

THE ROLE OF WORKING MEMORY CAPACITY AND EATING SELF-REGULATION: AN INTEGRATIVE APPROACH

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Abstract: In recent years, there has been significant interest in whether working memory capacity can be improved via repeated training in clinical, risk and healthy populations. This article investigates how working memory capacity (WMC) as facet of executive functioning may influence eating self-regulation in young people.

The objectives of the study were as follows: to provide an integrative theoretical framework of the effectiveness of enhancing working memory capacity on eating self-regulation, to review methodology concerning measuring this construct and to identify gaps in existing research evidence. Our study is focused on revealing the biases, strengths and weaknesses of existing studies published since 2010 to present. The connections between working memory operations and self-regulatory mechanisms are highlighted.

The central executive aspect of working memory has had relatively a big influence in cognitive psychology over the past several decades, but is only recently being considered in other areas of psychological theory and research. Evidence indicates that training memory capacity is likely to influence eating behavior. The findings can be used to provide guidance in the design of future change-oriented eating behavior studies or nutritional interventions regarding making healthy food choices.

Keywords: working memory, eating self-regulation, training

Introduction

Eating represents a defining part of our lives. Mostly because people engage in eating actions for the vital role which this behavior provide: the one of survival. Unfortunately, even if nowadays food is cheap and available in a great variety, many people find it difficult to successfully self-regulate their eating habits. Everyday people face multiple eating behavioral challenges: making food choices or simply trying to resist temptations. It is known that young people represents a very specific and vulnerable age group for food industry. They are constantly exposed by promotional messages and advertising that may increase consumption of unhealthy products (e.g. snacks or soft drinks). Besides, they are tend to experience more intense urges than children and adults in general. Under this circumstances, poor eating habits affect the liking of becoming overweight or obese when they grow up because nutritional

experiences in early life and lately in youth can have long-lasting consequences in adulthood (Wing et al., 2013).

Having this background outlined, the purpose of the present article was to explore the relationship between working memory capacity (WMC) and eating self-regulation in young people (17-20 years) in studies published since 2010 to present. More precisely, we sought to present an integrative theoretical framework of working memory operations as one of the three basic executive functions (alongside behavioral inhibition and task switching) and to review methodology concerning measuring this construct. Our study is also focused on revealing whether WMC can be enhanced via repeated training in general young population.

Self-regulation and eating self-regulation

In modern societies obesity among young people is certainly one of the biggest medical problems of the 21st century. As a result, more and more young attempt to control their weight through dieting which in scientific literature is named self-regulation.

This construct is a core aspect of the adaptive human behavior. Recently, there is firmly evidence that executive functions may orchestrate assumed to orchestrate perceptual, cognitive, and motor processes in the service of goal pursuit and attaining (Hoffmann, Schmeichel & Baddeley, 2012) regarding sexual behavior (Pronk, Karremans, & Wigboldus, 2011), drugs and substance use (Riggs, Spruijitt-Metz, Chou & Pentz, 2012), eating behavior (Goldschmidt et al., 2015; Limbers & Young, 2015), violence and aggressive behavior (DeWalle, Baumeister, Stillmann & Gailliot, 2007).

Self-regulation is a key concept in health programs, clinical intervention and personal projects and refers to purposive process of overriding of a long-term goal over a short-term goal of less importance.

According to Bauer & Baumeister (2011) self-regulation is viewed as "the capacity to override natural and automatic tendencies, desires, or behaviors, to pursue long-term goal even at the expense of short-term attractions, as an expression of the human behavior which reflects two modes of functioning"(p.65 in Vohs & Baumeister, 2011). The main idea was introduced by Epstein (1985; 1990; 1994) who underlined that one mode is called rational system which operates mostly consciously and uses logical and verbal rules. By contrast, the

other mode is an experiential system which functions automatically, nonverbally, intuitive and associated. It is quickly because of the use of shortcuts and heuristics, while the first one it is slower. This model of functioning is characterized by the dynamic of the both systems which are always working and the human behavior is depending on the dominant system (Hofmann, Friese & Strack, 2009).

