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Reward-related decision making and long-term weight loss maintenance

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ABSTRACT

Background: Heightened sensitivity towards reward and insensitivity towards disadvantageous consequences may constitute a driving factor underlying unrestricted food intake and consequent weight gain in people with overweight and obesity. Therefore, the present study applied a behavioral economics approach to investigate the potential contribution of poor reward-related decision making to unsuccessful long-term weight loss maintenance (i.e. weight cycling). Based on previous research, it was expected that successful long-term weight loss maintainers would show a better performance in a gambling task than their less successful counterparts.

Methods: Reward-related decision making was assessed post hoc using the Game of Dice Task in a total of 33 overweight and obese women who had either (a) successfully maintained initial weight loss of at least 10% of their body weight over one year or (b) had regained weight until at least their initial body weight prior to weight reduction (i.e. showed weight cycling).

Results: The groups did not differ in terms of age, current body weight, magnitude of initial weight reduction, educational level, and global intelligence level. As hypothesized, however, the group of successful long-term weight loss maintainers performed significantly better (i.e. showed less impulsive, more advantageous choices) in the Game of Dice Task than their less successful counterparts.

Conclusions: The findings suggest that poor reward-related decision making is associated with weight cycling which is considered a key concern in weight loss treatments for overweight and obesity. Furthermore, the findings speak in favor of specific psychological interventions that are designed to bolster reward-related decision making.

1. Introduction

Overweight and obesity have become a global epidemic that affected one third of adults by the year 2010 [1]. Being a leading cause of preventable death, it is associated with increased overall mortality [2] and reduced life expectancy [3]. Obese individuals are at risk for developing several severe somatic diseases such as diabetes, hypertension, cardiovascular disease, and cancer [4–8]. In addition, obesity is associated with a range of adverse psychological conditions such as depression, poor body image, and internalized weight bias [9]. The costs that obesity burdens on the society are tremendous [10,11]. Obesity is thus considered one of the most urgent public health concerns in the 21st century [12–14].

Hence, it is not surprising that the reduction of obesity has become one of the most urgent tasks of today's global health care. Behavioral interventions that intend to alter food intake and physical activity are the treatment of choice and have proven to lead to significant albeit little weight loss in the short-term (i.e. 5–10% on average) [15,16]. Bariatric surgery attains considerably greater weight reductions (i.e. 25% or 15 BMI points on average) and, in contrast to behavioral interventions, also significantly reduces mortality rates [17–19]. However, the long-term maintenance of such weight loss is considered a key concern as only a minority of people accomplishes to not regain a significant amount of weight in the long run [20–22]. Only 2 to 54% of participants of lifestyle interventions achieve long-term weight loss maintenance [23,24]. On average, people regain 50% of the body weight that was initially lost during one year after a behavioral intervention (i.e. so-called 'yo-yo dieting' or 'weight cycling') [24,25]. Partly depending on the sort of bariatric surgery, patients regain up to almost one third of the weight that they had lost within 6 years [17,26]. Eating behavior and physical activity appear to be robust predictors of long-term weight loss maintenance. As an example, the magnitude of change in binge eating in response to bariatric surgery and the level of post-operative loss of control over eating predict long-term post-operative weight loss [27,28]. Successful weight loss maintainers are more physically active and show healthier eating habits such as reduced food

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intake and limited snacking [29–31].

Given these findings, the question arises as to which factors can help to explain why some people are obviously more successful than others in resisting the temptation to eat and thus to successfully maintain weight reduction. People in most western countries live in an obesogenic environment where palatable food is highly visible and almost permanently accessible. Given that food is a natural reward [32,33], people who are generally good in forecasting risks (e.g. obesity and related health problems) and in resisting behavior that might be associated with tempting rewards should be better in resisting the omnipresent temptations of food intake [34,35]. Behavioral economics offer a theoretical framework that could help to understand why some individuals succeed more than others in this regard. In a behavioral economics framework, an individual's choice to eat or not eat a certain food in a certain moment depends on their preferences for or against (immediate) gratification at the expense of negative (long-term) consequences [36,37]. A preference for immediate reward is related to the construct of 'delay discounting' (i.e. a preference for smaller sooner rewards as opposed to larger later rewards) and a poor ability to inhibit immediate reward in pursuit of long-term goals and advantages [38]. In a broader context, this ability is covered by the construct of reward-related decision making which is considered a complex cognitive process that includes the assignment of values and probabilities to different behavioral options, the selection of one of these options based on the value assignment, the execution of specific behavior that is thought to lead to the desired outcome, the evaluation of the actual outcome and, finally, the learning and updating of the whole evaluation and action-selection process [39]. Several computerized tasks have been designed to measure this by either assessing the preference for smaller but immediate rewards over larger but delayed rewards (e.g. the Delay Discounting Task) [40], or assessing a higher tolerance of risk in favor of a desired reward (e.g. the Iowa Gambling Task and the Game of Dice Task) [41,42]. Both sorts of tasks have in common that when participants favor immediate or large but uncertain rewards they will actually obtain poorer outcomes in the long run. Additionally, the consideration of future consequences (e.g. of food intake) can also be assessed via self-report measures [43,44].

