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A review of the impact of decision heuristics on calorie underestimation and the implications for unhealthy eating

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A review of the impact of decision heuristics on calorie underestimation and the implications for unhealthy eating

Abstract

Purpose

The global rise in obesity can be closely linked to excessive calorie consumption and misperceptions regarding food intake. Thus, this narrative review aims to synthesize the existing literature on how heuristic cues—mental shortcuts used for decision-making—impact calorie underestimation and consequently lead to unhealthy eating habits.

Design/methodology/approach

In this review, we focus on synthesizing findings from studies in developed countries to provide an in-depth examination of how heuristic cues impact calorie underestimation and a comprehensive, cross-disciplinary understanding of the implications of these systematic cognitive dispositions in thinking that affect eating behaviours.

Findings

The main findings are that the dichotomous categorization of foods as healthy or unhealthy can result in underestimating the calorie content in those foods perceived as healthy. Although nutrition claims, health claims and campaigns help in the fight against obesity, there is also the risk that consumers' reliance on heuristic-based decision-making could aggravate the problem because a misinterpretation or misrepresentation could lead to calorie underestimation and overeating.

Originality

This paper is the only review to date that consolidates research on the topic, drawing from multiple disciplines.

Practical implications

In order to establish effective interventions for obesity prevalence whilst guaranteeing food accessibility, it is critical for interventions and policies to understand how consumers perceive calorie content and how they interpret claims on food marketing or packaging. Recognizing and addressing these heuristic-driven biases and understanding the factors influencing food choices are crucial for encouraging healthier eating habits.

Keywords. Biases; dietary choices; food decision-making; overconsumption; obesity

Background

People in developed countries arguably have more access to other healthier food options. However, there is a prevalence of obesity, which, among other factors, is attributed to unhealthy diets (Allender & Rayner, 2007; Janssen et al., 2020). Over the years, researchers have identified numerous elements that influence eating habits, among which is the impact of heuristics on the estimation of food calories and subsequent eating behaviour. There is evidence to suggest that while using these shortcuts is beneficial for processing a myriad of daily choices efficiently, they can be counterproductive in specific contexts—such as accurately assessing calorie content in food. Calorie underestimation, i.e., where individuals unintentionally miscalculate the caloric content of a meal, could be consequential, leading to overeating and, consequently, weight gain and associated health issues (Carels et al., 2006).

There is a dearth of reviews that specifically explore how heuristics influence this underestimation. Considering that the association between heuristics and calorie underestimation cuts across multiple disciplines like psychology, nutrition, public health, and marketing, this review helps to bring relevant studies together to provide a more holistic understanding. A comprehensive understanding of the drivers of unhealthy eating is critical for individual decision-making and policymakers aiming to create more effective health interventions. Thus, the paper examines the evidence of the relationship between heuristic cues and the systematic underestimation of calorie content, highlighting its implication for unhealthy eating behaviours and association with obesity. Specifically, the paper presents a synopsis of the association between caloric intake, diet quality and obesity, then synthesizes the evidence on the concept of heuristic biases, detailing how they contribute to skewed calorie estimations. The review also establishes evidence whether heuristic cues distort calorie judgments and generate biased perceptions of food healthiness, particularly in the context of health campaigns and nutritional claims. The review culminates in outlining a research agenda to fill the identified knowledge gaps.

A synopsis of the relationship between caloric intake, diets and obesity

Obesity is an unusual or excessive fat accumulation that causes health risks (WHO, 2022). People are regarded as overweight when their body mass index (BMI) is equal to or over 25 kg/m² and obese if the BMI is equal to or greater than 30 kg/m² (WHO, 2021). The global rate of overweight and obesity has been constantly growing over the past few decades, from 4% in 1975 to 18% in 2016 (WHO, 2022). Such prevalence of obesity has become epidemic proportions and a key driver to both the global burden of disease and a load on healthcare systems. It is reported that prevention programs are more effective than weight-loss programs (Müller et al., 2001). In terms of the health care cost alone, people living with obesity have about 30% more medical costs than those who have lower BMI (Lin & Li, 2021). The direct costs of obesity provided about 7% of the overall healthcare expenditure in the United States and approximately 1%–5% in Europe (Colditz, 1999). In the UK, it was estimated that overweight and obesity cost a massive £3.23 billion, accounting for about 5% of total NHS costs (Allender & Rayner, 2007).

