University of Tartu
School of Economics and Business Administration

Kristjan Pulk

COGNITIVE BIAS EFFECTS ON MEAL PERCEPTION

Master Thesis

Supervisors: professor Maaja Vadi, professor Tore Kristensen

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I have written this master's thesis independently. All viewpoints of other authors, literary sources and data from elsewhere used for writing this paper have been referenced.

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Author Kristjan Pulk

Abstract

This paper examines the effects of cognitive bias in meal estimations, in order to demonstrate the consequences that different food item additions have on the perceived caloric content, healthiness, and preference of the meal. The author conducts choice experiments using photographs of common food items with variable factors and includes novel statistical methods for comparative studies to determine the extent of the health halo effect. The results show that drinks have a large effect on how the meal is perceived as a whole, since including a glass of water with a meal resulted in a perceived healthiness increase despite the meal being identical in caloric content. Adding fries resulted in overly high caloric content estimations, while adding the same energy consistency worth of salad resulted in low rises in perceived caloric content. Furthermore, men were much more likely than females to prefer beer with their meal, even though the perception of healthiness is similar for both sexes. These findings demonstrate cognitive bias patterns and the primary method of estimation to be heuristic categorisation of food items. Diabetic people in particular were affected by healthy foods, while showing a binary attitude of avoidance towards perceivably unhealthy foods.

Keywords: cognitive bias, health halo, meal perception

1. Introduction

Obtaining accurate nutritional information by just perceiving a presented meal is a difficult task. Not only due to insufficient knowledge, but also since it is easy to misinterpret how much is presented or consumed. Contextual cues, such as portion size presentation, can significantly influence food consumption (Wansink & Chandon 2014). A doubling of meal volume is seen as a 50-70% increase in quantity (Chandon & Ordabayeva, 2009), while elongating the packaging makes a ¼ decrease in portion size be seen as a 2% decrease in volume (Ordabayeva & Chandon, 2013). Furthermore, eating is seen as an autonomous process dependent on heuristics (Cohen & Farley, 2008), a mental shortcut for making decisions (Tversky & Kahneman, 1984). Heuristics are useful for quickly arriving at conclusions even in situations of limited information.

However, sometimes heuristics fail at making correct assessments. These types of systematic patterns of irrationality can be described as cognitive bias (Kahneman & Tversky, 1974). Cognitive bias indicates that people make irrational decisions but those decisions have predictable patterns. Similarly to heuristics, cognitive biases can also be arguably useful and have beneficial practical implications in fields such as entrepreneurship and finance among others (Kahneman & Tversky 1996). On the other hand, there are many cognitive biases that could cause perceptual distortion, leading into inaccurate interpretation - in this case the misinterpretation of caloric content estimated and ingested.

The misinterpretation of nutritional value in the meal can contribute to excess weight gain or malnutrition, as how much food is perceived to be on the plate influences consumption (Wansink & Chandon, 2014). Excess weight gain poses as issue for the world, as 39% of adults in the world are considered overweight and 13% are considered obese - resulting in serious health issues (WHO 2018). Malnutrition is also problematic, as is evident with numerous eating disorders. Therefore both cases are considered in the study. Importantly, while weight gain due to misinterpretation is a problem for many developed nations it is not so for all parts of the world. There is a significant portion of people that are starving and would likely not be affected by cognitive bias effect similarly to countries where obtaining food is not an issue. However, relevant insight of how nutritional content could be perceived more accurately would still prove useful to many.

Furthermore, while healthier eating habits could be facilitated by education and higher awareness of nutritional information, food choices seem to be the domain of the unconscious. This means that developing contextual cues that make healthy choices perceived as norms would be a more effective way of influencing behavior. Such contextual cues can be described as nudges - small changes to the choice architecture that can have large effects when it comes to the decisions made in that context (Thaler & Sunstein, 2009). While nudges as intervention methods have gained large scale popularity, the technique is not applicable to every situation. Meals are a promising venture though, as cognitive biases could be employed to serve personal goals, instead of hindering them.

However, before nudges could be developed, a better understanding of the patterns underlying erroneous judgement needs to be achieved. While the differentiation between cognitive biases has been a controversial subject (Dougherty, Gettys, & Ogden, 1999; Gigerenzer, 1996), there's evidence that specific biases can be differentiated from each other a priori (Kahneman & Tversky, 1996). A taxonomy for food related cognitive biases has not been developed, but relying on theoretical developments and grouping techniques (Dimara, et al., 2018), the author would propose that these cognitive biases affecting meal perception could be segmented into three groups: information simplification, ease of processing and inferred meaning from irrelevant factors. The health halo effect is selected as an example, which refers to a biased perception of healthiness from irrelevant factors (Burton, et al., 2015). As an example of the health halo effect, the caloric content appraisal of a meal could decrease with the addition of a salad or a glass of water.

The relationship between cognitive patterns and meal estimation has not been thoroughly clarified yet, as the data on the influence of cognitive bias is rather sporadic and describes isolated effects. While the presence of the health halo effect has been demonstrated (Chandon & Wansink, 2007; Burton, et al., 2015; Talati et al., 2016) most of the research has been focused on the packaging rather than the actual food items in the meal, or deal with only single food items at a time. It is unknown what kind of an effect drinks have on the healthiness appraisal of the meal. Healthiness perception presents an interesting avenue for further research, as appraisals are likely influenced by cognitive biases.

The goal of this paper is to explain cognitive bias effects influencing meal perception via drink and dish modification. The influence of cognitive bias is tested with choice experiments, where the differences in assessments of individual pictures and effects between subjects are examined in the first experiment, while the second shows differences within subjects with a comparative setup. Experiments are conducted on Copenhagen Business School students and on people with diabetes in Estonia. Choice experiments are chosen in contrast to eye-tracking studies, a common research method in the field. The experimental design should better clarify the effects of different biases, rather than finding further evidence of attention bias.

The thesis is structured as follows. The introduction is followed by a literature overview, describing the theoretical framework for understanding food perception cues and cognitive biases relating to food decisions and meal estimation. Methods and data are described in section three, with discussion of the results in section four. Both the specific and more general implications of the results are considered in section five. Limitations and concluding remarks are given in the last part of the article, with remarks regarding future research avenues and acknowledgements by the author .

2. Literature overview on meal perception cues and cognitive biases

2.1 Food perception cues

People are rather poor at accurately estimating the caloric content of meals (Brindal, et al., 2012). Most judgements are made depending on a single factor, which in terms of meals, seems to be the identity of the components (Geier & Rozin, 2009). Sensory, emotional and normative drivers together with cognitive biases can have an effect on food estimations, as these factors can facilitate or interfere with the monitoring of consumption (Wansink & Chandon, 2014). Likewise, internal and external cues could be used to describe influences of consumption quantity and intake monitoring (Herman & Polivy, 2008). In this regard, both rationales describe similar effects in a different manner. Starting with the more general approach, figure 1 describes cues obtained externally or internally.