Using either of these methods of assessment, several studies have shown poor (i.e. more impulsive/disadvantageous) reward-related decision making in people with obesity, comparable to patients with an eating disorder [38,55]. However, so far only a few studies have examined the relation between reward-related decision making and actual success in weight reduction. Best et al. [56] found that children with steep (food-specific) delay discounting at baseline were less successful in a weight reduction treatment. Correspondingly, Witbracht et al. [57] have shown that poor reward-related decision making, assessed by the Iowa Gambling Task at the end of the intervention, was related to a smaller amount of weight loss during a diet-focused weight loss intervention for overweight women. These two previous studies on the relationship between reward-related decision making and actual weight loss are, however, either restricted to children or cover a rather short timeframe (i.e. 12 weeks). Since weight loss following behavioral interventions typically peaks at around 6 months and is then followed by weight regain for the majority of individuals [15], it is of great interest to also examine the relationship between reward-related decision making and long-term weight loss maintenance in adults. Therefore, the present study aimed to examine whether people who successfully maintained weight loss for one year show better reward-related decision making than those who experienced significant weight regain after initial weight reduction (i.e. yo-yo dieting/weight cycling).

2. Methods

2.1. Design

The study adopted a case control design comparing individuals with successful and unsuccessful long-term weight-loss maintenance in terms of their reward-related decision making.

2.2. Participants

Participants were recruited from patient registries of an obesity center at a university hospital and through advertisements in the local media. The study sample consisted of 33 adult women of whom 17 had successfully maintained their body weight after weight reduction, and 16 had regained weight after initial weight reduction. Participants in both groups had to have achieved successful weight reduction of at least 10% of their body weight. Participants in the group of successful weight loss maintainers further had to show successful maintenance of this 10% loss of body weight over one year, and a stable body weight for the last 3 months with weight fluctuations $\leq 5\%$. Participants who showed weight regain after initial weight reduction (i.e. showing yo-yo dieting/weight cycling) and reached at least their initial weight (i.e. prior to the weight reduction) were allocated to the group of unsuccessful weight loss maintainers. Weight trajectories were assessed retrospectively. Participants had achieved their weight reduction through behavioral treatments (e.g. dieting, fasting, mindful eating, nutrition counseling, physical activity) and/or medication. Exclusion criteria for both groups were: severe psychiatric, neurological, or somatic diseases, current substance abuse, and current psychotropic medication. All participants provided written informed consent. The study was approved by the ethics committee of the Medical Faculty of the University of Heidelberg.

2.3. Measures

2.3.1. Anthropometric measurements

Participants' body mass index (BMI; weight in kilograms divided by height in meters squared) was determined by objectively measuring body weight and height in the standing position, without shoes and in light clothing. It was calculated to the nearest 0.1 kg and 0.01 m. Retrospectively assessed weight trajectories were assessed in an interview (i.e., not objectively).

2.3.2. The Game of Dice Task (GDT)

The GDT [58] was used to assess reward-related decision making. In this task, participants are asked to guess the outcome of a dice game with the aim of maximizing their gains within 18 throws of a virtual dice. Participants are provided with a virtual starting capital of € 1000. Prior to each throw, they are asked to guess which number or combination of numbers presented on the screen contains the number that will be thrown in the upcoming trial. Participants are asked to choose among fixed alternatives, i.e. a single number, or a combination of two, three, or four numbers. If the thrown number fits the selected number or a number within the selected combination, the participant wins the pre-specified gain. If the thrown number, however, does not fit the selected number(s), the amount of money is discounted from the participant's current balance. The different choices are linked to different, fixed probabilities for gains and losses: a single number is associated with a 1:6 winning probability and a pre-specified gain/loss of € 1000, a combination of two numbers is associated with a 2:6 winning probability and a pre-specified gain/loss of € 500, a three-number combination goes along with a 3:6 winning probability and a pre-specified gain/loss of € 200, finally, the four-number combination is associated with the highest winning probability of 4:6 yet with the lowest amount of gain/loss (€ 100). Before the game starts, participants are explicitly briefed regarding these rules for gains and losses. In addition, the potential gains and losses associated with each of the alternatives are permanently presented on the screen. After each trial, the current gain or loss, the current balance, and the number of remaining trials are presented to the participant. In the end, a "net score" is calculated by subtracting the number of disadvantageous (i.e. choices of either a