Previous studies suggest that obesity results from the interaction of multiple aspects, including calorie utilization, physical activity, healthcare availability, and latent hereditary and environmental factors (Lin & Li, 2021). But amongst them, proper calorie utilization is emphasized. Tooze et al. (2004) and Larkin & Martin (2016) are examples of such studies that revealed the strong relationship between calorie underestimation and obesity. The imbalance between consumed and expended calories is frequently identified as a control point in current health recommendations to avoid obesity (Lin & Li, 2021; WHO, 2014). In addition, the increasing availability of energy-dense food and marketing that promotes them can significantly affect energy balance and consumers' decision making (Lin & Li, 2021; Yoo, 2018).

Biased calorie estimation arising from heuristics

Although the obesity pandemic has raised consumers' awareness of the degree of foods healthiness and weight-gain potential, it is still common for consumers to make snap decisions about food choices instead of selecting food based on informed decisions (Rozin et al., 1996; Baccelloni et al., 2021; Zafar et al., 2022; Campos et al., 2022). Such

phenomenon stems from heuristic (Tversky & Kahneman, 1974) [1]. That is, the decisions people make in real life are not always rational, given their limited knowledge, resources, and time. Instead, we use mental shortcuts or a rule of thumb to make quick judgements, broadly defined as heuristics (del Campo et al., 2016). Since there are many food decisions to make every day, analysing the consequences of each of them would be a very effortful and time-consuming process. For example, consumers are often overwhelmed by large amounts of food information, but these messages sometimes could compete and contradict each other (National Cancer Institute, 2005; Ramírez & Carmona, 2018). It is, therefore, inevitable for consumers to use mental shortcuts to make rapid decisions, even if they might be misleading (Provencher & Jacob, 2016).

Consumers perception of food as good–bad dichotomy and manifestation of the use of heuristics

Studies have shown that individuals often classify foods into specific categories, i.e., a good/bad, vice/virtue, healthy/unhealthy dichotomy depending on the attributes of food (Johansson et al., 2009; Carels et al., 2006, 2007; Oakes & Slotterback, 2001; Rozin & Holtermann, 2021;), and these perceptions can lead to bias in their estimation of the energy content of foods (Carels et al., 2006, 2007). Rozin et al. (1996) observed the trend where people categorize foods into either healthy or unhealthy groups, often attributing additional positive attributes (such as being nutrient-rich and low in calories) to the "healthy" foods. Rozin et al. (1996) and also found that participants thought that if food is unhealthy in large quantities, then it is also unhealthy in small amounts. There are findings that indicate that people have the illusion that healthy food items have fewer calories than unhealthy ones, regardless of the quantity (Oakes, 2005). Similarly, Carels et al. (2006) examined the participants in a behavioural weight loss program (BWLP) and drew a similar conclusion that food that is regarded as unhealthy is generally perceived to contain more calories than it actually does.

There is also a misperception that adding healthy food will improve the health perception of a meal and decrease its perceived calorie content (Chernev & Gal, 2010). Such paradox is also known as "dieter's paradox" because those who are more conscious of weight or

diet are more apt to believe adding a healthy food item will reduce the weight-gain tendency of a meal (Chernev, 2011).

However, there is a lack of studies that evaluate the calory estimation under the context of a whole meal but most studies only focused on individual healthy or unhealthy foods. This gap is addressed by Chernev and Gal (2010), who reported that the caloric underestimation bias is more significant based on a holistic evaluation of a meal than based on a piecemeal evaluation. The holistic evaluation is also closer to the actual scenarios where people like to combine virtue food and vice food in one meal.

Halos influences food classification dichotomy

Previous studies reported that there are three main types of contributors to the categorization of healthy food or unhealthy food. First, “health halo” and messages play a major role in judging the healthiness of food. Halo bias occurs when one positive attribute or feature shapes a generally favourable opinion of something. With respect to food, this cognitive bias can manifest when an individual judge the healthiness of a food item based solely on one appealing quality, such as organic, gluten-free, fair trade or “natural” labels, while overlooking other elements like calories, sugar content or overall nutritional content (Berry & Romero, 2021). The health halo effect, for example, was also evident in Chandon & Wansink (2007), where restaurants that claim to provide “healthy” food options make consumers more prone to caloric underestimation of main courses and then purchase caloric-dense side dishes than those restaurants which do not make such health claim.

Second, front-of-pack symbols, packaging colour and selective highlight of nutritional content have been known to impact food classification as healthy or unhealthy. Wells et al. (2007) demonstrated that consumers utilize information on packaging to help them make food decisions during purchase. Nevertheless, such information can mislead children and their parents and make them mistakenly consider the food product healthy (Hawkes, 2010). Elliott (2008, 2009) discovered that many food products for children with nutrition claims were not holistically nutritious, as indicated according to the cited nutrition criteria. However, children perceived them as healthy merely due to the claims on the packaging.