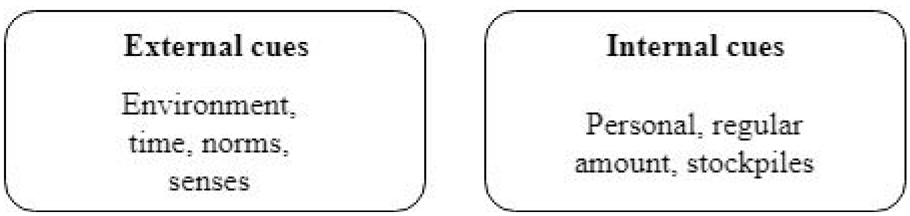

Fig 1. Cues that influence meal perception (Herman & Polivy, 2008).

Internal cues refer to what the person regularly does - what and how much do they usually buy, how much food they usually serve themselves and how much they have stockpiled, while external cues refer to what people experience in the environment outside of their inner factors, in essence shaping how their future internal cues will develop (Herman & Polivy, 2008; Wansink & Chandon, 2014). However, the influence of internal cues is widely overestimated in comparison to external cues (Vartanian et al., 2017). Feeling hungry is perhaps more tangible than how much people around you are eating, but both are considerable factors in how much is consumed. Reward foods, such as sweets are particularly easy to consume when they are already stockpiled at home. These factors could be seen as describing the habits of a person that have already been developed in regards to previous contact with external factors.

External cues can be divided into two categories - normative cues, which affect all eaters without discrimination, and sensory cues, which affect obese and dieting people in particular. A sensory cue, such as palatability, directs how the food is experienced, but normative cues direct how much of that is sensible to eat. (Herman & Polivy, 2008). While this division makes intuitive sense, there is still plenty of overlap between these categories, as shown by combining inhibitive internal cues and augmentative normative cues (Vartanian et al., 2017). An example of an inhibitive cue in this case would be having a large supply of potato chips at home and an augmentative cue would be particularly heavy chips consumers in the vicinity. Multiple cues are interpreted simultaneously, yet some may prove to be more potent than others.

Another way to look at it would be to examine the drivers of food consumption and how consumption monitoring is interfered with. Sensory, emotional and normative drivers of food consumption influence both the amount consumed and the way that the amount is perceived (Wansink & Chandon, 2014). Cultural effects and trends could also play a role in consumption, as the amount varies due to trends in food choice (Kearney, 2010). As an example, craft beer was largely unknown in Estonia merely 20 years ago, with the breweries focusing on mass markets. However, now craft beer is amidst a significant boom, signifying a consumption trend. Many of the consumption drivers are likely present at the same time - a person could be feeling stressed (emotional), smell the appetizing scent of a meal (sensory) and be at the presence of other eaters (normative) at the same time. Adding the influence of the particularities of the location, dinnerware (Van Ittersum & Wansink, 2012) and numerous other personal factors, it makes for a complicated picture. An overview of this classification is depicted in figure 2.

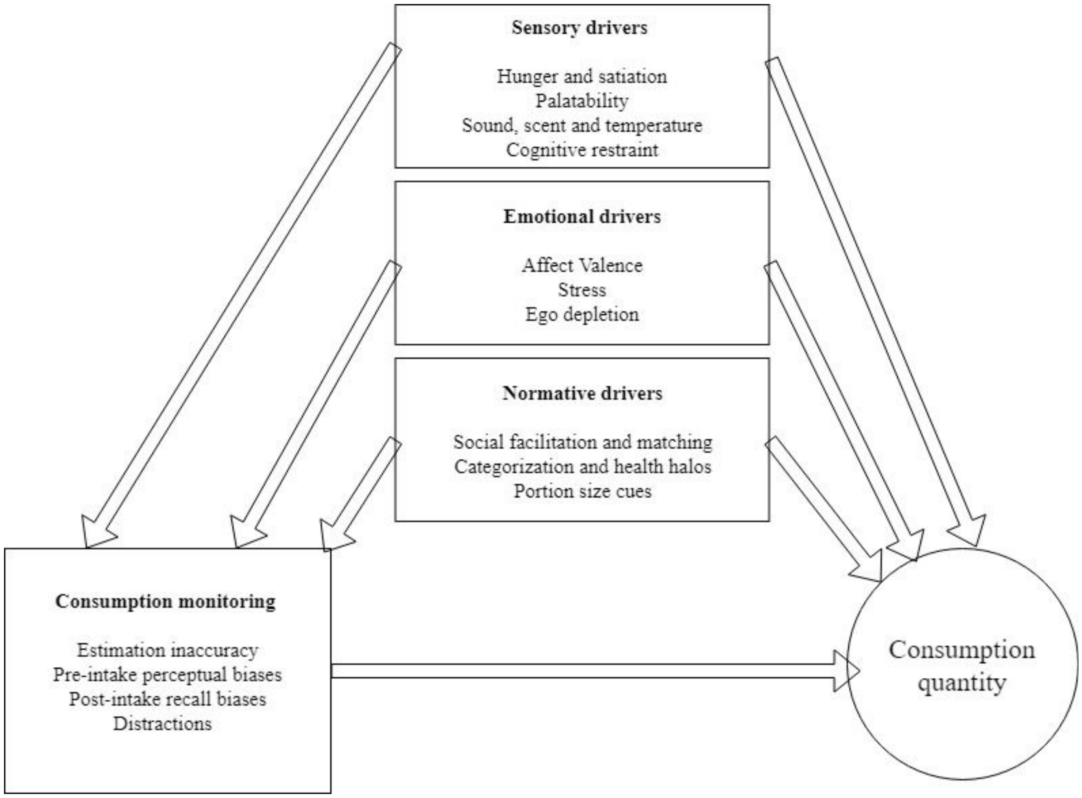

Fig 2. Drivers of food consumption and consumption monitoring (Wansink & Chandon, 2014). Note: many of the effects can be present simultaneously, and likely are. Cognitive biases are most present in consumption monitoring - the estimation and perception of how much is set on the plate and how much is eaten.

Starting from the top row on fig. 2, sensory drivers are motivators that we infer from our senses. Notably there are more than just five ways of perceiving the environment and these are not at all separable, but rather a synthesis of the complex data that is interpreted by the brain (Jarrett, 2015). However, this information can get mixed up and provide contradicting results. Following this idea, sommeliers were completely fooled by white wine that was dyed red, as the tasting was subsequently followed by descriptions regular for red wine (Brochet & Dubourdieu, 2001). This demonstrates that even professionals could be deceived by simple changes in presentation. In addition to sight. the taste of food is also heavily influenced by the scent of it (Shimemura, Fujita, & Kashimori, 2016). In other words, pinching your nose during eating a meal will alter how the food tastes.

Continuing with sensory drivers, considerably less is known about the effect of sound on the taste of food. Music described as ‘sweet’ or ‘bitter’ could potentially influence people towards describing the food being eaten with similar descriptors (Crisinel et al., 2012). However, these findings are still inconclusive (Höchenberger & Ohla, 2019). Interestingly, the amount of sound (“crunch”) a particular food makes could increase saliency, resulting in a decrease in consumption (Elder & Mohr, 2016). Furthermore, while touching food is not usually considered, there’s evidence that the feel of the container will change how the taste of the food is perceived (Krishna & Morrin, 2008). Touch also relates more to the texture of food, where food is rated as more sour when it has a rough surface compared to a smoother one (Slocombe, Carmichael, & Simner, 2016). These findings confirm a much more convoluted sense of perception than what is usually consciously described.

