An introduction to the special issue on 'Executive function training & eating behaviour'

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Over the last few decades, we have seen major changes to daily diets, which have moved from being plant-based to more high-fat, animal-based diets (Hill, Wyatt, Reed, & Peters, 2003). These dietary changes together with increasingly sedentary lifestyles have fuelled a global rise in obesity rates (Finucane et al., 2011; Flegal, 2005; Haslam & James, 2005; Wang & Beydoun, 2007). In 2014, around 2 billion adults were overweight, of which over 600 billion were obese (World Health Organization, 2014). Importantly, overweight and obesity, as well as their related noncommunicable diseases, are largely preventable and many intervention and prevention programs are currently aimed at finding feasible ways to cope with our food-rich environment and adhere to the simple principles of the energy balance equation. For many, however, this equation is easily understood but difficult to balance: Though most people realize the risks associated with excess bodyweight, only a small proportion of people who attempt to lose weight are able to reduce their bodyweight over an extended period of time (Jeffery et al., 2000; Mann et al., 2007). According to contemporary dual-process theories, the difficulty in adhering to more healthy diets lies in regulating unintentional, fast-acting impulses that are triggered by salient temptations like palatable, energy-dense foods (e.g., Hofmann, Friese, & Strack, 2009). Whenever conflicts arise between long-term goals (e.g., stick to one's diet) and reward-oriented impulsive tendencies (e.g., indulge in a delicious piece of chocolate cake), enacting goal-directed behaviour requires the active regulation of automatic impulses. Successful self-regulation critically depends on both motivation to pursue long-term goals, and on the capacity to exert top-down control, which is strongly related to executive functions (Hofmann, Schmeichel, & Baddeley, 2012; Kotabe & Hofmann, 2015).

Executive functioning is an umbrella term encompassing a number of higher-order cognitive processes that afford goal-directed action amid the endless possibilities afforded to us in real-life situations (Hofmann et al., 2012; Miyake et al., 2000). Executive functions enable the control over thoughts, emotions, and actions via a number of related but distinct sub functions, including the ability to maintain and update relevant information in working memory ('updating'), the ability to inhibit prepotent impulses ('inhibition'), and the ability to shift between tasks or mental sets ('shifting'; Miyake et al., 2000). For each of these three executive functions there is a growing body of evidence to suggest that lower executive function ability is related to excessive eating behaviour and overweight, which has spurred subsequent interest into the possibility of executive function training as a means to change unhealthy eating behaviour and decrease overweight. In the past few years, there has been an exponential increase in research papers on this topic and the aim of this Special Issue is to bring together recent work in this emerging area of research: The first part of this Special Issue addresses the role of executive functions in eating behaviour and overweight. The second part of this Special Issue presents recent research on training executive functions to reduce overconsumption and overweight.

The review paper by Dohle, Diel, and Hofmann (2017) outlines how the three broad facets of executive functions, working memory, response inhibition, and set-shifting, contribute to the successful self-regulation of eating behaviour. Their review shows that there is a direct link between these executive functions and eating behaviour with poorer executive functioning predicting more unhealthy food intake. However, executive functions also indirectly influence eating behaviour by enabling a stronger correspondence between intentions and behaviour. The study by Whitelock, Nouwen, van den Akker, and Higgs (2017) builds upon the evidence that suggests a role for working memory in eating behaviour by examining which of the working memory sub-components, namely updating, the phonological loop and the visuospatial sketchpad, are involved in eating behaviour. Their findings show that visuospatial working memory in particular is an important predictor of food intake and dieting success. Better visuospatial working memory may be essential to prevent the elaboration of food thoughts into cravings (see also May, Kavanagh, & Andrade, 2015). Besides providing control over food cravings, working memory may also be implicated in the self-regulation of food intake via episodic recall (Higgs, 2016). Episodic recall of past eating episodes may be especially important by enabling meal-to-meal compensatory adjustments in food intake to prevent overeating. In line with this idea, Martin, Davidson, and McCrory (2017) show that poorer episodic recall is indeed associated with uncontrolled eating behaviour. Similar involvement of executive functions in the regulation of food intake and overweight has been demonstrated in children, and such individual differences in executive functions are related to weight loss outcomes in treatment (Hayes, Eichen, Barch, & Wilfley, 2017). Extending these findings, Goldschmidt et al. (2017) investigated the relationship between a wide range of executive functioning constructs, including working memory capacity, and body weight in children. Results showed a significant association between planning abilities and overweight, and between working memory capacity and concomitant overweight and loss of control eating.