From this point of view, self-regulations becomes a key moderator between automatic and deliberate actions whereby people exert control over their own behavior. However, this construct is conceptually distinct from self-control which is used to delimit a narrower category of self-regulatory processes; those that refer to "unwanted, prepotent impulses or urges" (Hofmann, Schmeichel & Baddeley, 2013, p. 174).

Specifically, eating self-regulation is defined as "the ability to initiate goal-related behaviors, to consistently self-monitor dietary intake, to regularly apply willpower to resist temptations, to self-evaluate where one stands in relationship to goal-attainment and finally to maintain motivation to positively change eating behavior" (Reed et al., 2015, p. 7).

Studies linking executive functioning and the management of body weight showed in both cross-sectional and prospective research design that there is a strong evidence which supports the idea that executive functions subserve the capacity aspect of eating self-regulation (e.g. in preschool children-Pieper & Laugero, 2013; Hughes, Power, O'Connor & Fisher, 2015; in school children- Groppe & Elsner 2015; in adolescents-Goldschmidt, Hipwell, Stepp, McTigue & Keenan, 2015; and in young respectively- Kelly, Bulik & Mazzeo, 2013).

Executive functions

Executive functions refer to a set of cognitive processes that support the regulation of thoughts and emotions, behaviors and enable self-control. Executive functions are complex and it appears they develop dramatically during infancy and childhood (Beck, Schaefer, Pang & Carlson, 2011) and predict later success in school, health and wealth (Moffitt et al., 2011).

As reported by Miyake et al., 2000, executive functions include working memory operations such as: 1) shifting between tasks or mental sets ('shifting'), 2) updating and monitoring working memory representations and it is closely linked to the notion of working memory, which is associated with the activity in prefrontal cortex. This 'updating' function

implies the active manipulation of relevant information in working memory rather than passively storage. 3) inhibition of dominant or prepotent responses which is a deliberate and controlled suppression of automatic responses.

However, this three components although distinguishable, it seems to share considerable underlying commonality (Hofmann, Friese, Schmeichel & Baddeley, 2011).

Nevertheless, the aim of the present study is to examine the role of working memory capacity in eating self-regulatory mechanisms.

Previous studies suggested that individual differences in executive functioning are often referred to under the label of working memory capacity and this assumption seemed to be a real interest for the researchers over the last decades.

Working memory capacity (WMC)

In general, WMC is conceptualized being an ability to focus on goal-relevant information, maintain an active mental representation of it and shield from interference or distraction. Although contemporary perspectives have roots in earlier models of short-memory (Peterson & Peterson, 1959), recent frameworks support the updated model proposed by Baddeley (2000; 2007), who emphasize the active role in manipulating the information rather than information storage per se. It requires top-down control of attention toward goal-relevant information by suppressing ruminative thoughts along with mindfulness being considered a higher-order component function of central executive system (Brown & Ryan, 2003; Posner & Rothbath, 2000).

Indeed, it has been showed that WMC relate to people's ability to regulate their own thoughts (Bomyea & Amir, 2011), emotions (Schmeichel & Demaree, 2010) and eating behavior (e.g. concerning food intake Houben, Dansen & Jansen, 2016; or food rewards Higgs, 2016).

According to Smith, Hay, Campbell & Troller (2011), research suggests that increased adiposity is associated with poor cognitive performance. In other words, obesity seemed to be related to cognitive deficits especially in children, adolescents and adults. In addition, poorer executive functioning may manifest in disturbed eating behaviors such as binge eating (Ames et al., 2014; Allen et al., 2013). Therefore, our main concern is whether training cognitive

control and WMC in particular may translate into successful eating self-regulation in young people.

Currently, however studies investigating this assumption in children, adolescents and young people are relatively rare. Despite this, previous studies indicated that working memory may be improved through training by reducing clinical symptoms (Klingberg, 2010; Morrison & Chein, 2011 as cited in Houben, Dassen & Jansen, 2016). So far, the links between WMC and eating behavior have rarely been investigated in non-clinical population.