Having examined the sensory drivers of consumption monitoring, the role of cognitive restraint, or the ability to exert willpower over impulse, is taken into account. Dieters could be described as restrained eaters and are more governed by the rules and regulations of their chosen diet than of hunger - which often results in the failure of restraint and indulgence of food deemed forbidden or binge eating on something pleasant (Fedoroff, Polivy, & Herman, 2003). However, applying too much restraint can lead to ego depletion, which refers to the notion that decision-making processes in the mind take a toll on willpower, thus making future decisions more difficult (Baumeister, et al., 1998). As a result, ego depleted people who have made numerous decisions exhibit less willpower for future decisions, which makes them more susceptible to contextual manipulations (Hou, 2017). The mental resource can simply be used up.

The state of ego depletion closely relates to emotional drivers, which signify how the person feels. Affect valence, the effect that people seem to eat more when stressed and less when happy has been well documented, with the effect increased in restrained eaters (Sproesser, Schupp, & Renner, 2014; Greeno & Wing, 1994). Furthermore, normative cues affect how a certain way of behavior is seen as a norm in a given context. Contextual factors such as meal companions (Herman & Polivy, 2005), health perception of the meal (Burton, Cook, Howlett, & Newman, 2015), portion size (Kerameas, Vartanian, Herman, & Polivy, 2015) or packaging cues (Ordabayeva & Chandon, 2013; Petit, Velasco, & Spence 2018) influence consumption. It seems that these types of influences remain somewhat understated consciously.

In addition to the drivers listed above, distractions such as using a smartphone (Grewal, et al., 2018), what music is played (Petruzzellis, Chebat, & Palumbo, 2018) or watching television (Wansink, Just, & Payne, 2009) affect how much food is consumed, as people are that much less aware of their consumption quantity. A difference of 15-20% of calories consumed per day can go unnoticed, which in a 2000 calories recommended daily amount translates to a difference of 9000 calories eaten per month without actually being aware of any change in food consumption volume (Hall et al., 2011). Yet this is only the overeating people are not aware of doing. In addition, people often indulge themselves with excessive food consumption, insecure people (Stinson et al., 2018) and food restrictive (certain diet groups, such as keto) people in particular (Keller, Hartmann & Siegrist 2016). While it may feel necessary to binge eat an entire tub of ice cream after a stressful event, perhaps a smaller quantity packaged differently would achieve the same result.

Sensory, emotional and normative cues can thus interfere with the perception of consumption, resulting in estimations that far differ from the actual amounts consumed. As the accounting of caloric intake can be disrupted with a multitude of effects and even dinnerware used, seeing how people perceive meals can shed light on why people underestimate the amount of calories in a meal. Perhaps by understanding the effects involved and being able to devote attention to relevant information instead of simply inferring meaning for non-related data, people would be better equipped to estimate their consumption. This refers back to the importance of saliency, where being more aware of the current action engaged in will result in more control, which seems to be an important aspect in decreasing unwanted consumption. While consumption monitoring is affected by different drivers, both the drivers and the interpretation of cues obtained internally and externally can be demonstrated to produce incorrect perceptions. Systematic types of these occurrences can be described as cognitive biases.

2.2 Cognitive biases influencing meal perception

Cognitive bias describes predictable patterns of irrational decisions, which is in contrast to rational choice models of human behavior (Kahneman & Tversky, 1974). Thus cognitive bias is seen as a systematic error of thought where judgement deviates from norm or logical processes (Ariely, 2008; Haselton, Nettle & Andrews, 2005). The heuristics (Kahneman & Tversky, 1974; Wansink, Just, & Payne, 2009), internal / external cues (Herman & Polivy, 2008) and consumption monitoring aspects (Wansink & Chandon, 2014) described in the previous chapter are closely tied with cognitive biases, as patterns of incorrect estimation are present in meal perception. The perception and estimation of the quantity of food can widely wary in predictable ways, when sufficient salient modification is used. An internal cue of having already had enough to eat can be overtaken by external effects, suggesting the person to eat more. Many such patterns can be identified as cognitive biases.

While there is likely an advantageous evolutionary reason for most cognitive biases, some of these kick in at inopportune situations or fail at producing accurate results (Gigerenzer & Gaissmaier, 2011; Kahneman & Tversky, 1996). A wide array of over 200 cognitive biases can be described (Dimara et al, 2018) but not all are present in meal estimations. The author proposes the following classification of cognitive biases that have an effect on meal perception, in order to better categorize possible effects: information simplification, quick processing and inferred meaning. These categories are presented in figure 3, which is illustrative.

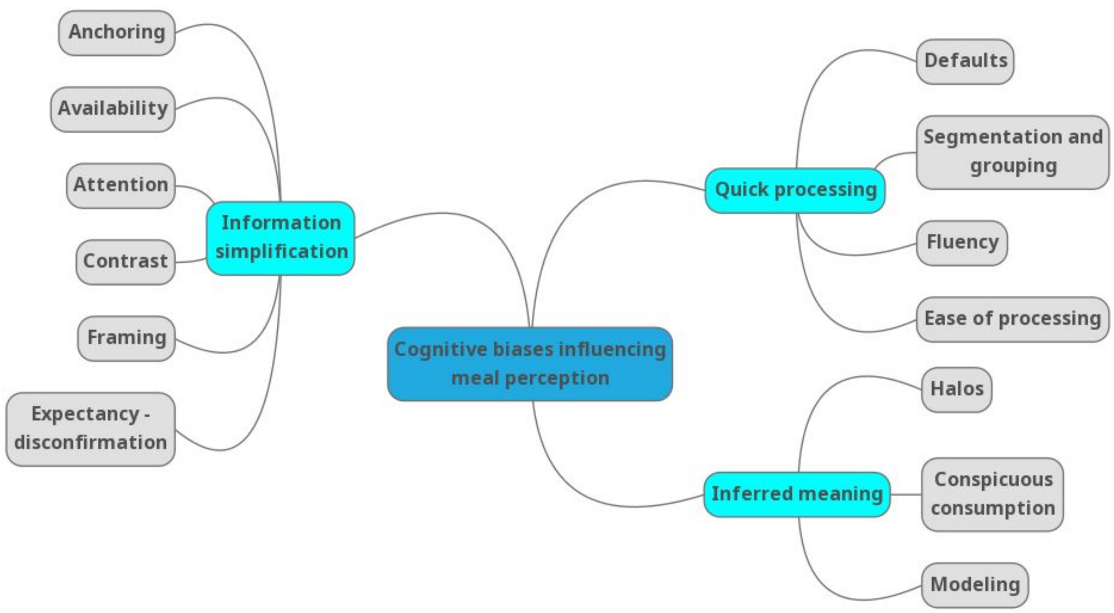

Fig. 3. Cognitive biases influencing meal perception. Based on: (Dimara et al., 2018; Kahneman, Tversky 1974; Wansink, Just & Payne, 2009; Pothos et al., 2009; Nisbett, Storms 1974, Kiefer, Trumpp 2012; Kerameas 2015; Kidwell 2008; Burton 2015)

Cognitive biases are not mutually exclusive and many are likely present at the same time. This means that different biases from different categories could be at effect at the same time. It is also unlikely that the categorization is as distinct as pictured in the illustration, as there could be considerable spillover between different effects, ie. the expectancy - disconfirmation effect and anchoring biases are closely related to each other, while some of the information simplification processes could potentially also be regarded as a need for meaning in the situation. Yet this type of classification of biases is distinct enough for this segmentation to yield decent descriptive power. This is important, as cognitive biases of one category could be better suited towards some issues than others. That said, each of the cognitive bias categories is then considered in the following sections.