Apart from nutrition claims, the presence of a no-allergen symbol, a 'health' front-of-pack symbol, and a green colour also influence their perception of the healthiness of food products. Another factor is the perceived nutritional content of food. For example, it was found in both behavioural weight loss participants and middle-aged adult participants that the health perceptions of food were mostly determined by fat, no matter whether the rating was based on food names or food descriptions (Carels et al., 2006; Oakes & Slotterback, 2001). Other nutrition such as fibre, vitamins and minerals also exerted influence but not as much as fat content (Carels et al., 2006).

Third, the rate of healthiness is also influenced by some stereotypical beliefs associated with a food's name and description (Provencher et al., 2009; Provencher & Jacob, 2016). Some food items are believed to be healthy and wholesome while others are regarded as junk, fatty or empty calories, but people rarely describe a food's health value as medium (Oakes, 2005). There is also a stereotype such that even if the calorie content information was provided to participants, they still believed unhealthy food with lower energy led to more weight gain than healthy food with higher energy (Oakes & Slotterback, 2005). Oakes (2005) and Oakes, (2006) study showed that the focus on specific foods being either good or bad, especially regarding their fat content, was frequently exaggerated. These studies conclude that the widespread acceptance of this good versus bad perspective on food among Americans might be playing a role in the increasing rates of obesity.

Understanding how heuristics leads to biased healthiness perceptions from nutrition and health claims and campaigns

Two types of claims on food i.e., nutrition claims and health claims, are defined in EU Regulation 1924/2006 (EU, 2006). This regulation identified health claims as claims that state, suggest or imply an association between a food or food genre and health benefits (EU, 2006). Such claims typically stress a function which has been generally acknowledged by scientific research. For example, "this product contains calcium and is beneficial for developing strong bones and teeth". As for nutrition claims, they are intended to suggest, state, or imply the specific beneficial nutritional properties of a food given the nutrients or

energy content it contains (e.g., fat-free, sugar-free, source of fibre) (EU, 2006). Nutrition and health claims are potentially potent approaches to communicating with consumers about information on food properties and their health benefits, without which consumers may still not be aware of these messages (Leathwood et al., 2007). Currently, following the trend of emphasizing contributions to health, food manufacturers are progressively applying such labels, including five-a-day labels (Appleton & Pidgeon, 2018; Leathwood et al., 2007). Adding these labels raises consumer awareness of healthy food options and promotes more well-informed dietary patterns (Provencher & Jacob, 2016).

Similarly, there is the five-a-day campaign which was launched according to the recommendation from the World Health Organization (WHO) that having a minimum of 400g (five portions for adults) of fruit and vegetables each day can reduce the risk of severe health issues such as heart disease, stroke, and some types of cancer (NHS, 2022b). In the UK, fruit and vegetable food products are labelled as "... of your five a day," to encourage people to eat a combination of at least five portions of fruit and vegetables. Other countries e.g., France, Germany and the United States also have similar labels depending on local recommendations (Appleton & Pidgeon, 2018).

Although the policy and regulations of nutrition and health claims are designed to allow consumers to easily distinguish the health properties of food products while ensuring that they are not misled by this information (Orquin & Scholderer, 2015). However, their presence in food marketing or food packaging could also bias perception, given how consumers process information differently. For example, there are concerns that consumers may confuse the 5-a-day logo with health claims on composite foods and contradict the goal of healthy eating.

Misunderstanding of nutrition and health claims and campaigns

Consumers' understanding of label claims also follows the basic information-processing pattern (thinking–liking–behaving). This pattern was used to analyze food purchase behaviour (Keller et al., 1997; Leathwood et al., 2007). Keller et al. (1997) stated that the

influence of nutrition and health claims was determined by consumer's awareness of the claims, inferences from and credibility of them, and motivation to turn them into actions.

With factors varying across individuals, consumers' interpretations of the claims can hardly be guaranteed to be consistent. Van Trijp & van der Lans (2007) asked consumers to rate their ability to understand a series of nutrition and health claims and their advantages. Surprisingly, even for the simpler claims, the respondents who considered them as 'quite easy' or 'very easy' to understand were scarcely over 75–80%. Van Trijp and Van der Lans (2007) also found that claims that involve unfamiliar technical jargon could give rise to confusion in consumers. For example, with probiotic yoghurt, around 75% of participants from the UK, Germany and Italy reported that the health claim which states that "...helps strengthen the body's natural defence system" was understandable to them. However, after changing this claim to "helps strengthen the body's natural defence system because it contains probiotics", the participants from UK, Germany and Italy who understood this term dropped to 60%, 60% and only 25%, respectively.