As we stated in the beginning of the article, we attempt to analyze research studies and works which connect WMC and eating food self-regulation since 2010 to present.

In 2010, Edwards et al., showed that a high-fat diet blunts whole-body efficiency and cognitive performance in sedentary men. Specifically, high-fat diet consumption increased participant's simple reaction times and decreased power of attention. Their research is consistent with previous studies (Greenwood, Winocur, 2005; Pistell et al., 2010).

In an influential review of the association between obesity and cognitive function across the lifespan, Smith, Hay, Campbell & Troller, 2011 highlighted that executive function is the most consistent deficit found in obese individuals and covers a wide area of cognitive processes such as planning, regulation, sequencing and achievement of complex-oriented behavior and thought which in turn may impact on eating behavior, thus creating a possible bidirectional relationship.

Similarly, a correlational study explored the interrelationships between measures of executive function (mindfulness, self-control and working memory) and mental and behavioral health respectively and reported that self-control, an important aspect of self-regulation behavior is strongly correlated with both working memory ($r=0.51$, $p<0.05$) and mindfulness ($r=0.38$, $p<0.10$). Nevertheless, due to this type of the study causal mechanisms are neglected.

On one hand, there are studies which revealed that the relationship between obesity and WMC is unidirectional (Nguyen, Killcross & Jenkins, 2014). Gonzales et al., 2010 used functional magnetic resonance imaging (fMRI) to compare normal, overweight, and obese individuals during working memory tasks. As expected, the obese group exhibited much lower task-related activation in the right parietal cortex. In other words obesity causes the cognitive dysfunctions, including low scores in working memory capacity tests.

Higgs, 2016 reviewed the influence of working memory and episodic memory processes on responses to food cues and concluded that there is now evidence that working memory is important in determining the attention we pay to food cues (Rutters, Kumar, Higgs, & Humphreys, 2014) and successful dieting has been associated with the activation of health-related goals rather than hedonic thoughts related to food stimuli which may affect how attention to food is guided by working memory.

On the other hand, other studies have instead indicated the opposite: the individuals who lost a great excess of weight had an improvement of their scores in working memory (Halyburton et al., 2007) which could mean that there is needed more research on this topic in order to reveal the complex relationship between working memory capacity and eating self-regulation.

Recently, there has been significant interest in whether WMC can be improved by adaptive and extended training. It has also outlined that WM training reduced pathological ruminative thoughts about food, weight and body shape (Hoube, Dassen & Jansen, 2011). Although there are strong evidence in this direction (Jha, Stanley, Kiyonaga, Wong & Gelfand, 2010) and WMC training appears to positively influence eating self-regulation (Veling, Aarts & Papies, 2011), reducing emotional eating and psychopathological eating concerns in overweight participants (Houben & Jansen, 2011) the extent to which these performances generalize and show transfer in everyday actions requires more empirical support.

Conclusions

A synthesis of the examined research suggests that working memory is one of the most influential theoretical constructs in cognitive psychology. Working memory plays a significant role in self-regulation. In fact, it has been argued that working memory (WM) may very well lie at the heart of successful cognitive control (as cited in Houben, Dassen & Jansen, 2011). It has been suggested that more scientific evidence is needed to support the transfer of WM training to everyday behavior (Shipstead, Redick & Engle, 2012).

All in all, the data reviewed here suggest that high level cognitive processes, such as working memory affect eating by modulating our responses to food reward cues. If these cognitions are disrupted, then eating behavior may become less flexible and more habitual.

This work highlight that there is a little evidence that training WMC may produce improvement in cognitive functioning. There has been also a paucity of research examining the association between executive functions and dietary behaviors in young adults (Limbers & Young, 2015). Also, more longitudinal research is needed to determine the directionality of such relationships, to point towards crucial intervention time periods in the development of children, and to inform effective treatment programs. This article outline the urgent need to stimulate obesity research and nutritional programs in order to help teenagers and young adults (given the fact that young obesity rates have risen dramatically over the past few decades), to successfully regulate their eating behavior and a possible direction may be enhancing WMC via training which may prevent and treat obesity.

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