2.2.1 Information simplification biases

The information simplification biases described in fig. 3 stem from an overflow of information that we are bombarded with. Much of the information is complicated to understand, which makes us often fall back to heuristic decisions - things that we have usually done, gravitating towards the familiar. However, this could also indicate that getting used to something can lower our guard, while bizarre events could be seen as much more impactful. It is also much easier to believe something that conforms to already known information, whether that is about nutritional quality or common wisdom.

How choices are presented has an influence on what decisions are made - this notion is one of the key insights in behavioral economics. The presentation of choices is described as the choice architecture of a particular context or task (Thaler & Sunstein, 2009). Choice architecture indicates that choices can be presented in different ways and different contexts, directing attention towards or from some attributes of the product or service, which will in turn influence the perception of the relative attractiveness of that product or service (Kahneman & Tversky, 1979). Framing attributes (presenting the same information of an aspect) differently can have a large influence on the perception of that food, such as framing a type of product as 95% lean or as 5% fat (Levin, Schneider, & Gaeth, 1998). The information of the attribute is identical, but the emphasis is different. Framing messages as positive and self-relevant can have an effect on customer behavior in fruit and vegetable consumption (Dijkstra, Rothman, & Pietersma, 2011). It has also been shown that the framing of a health message can have different consequences with functional food (van Kleef, van Trijp, & Luning, 2005). It is not just the message that is important, but also how it is served.

In accordance to expectancy - disconfirmation theory, consumer behavior is affected by the expectations and their correspondence to the situation presented (Oliver, 1977). When consumers are presented with healthier nutritional information than they previously expected for a food that is perceived as unhealthy, they exhibit more positive attitudes and an increased chance for purchase compared to a no prior nutritional information situation (Burton et al., 2015). Peculiarly, when the nutritional information is less healthy than expected, consumers exhibit a more negative attitude and a decreased chance for purchase (Burton et al., 2006). Having a predisposition towards a particular food item can have a serious effect on consumption when that expectation is not matched.

In experiments with manipulations of some part of the healthiness perception of prospective customers the expected result of expectancy - disconfirmation theory holds true for foods perceived as unhealthy, meaning that if people are surprised by the unexpectedly low caloric value of that food, they tend to purchase more of it (Tangari et al., 2019). The situation where unhealthy products are perceived as healthier and result in higher consumption can be described as a consumption backfire effect. However, the consumption backfire effect was not noticed with foods perceived as healthy and the researchers found that the effect could be mitigated with higher caloric information. Findings such as those previously outlined imply that manipulating the expectations of people in regards to the food products that they encounter or changing the way the nutritional information is presented will have an effect on consumer behavior.

Closely related to expectancy - disconfirmation theory, the anchoring effect shows that mere exposure to a number will influence people by serving as a reference point for further decisions, which occurs without awareness of the effect (Kahneman & Tversky, 1974). Anchors such as 4 apples for 8 € or limit of 5 per person can have an effect on decisions about purchase quantities in comparison to 1 apple for 2 € or limit of 50 per person (Wansink, Kent, & Hoch, 1998). An anchoring and adjustment behavioral model seeks to explain this, by noting that consumers are often primed with low initial anchors which adjust upward depending on factors such as price, possibilities for substitution and so on. Consumers can often fail to adjust much from their initially primed anchor, thus resulting in purchases that are dependant on the context. This effect has been consistently shown in experiments, where people buy higher quantities of items when the promotional anchor is high whereas when the anchor is set lower (Wansink, Kent, & Hoch, 1998). Anchoring is not limited only to numbers, but refers to the priming of unconscious expectations.

Thus the anchoring effect implies that the food choices made by people can be affected by first exposing them to arbitrarily large or small numbers, which in turn can influence decisions to be respectively of larger or smaller quantity. A person who has been primed with a number such as 500 calories, perhaps presented on the nutritional label of the item they were purchasing could thus be more inclined to purchase a larger quantity than without the priming. An example of a non-numeric type of anchor would be spatial anchoring, which has to do with anchoring regarding a specific physical location, item or situation. Similarly to some people finding more motivation in working in a specific location (such as their office), this could also perhaps play a role in eating behavior, such that spatials anchors relating to eating in a particular part or room of a house will invoke certain behavioral patterns than would in a different position.

While the meaningful content of the message will remain the same in these tests, simply changing the way it is presented have also led to interesting results in terms of fluency and ease of processing of those messages - with messages that are easier to process being perceived as more truthful and evoke a heuristic approach to making decisions (Schwarz, 2004). This suggests that framing food choices in a way that is easy to process will make it easier for people to make better decisions when the environment is set up to facilitate that. Framing solutions could also lead to shopping momentum, where purchasing something can lead to a psychological impulse to buy even more, which increases the chance for an even unrelated purchase (Dhar, Huber, & Khan, 2007). However, framing the situation in a correct manner could increase the likelihood of the customer also making a related purchase.

2.2.2 Quick processing biases

Referencing the next group in fig. 3, quick processing biases are considered. Quick processing biases signify that some decisions are not equally important to others and there is a need to decide quickly. A chance could be lost when not taking an action fast enough. Therefore some information needs to be processed quick and possibly unconsciously, as it could likely provide an advantage compared to others, who lull over every decision. This also means that immediate effects are perhaps often overstated to the experiencer, while the consequences in the future are discounted and seem diminished. Cognitive biases in this category thus have large implications in how food preference changes, as the preference towards a tub of ice cream is probably different right before consumption and immediately afterwards.

A default or status quo bias is described as a tendency to keep the option that is preselected in a given presentation of choices, such as the applications that are pre-installed of a mobile phone (Thaler & Sunstein, 2009). This type of bias is very malleable and people can be directed towards making healthier choices for themselves by changing small factors, such as non-informational designs on a restaurant menu (Bergeron, Doyon, Saulais, & Labrecque, 2019). An easy way to notice this type of bias is taking a look at the usage of communal coffee machines in workplaces or universities- it is highly unlikely that each person really has the same preference for the amount of sugar included in their coffee. Yet still, people rarely select a different amount of added sugar than the default set in the machine.