Misrepresentation and exaggeration of nutrition and health claims and campaigns

In marketing food, the exact health benefits of food products could be inappropriately broadened and exaggerated using these claims. As a result, the bias will be reflected in consumers' perceived healthfulness, appropriate portion size and calorie estimation of food products. Consumers assume products with low-fat claims generally have fewer calories, but the actual reduction in calories is not as substantial as they deduced (Wansink, 2004). Similar exaggeration happens in 5-a-day labels as well. Due to the nutrition breakdown during the processing, it is recommended in WHO's 5-a-day guidelines that fruit juice, vegetable juice and smoothies should only be regarded as one portion of 5-a-day regardless of the portion size (NHS, 2022a; WHO, 1990). However, that there are still smoothies in the UK's market labelled as "2 of your 5-a-day", which do not contain any crushed fruit in their ingredients (Appleton & Pidgeon, 2018).

In addition, it is argued that the 5-a-day label set a goal that, to some extent, discourages people from consuming more than five portions of fruit and vegetables (Appleton &

Pidgeon, 2018). Because people tend to meet a goal instead of exceeding it (Cullen et al., 2001), when people have already consumed a food labelled as "2 of your 5-a-day", they are more likely to decrease their later effort and subsequently only consume up to another three fruit and vegetable portions.

It has also been reported that nutrition claims can improve the perceived healthfulness of food products even though the product is not considered a healthy food based on conventional categorization. A good example is a study on chocolate bars (Andrews et al., 2009; Ebnetter et al., 2013). Before adding claims, no respondents saw chocolate bars as healthy food. With the claim that the chocolate bars had reduced fat and calories, 22% of the respondents believed that these chocolate bars were healthy for them (Andrews et al., 2009). On top of this, such influence on perceived healthfulness is argued to be moderated by consumers' health consciousness and the presence of a nutrition fact panel (Mai & Hoffmann, 2015). Mai and Hoffmann (2015) found that yoghurts with "reduced-fat" or "reduced-sugar" claims are considered healthier than regular yoghurts for health-conscious consumers. On the contrary, less health-conscious consumers hardly perceived the yoghurts labelled as "reduced-fat" or "reduced-sugar" are healthier than the regular version.

Finding on overconsumption from biased healthiness perceptions from nutrition and health claims and campaigns

Faulkner et al. (2013) observed an almost 50% calorie underestimation in coleslaw labelled as "reduced fat". Such underestimation was followed by the expansion of the perceived appropriate portion size. Chan et al., (2004) and Geyskens et al., (2007) reported that respondents see "low-fat" claims as permission to eat more. Low-fat claims have been shown to cause overconsumption by reducing guilt (Wansink & Chandon, 2006).

In terms of food choice, when healthy and unhealthy foods are combined, it can give some consumers a justification to choose indulgent, unhealthy food and to average rather than sum calories from such combinations (Chernev & David, 2010). In addition, it is believed that because of the licensing effect, the consumption of low-fat food can increase the consumption of other complementary products (Cleeren et al., 2016). More so, from the

licensing effect point of view, nutrition claims such as reduced-sugar or campaigns such as 5-a-day, which also stress virtuous attributes, can also enhance the virtue categorization of a whole meal and act as permission to have more unhealthy options included in the meal.

Collectively, these studies are evidence that halo effect can enhance immediate eating intentions, result in calories underestimation and lead to greater purchase and consumption of the products with such claims.

Summary of knowledge gaps, research agenda and concluding comments

Studies on calorie underestimation have not exhaustively considered the role of such health and nutrition information in virtue categorization. Many past studies asked participants to evaluate the calorie content in scenarios virtue foods are used. The limitation of such existing studies is that the impact of the external information presented along with the food (e.g., health/nutrition claim, brand, packaging colour), which also exists in virtue scenarios, is not fully understood.

Similar to the point raised in previous studies on calorie underestimation (Carels et al., 2007; Chernev, 2011), the influence of claims was mainly assessed in single food items (Ebnetter et al., 2013; Faulkner et al., 2013; Wansink & Chandon, 2006). Due to the licensing effect on consumer choice, such influence tends to be spread to the consumption and purchase in which these food with claims is involved – as aspect which needs further research. In addition, although nutrition and health claims have been proven to result in unintended outcomes when heuristics drive choices, there are gaps in understanding of the extent to which they could mislead consumers to underestimate the calorie content.

Also, studies investigating claims have a skewed focus on fat-related nutrition claims (e.g., low-fat). But for overweight and obesity, core nutrition claims are not only associated with fat but also sugar and energy content (WHO, 2021). The nutrition claims about sugar and energy content are not fully investigated in previous studies and the generalizability of some results are low (Oostenbach et al., 2019).

Note

1. Readers can refer to Hjeij & Vilks, (2023) review for a detailed discussion on the evolution of the modern notion of heuristics.

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