when examining the role of executive function in eating behaviour, these variables were controlled for in the current study.

Method

Participants

One hundred and fifteen normal to overweight undergraduate students from a variety of disciplines (mean age: 19.79 years, $SD = 1.95$, 83 females) were recruited to participate in a study on self-control and eating behaviour in exchange for course credit. Inclusion criteria included holding an intention to eat healthier, not colour blind, fluent in English, having regular access to the internet, and having no current or prior diagnosis of an eating disorder. All participants provided informed consent before taking part in the study, which was approved by the university Human Research and Ethics Committee.

Materials and measures

BMI and eating disorder status

BMI was calculated from participants' self-reported height and current weight. Participants were also asked to indicate the presence of a current or lifetime eating disorder diagnosis.

Eating style

Eating style was measured using the Dutch Eating Behaviour Questionnaire (van Strien, Frijters, Bergers, & Defares, 1986), which consists of 10 items assessing restrained eating (i.e., the tendency

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