The segmentation effect is perhaps a better descriptor of a cognitive bias usually referred to as a unit effect (a single unit of food is considered appropriate to eat), suggesting that when a single unit of food is separated into multiple smaller units, people eat less, but then again eat more than a single unit in that new food composition (Kerameas et al., 2015). The segmentation bias seems to be consistent with fluency theory (Schwarz, 2004) as eating more than a single piece is more likely to start an inner thinking process of "Do I want to eat another one?" instead of simply finishing the food on one's single plate. This in turn establishes a processing requirement which leads to more attention being directed towards how much is fit to eat in that situation. Quickly processing the amount of food presented in a singular unit and deciding to eat it is a single decision, deciding to start eating another plate of food is regarded as a new decision. In other words, it's more likely to eat more of something of which less decisions are required. This could also indicate that having to open an additional packet or serving of snacks, such as potato chips, would reduce consumption, as that action would require an additional thought process compared to eating the whole content of a larger container.

2.2.3 Inferred meaning biases

Lack of meaning is confusing to people and could produce feelings of pointlessness, loneliness (Tam & Chan, 2019), with the presence and search for meaning being considered as inherent traits for humans (Zhang, et. al., 2018). These gaps in finding meaning are then often filled out by seemingly irrelevant information, or too much emphasis is put on a particularity at observation, when it might have little to no bearing to the actual occurrence. This group of cognitive biases refers exactly to those situations (see fig. 3 for an overview). If one food item gave food poisoning to a friend once, we are quite likely to avoid that food ourselves, but the actual reason might have been allergies or a human error in the restaurant. It is also easy to generalize and categorize, often erroneously, through the use of limited personal contact or stereotypical opinions of particular products and their users.

Being able to impress others with status or wealth can influence decisions, which is referred to as conspicuous consumption (Bronner & de Hoog, 2018). This has also been applied to food related decisions, where similar influences have been noted. Tendencies to indulge or to flaunt particular eating habits and dietary decisions to others seem to motivate people to purchase functional foods (Barauskaite et al., 2018). The effect on behavior when it is tied with a social setting or the perceived behavior of others is referred to as modeling. Modeling in the context of cognitive bias refers to people matching their consumption volume in accordance to what their social partners eat (Herman & Polivy, 2005). Interestingly, the modeling effect is noted even when the person is already full (Herman, Roth, & Polivy, 2003) or has been starving (Goldman, Herman, & Polivy, 1991). Thus, a person with a slightly smaller appetite could be encouraged to eat more due to the consumers of higher quantities present, or vice versa.

As an example of modeling, showing a person what the average number of cookies being ordered by other people is, they seem to adjust their own order rates accordingly. Order sizes are considerably larger when exposed to a high consumption amount of others (eg. being in a table of heavy eaters) than they were when people were instead shown a low consumption amount (eg. being situated in a table with light eaters). (Hou, 2017). The modeling effect seems to suggest a social aspect to eating, which means that perceived changes in typical behavior or the behavior of peers will have an influence on the consumption rate. This could have important implications, as getting more people to partake in healthier eating of lower (just right) volumes will make the environment easier for other people to join, even without conscious decision in that regard. According to this theory, making people more aware of the comparatively low amount of food consumed by peers could make a difference in overall food consumption rate.

The halo effect (ie. health halo) is referred to as a bias for people to infer meaning or information based on incomplete or irrelevant information presented to them - in this case, often leading them to perceive a high caloric intake food as healthier (Talati et al., 2016). There can be numerous reasons for a health halo - how the company brands and positions themselves as healthy in the case of Subway (Chandon & Wansink, 2007), the corporate social responsibility actions (Peloza, Ye, & Montford, 2015), packaging labels (Sundar & Kardes, 2015) and serving size recommendations nudging people to consume extra quantities of perceived healthy foods (Bui, Tangari, & Haws, 2017) or even how the product is named (Fernan, Schuldt, & Niederdeppe, 2018). In fact, simply mentioning the word "organic" on the packaging can lead people to believe that the food is of lower caloric content (Schuldt, Muller, & Schwarz, 2012). The health star rating seems to be one of the better methods in combating this bias from leading to poor decisions (Talati et al., 2016). While there are other systems for this, a controlled way of presenting relevant information seems as one of the best tools to combat the ill effects of the bias.

The health halo cognitive bias is selected as a demonstration in the following empiric experiments conducted in this paper. The health halo cognitive bias was singled out due to the following reasons. Firstly, there is a research gap in this field - it is less researched and most other papers are published only recently. Secondly, these studies are often conducted using branding, packaging and text based approaches but there's also a large industry that instead of those particularities deals with imagery, such as restaurants and online ordering services. Health halo effects on meals is not considered yet, with research being largely contained to single food items, but this is not how food is typically appraised. Thirdly, there seems to be a lot of potential in this kind of context manipulation, which could result in large effects on perception. Perhaps small changes in meal image presentation have a comparable effect or even surpass the effects of the description on the packaging.

An interesting focus group for researching health halo effects could be diabetic people, as they receive comparatively strict guidelines for nutrition following the diagnosis. Adding to that, regular medical appointments are conducted, where the person is advised on their eating habits to mitigate ill effects. That said, education level and interest in nutrition do not seem to be significant factors in directing people with diabetes toward healthier decisions after a diagnosis (Yu Ma, Ailawadi, & Grewal, 2013). It is unclear whether the perception and estimation of meal properties remain similar to the rest of the population or not, while contemporary research has found some success in using cognitive bias methods with obese adults (Mehl, Morys, Villringer, & Horstmann, 2019). From this and the key notes from the previous chapter, the following premises are constructed:

1. Premise: information obtained from internal / external cues and consumption drivers can produce inaccurate results when using heuristics, creating cognitive biases.
2. Premise: there are hundreds of biases, but not all are related to meal estimation. The meal estimation related biases could be categorized as information simplification, quick processing and inferred meaning biases.
3. Premise: since people highly incentivised toward healthier food consumption (diabetic) are not affected by nutritional interest or education, meal evaluations are not that dependent on the nutritional knowledge of the person.
4. Premise: because there are multitudes of cognitives biases present at meal estimation, the perception of healthiness and caloric content people perceive can be irrational and dependant on the food items present.
5. Premise: since the health perception of meals depends on the food items that are present, meals with equal caloric content will be judged differently depending on the food items present.
6. Premise: due to the caloric content in meals being influenced by irrelevant factors to the content (such as packaging labels), drinks accompanying the meal are also subject subject to health halo bias effects.

With these premises, the following hypothesis for this research are constructed:

- Hypothesis 1: adding a perceivably healthy food to a meal, will make people judge the meal to be less caloric content than they would with a perceivably unhealthy food.

- Hypothesis 2: Presenting a diabetic person with a comparison with an added perceivably healthy food, the judgements of caloric content would still be less than they would be with a perceivably unhealthy food. In other words, there will not be any significant differences between diabetic people and people without diabetes.
- Hypothesis 3: Presenting a person with a meal that has a drink added to it, will make them judge the meal to be of less caloric content than it is when the drink is perceived as healthy, and of more caloric content than it is, when the drink is perceived as unhealthy.
- Hypothesis 4: Accompanying an alcoholic beverage with the meal will make a person perceive the meal as unhealthier, when compared to the same meal with a non-alcoholic beverage.