Over the past years, the possibility of executive function training as an intervention for excessive food intake and overweight has received more and more interest in the scientific community. Jones, Hardman, Lawrence, and Field (2017) present a critical review of the available evidence for the effectiveness of both interventions that aim to improve general executive functioning

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abilities and interventions that aim to modify (control over) impulsive responses to food cues. With respect to capacity driven training, the reviewed evidence suggests limited potential for general inhibition training as an intervention for overeating and overweight. For working memory training, there is at least some evidence that this type of intervention increases working memory capacity and transfers to behaviour outside of the laboratory. Interventions that aim to modify impulsive responding to food cues typically involve learning new associations between food cues and avoidance or inhibition. Jones et al. conclude that these types of training are often successful in influencing food intake in the laboratory, but that more research is needed on the generalization to real-world behaviour. Forman et al. (2017) agree that the key challenges for executive function training include improving training adherence to improve effectiveness and increasing transfer to behaviour outside of the laboratory. In their review, they describe technological innovations, including remote training at home, training via smartphone, gamification, virtual reality, and personalization, that have the potential to address these difficulties related to the effectiveness and feasibility of executive function training. More research is needed to examine the possible benefits of such technological innovations, as part of the ongoing effort to improve the potency of executive function training for appetitive behaviours. Another approach to enhancing executive control involves the use of non-invasive brain stimulation (NIBS) techniques to change the excitability of specific brain regions using electromagnetic devices. In the field of eating behaviours and self-regulation, there has been ample interest in the use of NIBS methods that target the prefrontal cortex which is centrally implicated in executive control over behaviour (e.g, Fassbender et al., 2004; Figner et al., 2010; Miller & Cohen, 2001). Hall and Vincent (2017) present a critical review of the available evidence in this area and conclude that both single-session and multisession NIBS methods reliably appear to influence food craving, although repetitive transcranial magnetic stimulation (rTMS) appears to show more promise than transcranial direct current stimulation (tDCS). Given these encouraging findings, it would be interesting for future research to investigate whether NIBS might synergize with cognitive training strategies that target executive functions to enhance training outcomes.

This special issue also includes some recent efforts in this area of research including studies that tested the effect of training aimed at improving general executive functioning abilities. Dassen, Houben, Van Breukelen, and Jansen (2017), for instance, examined the effect of a gamified working memory training on eating behaviour and weight in a sample of overweight participants. Relative to control, working memory training increased working memory capacity and reduced food intake. However, results showed no significant effect of training on weight loss indicating that any effects of working memory training are probably short-lived if training is not maintained over a longer period of time. Other studies in this special issue targeted impulsive responses to food cues via training rather than attempting to increase general executive functioning abilities. Chen, Veling, Dijksterhuis, and Holland (2017) examined the role of inhibition capacity on food-specific inhibition training. Food items were consistently paired with either go or no-go cues. Evaluations of these items were measured before and after go/no-go training. In two studies, they consistently showed that no-go foods were liked less after the training compared to both go foods and foods not used in the training, while individual inhibition capacity did not seem to moderate the training's effectiveness. Consistent with these findings, Porter et al. (2017) show that go/no-go training that consistently maps unhealthy food items onto no-go cues increases children's choice of healthy food over energy-dense unhealthy foods compared to both food and non-food control tasks. Braet, Verbeken, Naets, Houben, and Boendermaker (2017) examined whether a training program that combined food-specific go/no-go training with food-related attention and approach retraining would improve weight maintenance in obese children following an inpatient weight control program. In contrast to previous findings, no significant difference was found in the maintenance of weight loss in children who received the training compared to children in the active control condition. In line with the conclusions of Jones et al. these findings illustrate the effectiveness of food-specific inhibition training for influencing eating behaviours in the laboratory, and the difficulty of extending the effects to eating behaviour and weight management outside the laboratory. Zoltak, Veling, Chen and Holland (2017) examined a different approach to modifying impulsive reactions to food and examined the possibility of increasing attention towards certain food items. More specifically, they investigated whether choices for low value food items over high value food items can be increased via cued-approach training. Across two studies, they found that choices for low value foods can be increased via cued-approach training, though only when the value difference between the low and high value items was relatively small. Further, high value items were nevertheless overall preferred over low value items and whether cued-approach training could be effective in shifting the balance from choosing (relatively high value) unhealthy food items to (relatively low value) healthy food items, therefore, needs further investigation.

In conclusion, this Special Issue aims to provide readers with an overview of research on the role of executive control in eating behaviour and the potential of training executive control to reduce overeating and overweight. While there is compelling evidence that executive functioning training can increase the successful self-regulation of eating behaviour, it is also clear that there is quite substantial heterogeneity between different studies. Future research needs to further establish the working mechanisms of the different types of training as well as their boundary conditions in a more detailed and systematic manner to better understand how and when we can expect transfer and benefits from training. Further, the role of motivation has been often neglected but may be key to obtaining transfer effects of executive control training to eating behaviour beyond the laboratory. In sum, research on executive control over eating behaviour remains an exciting area of research and hopefully this Special Issue will spur further systematic and confirmatory research with respect to executive control training in the hopes of establishing new psychological interventions to help people change their eating habits and lose weight.

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