The cognitive biases outlined in previous sections of this chapter seem to have an impact on the formulation of personal eating habits, the internal factor of eating behavior. After all, an internal measure of regular eating portions can be manipulated with external cues in the environment. A perceivably regular portion of potato chips poured into a bowl can be as affected by the size of the bowl, the organic labeling of the package and the emotional state of the pourer or the number of distractors present. Since these effects are present at both the at the point of purchase and at decisions to consume the product, and have been for a while, it would be reasonable to think that the internal habits of a person are affected at a longer time scale. Thus it might be worthwhile to consider how much of our eating habits regarding the size of portions are not really determined by the hunger for sustenance.

3. Methods and data

3.1 Methodology

This study exploits choice experiments in order to reach the research goal. Experiments in economics are similar to observational methods, but instead of looking at only natural happenings, human participants are used to answer research questions in a controlled manner (Croson, 2002). This method is mainly used in economics to determine personal level attributes, such as effort (Charness, Gneezy, & Henderson, 2018) or to describe specific consumer research phenomenon, like saliency or privacy (Grether & Wilde, 1984). An experimental approach can yield substantial information that other methods could not, as data is not available for the specific natural occurrence. In addition, there is a much greater amount of control that can be exerted when compared to observation alone, which allows for replication and a more focused way of testing a theory. An experimental design is not without a downside, as social lab experiments are often critiqued of not actually measuring what they claim to, mostly inadvertently (Bardsley, 2005). Taking the critique into consideration, field experiments were conducted to better simulate an ordinary and comfortable situation for the participants, at the expense of some control.

Calories were chosen to be the metric of choice since the most consistent theory to describe weight gain seems to be the calories in - calories out model, which indicates that weight gain is determined by the amount of excess energy in the body (Howell & Kones, 2017). While there are many other theories (Ludwig & Ebbeling, 2018; Sze & Schloss, 2017) and criticism (Riera-Crichton & Tefft, 2014), the predictions made with the excess energy model have good descriptive power. Thus, in the context of this paper, the calories in - calories out model will be regarded to be a sufficient descriptor of the root cause of obesity, from which can be inferred that meal healthiness can be largely described by caloric content.

3.2 Experiment 1 - role of side dish in meal perception and caloric content estimation

3.2.1 Methods

Pictures of fast food with the following modifications were presented to Copenhagen Business School university students:

1. 13.5 pieces of chicken nuggets (600 kcal)
2. 13.5 pieces of chicken nuggets (600 kcal) with 100g fresh salad (154 kcal) totalling 756 kcal

3. 13.5 pieces of chicken nuggets (600 kcal) with 53g french fries (154 kcal) totalling 756 kcal

These food items were chosen since they are easy to recognize for most people. University students were chosen due to higher exposure to such food items. People were approached in the university cafeteria eating lounge, to ensure a fitting environment for food related questions. Depending on the picture shown, the groups then formed as G1 (none), G2 (salad) and G3 (fries).

The experimenter introduced themselves to the subjects and described shortly what the study was for and that it was about caloric content estimations. Additional details about the goal of the paper were not given. Each person, or group of people, was presented with one printed out food item picture from the set listed above. The choice of the picture was random. They were then handed a printed out questionnaire (see ch 7.1) where they marked their answers. Questions that were about necessary identification of the food items were answered. Likewise, questions detailing filling out the form were answered. The experimenter declined questions that would give any extra information to the subjects, such as number of pieces or where they were purchased. Upon handing the subjects the questionnaire, the experimenter either waited at the table holding the picture up so that it was easier to see, or proceeded to the next subjects with a different picture from the set. The subjects had conversations among themselves, but this did not seem to have an effect on the answers, as each person within a group still reported a different opinion than the others.

The sample was generated using convenience sampling out of the students in the eating area. Out of 151 people approached, 148 people agreed to take part in the experiment. The participation rate was thus 98%. Out of the 148, two did not fill in the primary question, which was caloric content. The experimenter had doubts about two additional answers, where there was a high chance of deceptive answers and were defined to be outliers (over 3

SD). Those answers were excluded. The sample size thus ended up at 144 Copenhagen Business School students.

3.2.2 Results

G1 had 43 respondents, G2 49 and G3 had 52. In group 1 and 2 there was one estimation that exceeded the actual caloric content by twice or more, while group 3 had 9 estimations of such kind. One answer (2%) in group 1 and 8 answers (15%) in group 3 estimated the meal to be that of daily recommended amount (2000 kcal) or exceeding it. An overview of the answers in regards to calorie estimations is presented in figure 4.

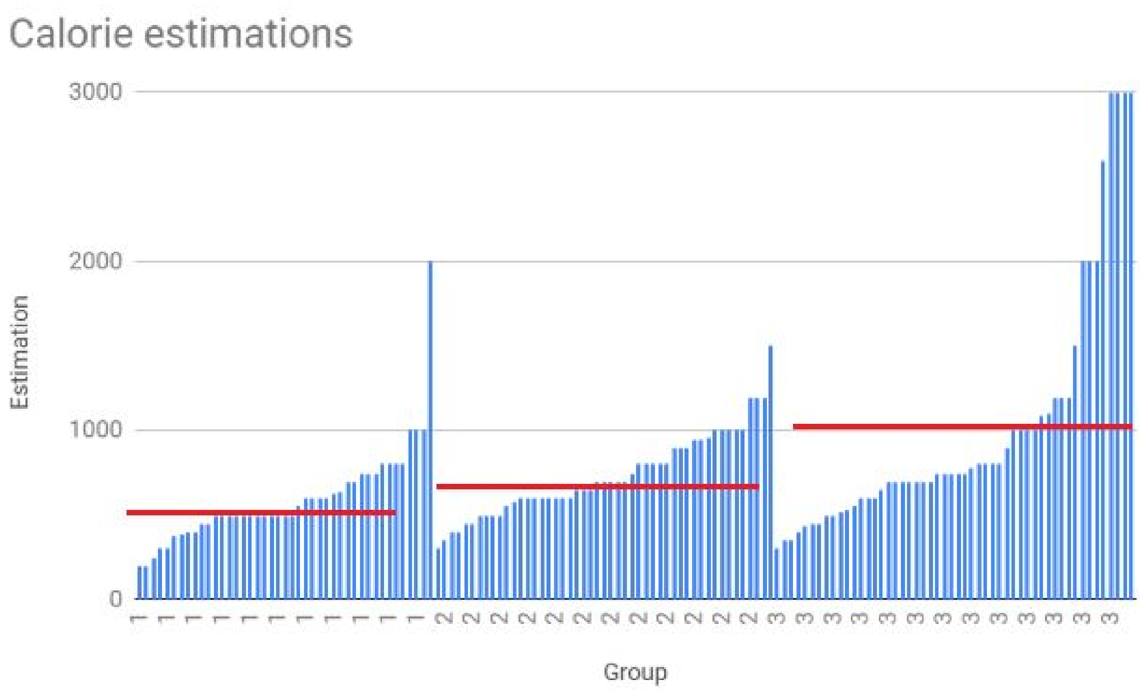

Fig 4. Overview of caloric estimations in experiment 1. Note: the X axis indicates the group of the participant, so that 1 is no alteration, 2 is with salad and 3 is with fries. This chart does not indicate a rise, the answers of each group of participants is sorted by group and then in an ascending order. The red line signifies the mean of the group.

The mean, SD and median were then computed out of the data set. The mean estimation of the control group (group 1) was remarkably accurate, hitting the exact caloric content that the meal consisted of. However, the standard deviation for the group is large, at nearly half of the mean. Group 2 (salad) also estimated the caloric content of the meal well. The standard deviation of the group was also lowest, with nearly ⅓ of the mean. However, group 3 (fries) preformed rather poorly in estimating the objective caloric content. An overview of these results is given in the following table.

Table 2. Number of participants, mean, objective caloric content, std. deviation and median values for choice experiment 1 with the CBS sample. Note: group 1 were presented with the picture with only chicken nuggets, group 2 with the nuggets and a salad, group 3 with the nuggets and fries. Total of 144 respondents

Group	N	Mean	Objective caloric content (kcal)	SD	Median
1	43	599.77	600	294.89	500
2	49	737.59	756	250.36	700
3	52	1023.00	756	733.82	750

A t-test was conducted to check the significance of the differences between G2 and G3. There was not a significant difference in scores for calorie estimation between group 2 ($M = 737.59$, $SD = 250.36$) and group 3 ($M = 1023$, $SD = 733.82$), condition $t(1) = 15.58$, $p = .000$. These groups were chosen since G1 estimated a meal with a different objective caloric content, which in turn would affect ANOVA results to show as significant in any case. ANOVA ($F(1,99) = 6.67$; $p = .011$). There is a significant difference between G2 and G3. The difference in perceived caloric was slightly lower than the objective amount for G2 and much higher than the objective amount for G3. Such differences signify a cognitive bias, since even though the two meals contained equal amounts of objective calories, the amount perceived by the subjects differed substantially in a systematic manner.

Following that, a MANOVA test was conducted. This showed that there are differences between groups for the perceived healthiness ($F(2,142) = 28.74$; $p = .00$) but not for the amount that people were willing to pay ($F(2,142) = 2.29$); $p = .10$). There was no connection between people with higher self-assessed caloric knowledge scores and those with lower scores ANOVA ($F(5,142) = .51$, $p = .76$) suggesting that people that thought they would assess caloric content better did not actually do so. The perceived healthiness of the meal also differed by a point on a likert 6 point scale, where G1 (mean 1.67; SD .71), G2 (mean 2.77; SD .82), G3 (mean 1.83; SD .70).

3.3 Meal perception and caloric content estimation differences for diabetic people

3.3.1 Methods

Pictures of fast food with the following modifications were presented to people with diabetes in Estonia, ending up with the following groups:

2. 13.5 pieces of chicken nuggets (600 kcal) with 100g fresh salad (154 kcal) totalling 756 kcal
3. 13.5 pieces of chicken nuggets (600 kcal) with 53g french fries (154 kcal) totalling 756 kcal

The sample consisted of very various age groups. The picture without any modification (without any side dish) that was shown to group 1 from the previous experiment was excluded, as the main differences and effects seemed to be present between pictures 2 and 3. The group numbering is presented in this way to make comparisons between this sample and the CBS sample easier to read. Diabetic people were chosen since they should be one of the sample groups most aware of caloric content and more mindful of what they eat. However, the setting was quite different. The questionnaires and one picture from the set were distributed to Estonian diabetic nurses or general practitioners, who would show them to a diabetic patient after a regular monthly check up. This change was necessary in order to receive the data. The questionnaire was translated into Estonian while keeping as much of it as similar as possible, which is included in ap. 2. The GP or nurse presented one of the pictures to diabetic patients after their regular monthly check-up, being careful not to give any additional information about the study than intended.

The sample was thus composed of people with a particular trait that differentiated them from the rest of the population. The results of 72 people who participated in the study were recorded. The overall participation rate is unknown, as this data was not gathered. Out of the 72, two did not fill in the primary question - these answers were excluded. The sample size thus ended up at 70 diabetic Estonians of very various age groups. The grouping of the participants is based on the same logic as before, with group 2 having the picture with the salad presented to them and group 3 seeing the picture with fries.

3.3.2 Results

G2 had 47 participants while G3 had 23. The SD was somewhat lower for the salad picture than in the previous experiment, but much lower for the picture with fries (diabetic 250.36 vs CBS 733). A similar pattern arose from the healthiness assessment of the meal, with half of the people surveyed describing fries as extremely unhealthy (rated 1) or very unhealthy (rated 2) while barely 20% of the respondents in G2 chose those answers to describe the picture. Following this analysis, the mean, SD and median values were then computed out of the dataset. An overview of these values is described in table 3.

Table 3. Number of participants, mean, objective caloric content, std. deviation and median values for choice experiment with the diabetic people sample. Note: group 2 saw the picture with the chicken nuggets and salad, group 3 saw the picture with the nuggets and fries. Total of 70 respondents. *low due to complete avoidance of the particular food.

Group	N	Mean	Objective caloric content (kcal)	SD	Median
2	47	500.81	756	204.35	500
3	23	579.57*	756	250.36	500

The significance of the groups for the estimation of calories was tested and there was not a significant difference in scores for calorie estimation between group 2 ($M = 500.81$, $SD = 204.35$) and group 3 ($M = 579.57$, $SD = 250.36$) condition $t(1) = -1.16$, $p = .24$. This is very likely to be due to more developed categories for healthy and unhealthy food items. but no actual better understanding of the caloric content of those items. Following that, a MANOVA test was conducted from the dataset using SPSS. The test indicated differences between groups for healthiness but not for price. This is be elaborated with t-tests, which showed significant differences for healthiness $t(1) = 21.96$, $p = 0.00$ and for price $t(1) = .29$, $p = 0.59$.

As before, a connection between people with higher self-assessed caloric knowledge scores and those with lower scores ANOVA ($F(5,23) = .81$, $p = .70$) could not be demonstrated. In fact, diabetic people of either groups evaluated themselves to be worse appraisals of caloric content. The perceived healthiness of the meal also differed by a full point, with G2 (mean 3.34; SD 1.08), G3 (mean 2.34; SD .97). The most important part was somewhat more indirect - as nearly 20% of the diabetic people in G2 showed and explained complete avoidance towards the food being presented to them. This effect was not present in group 1. As such, the low mean of calories shown is due to the avoidance.

3.4 Experiment 2 - role of drinks in meal perception and caloric content estimation

3.4.1 Methods

Six meal pictures with different modified factors were presented to Copenhagen Business School students. The modifications were either in the dish (fries or without fries) or in the drink (water, soda, beer). This created a matrix and the factors could be combined into 6 comparisons. A quick overview of these comparisons are found in ap. 7.5. The setup created a closed Euler’s trail, in other words an Eulerian cycle, with the path visiting each factor point in the graph once. This setup allowed to separate each factor from the rest, resulting in a detailed map for each manipulation separately.

The food items for the pictures were chosen so that they are easy to recognize for most people. The drinks were chosen to be ones that are regularly consumed, as water, soda drinks and beer are three of the most common drinks in the population. University students were chosen due to higher exposure to the dishes. The caloric content in all of the pictures presented were roughly the same, varying by a maximum of 60 kcal, including measurement error. The dishes were roughly 650 calories, a common size for a lunch.

The survey was created in an online tool SurveyHero. Each question had two pictures, as described in table 3.2, and two scales to indicate perceived healthiness and preference. The scales were -100 to 100 point scales with the numerical values hidden to the participants. This was done in order to alleviate bias towards a typical value, such as only full tens or only even numbers. The survey contained a warm-up question designed to ensure that the participant was familiar with how the program functioned. One sample of these comparison questions is depicted in ap. 3.

People were approached in the university cafeteria food court, to ensure a fitting environment for food related questions. The experimenter introduced themselves to the subjects and described that the study was about meal perception. Additional details about the goal of the paper were given only after all the participants in the table had filled out the survey. The participants used the experimenters computer in order to fill out the form and see the pictures of the meals. The experimenter showed how to use the computer to fill out the form and that every dish had more or less the same amount of calories. Information about how many questions there were and how long the survey would take was also detailed. Questions that were about necessary identification of the food items were answered. The experimenter declined questions that would give any extra information to the subjects.

Upon handing the subjects the computer, the experimenter waited at the table. The subjects were instructed not to have conversations among themselves. Only tables of a single person or two people were approached, as filling out the study took more time than at first anticipated. This was done in order to minimize discomfort of the participants. The sample was generated using convenience sampling out of the students in the eating area, with the limitation previously mentioned. Out of 92 people approached, 66 people agreed to take part in the experiment. The participation rate was thus 72%. Out of the 66, 8 participants neglected to answer one or more of the questions, making their results unusable. The sample size ended up at 58 Copenhagen Business School students.

In order to set up the comparison experiment, an interview was conducted with Gorm Gabrielsen in Copenhagen Business School in March 2019 (Gabrielsen, 2019). The statistical method for the experiment is based on a combination of graph theory and algebra. It includes a "bottom-up approach" which contrasts the regular studies in marketing where the aggregated consumer is the focus. In essence, this way of measuring effects will keep individual variation from dissipating (Gabrielsen, & Kristensen, 2016). The differences present on the individual level are then later on aggregated, when these variations are found. This will result in a better understanding of people, producing better results that reflect actual occurrences rather than using an aggregated average person as a baseline.

3.4.2 Results

The data was analysed in SPSS, using a custom added program by prof. Gabrielsen's to create the structure necessary for the comparison. This method does not calculate any effects in absolute terms, but rather in distances between a reference point and the factor in question. This signifies a relative difference. A -100 to 100 scale was used and the distances are then computed. The following coding was used:

- y1 – the perceived healthiness that people observed when comparing the meals

- y2 - the preference of people when comparing meals
- Drink modification b1 = water; b2 = soda drink; b3 = light beer
- Meal modification c1 = without fries; c2 = with fries

The first model tested for relevance and descriptive value. A general linear model of the mentioned modificators was constructed. B stands for the difference between the reference and the factor under observance. An ANOVA test was carried out and showed significant differences ANOVA ($F(3,56)= 132.75$, $p = .00$. Interference between modificators were not detected, R sq. = 51.9%.

B3 was chosen as a reference for the drinks and c2 was chosen as a reference for dishes. An overview of these results can be found at ap. 7.6. The differences between the drinks and dishes in terms of perceived healthiness were B (b1) = 37.98, $p = .00$. This indicates a large positive distance of healthiness perception between water (b1) compared to beer (b3). B (b2) = -5.72, $p = .02$ indicates that the soft drink (b2) was rated negatively compared to beer (b3) but at a much smaller magnitude. For fries, B(c1) = 11.93, $p = .00$ shows that there is a medium distance in health perception that is induced by the inclusion of fries in the dish. All following results are presented in the same manner. The differences for the preferences of the presented meals were small and not statistically significant: B (b1) = 3.46, $p = .39$; B (b2) = -4.75, $p = .23$; B(c1) = -4.59, $p = .10$.

Following that, the same data was cross-referenced with the gender of the participants. This could potentially shed light towards whether men and women view these types of foods differently. An overview of these results can be found in ap. 7.7.The perceived healthiness of the meals remained very similar for both men and women. For males B (b1) = 39.61, $p = .00$; B (b2) = -4.03, $p = .30$; B(c1) = 13.59, $p = .00$. For females B (b1) = 36.80, $p = .00$; B (b2) = -6.94, $p = .03$; B(c1) = -10.74, $p = .00$. However, sorting participants by gender resulted in the following differences for the preference of the meals: for males B (b1) = -16.15, $p = .00$; B (b2) = -18.46, $p = .00$; B(c1) = -3.59, $p = .40$. For females B (b1) =

17.63, $p = .00$; B (b2) = 5.13, $p = .32$; B (c1) = -5.32, $p = .14$. This shows that males have a preference toward beer, while females would rather prefer the water.

4. Discussion and implications

4.1 Discussion

The results of this study showed several patterns of irrational cue interpretation. These are described as an evaluation of the validity of each of the hypothesis (presented in ch. 2.2) The first hypothesis assumed that a health halo effect would make a person judge meals with a perceivably healthy food added to it overly healthier and that the addition of a perceivably unhealthy food item would make the meal seem overly unhealthier. The first experiment confirmed that the differences between adding a salad or the same energy content of fries resulted in widely different perceptions. Hypothesis 1 was accepted. The large mismatch between the actual and perceived calories indicate a cognitive bias is at effect. At the same time, this could indicate a lack of knowledge by the participants. Insufficient knowledge is considered unlikely, as major sellers of fries are required to present caloric information already both at purchase and on the packaging. Since chicken nuggets, fries and regular fresh salads are common food item for university students, it would seem that insufficient knowledge is not the cause of the misestimation.

The second hypothesis assumed that the health halo effect would dominate over even regular, monthly nutrition consultation, as is the case with diabetic people. The hypothesis was accepted. The findings with the diabetic people suggest that people were even more influenced by the health halo effect when it came to perceivably healthy food, but often showed complete avoidance when it came to perceivably unhealthy food. People did not even want to estimate the caloric content of the perceivably unhealthier meal. This is a much more emotional approach to estimation than previously considered. In addition, while the amount of calories estimated did not differ that much between the two groups, the healthiness assessment did.

The third hypothesis assumed that presenting a person with a meal that has a drink added to it, will make them judge the meal to be overly healthier than it is when the drink is perceived as healthy, and overly unhealthier when the drink is perceived as unhealthy. Experiment 2 confirmed that water is seen as much healthier than other common drinks, while sugary drinks are seen as unhealthier than they are in caloric content. Hypothesis 3 was accepted. This again indicates that a cognitive bias is at effect, since through separating each factor used in the meal, water received much higher healthiness scores, even though the amount of calories was largely the same.

The fourth hypothesis assumed that accompanying an alcoholic beverage with the meal will make a person perceive the meal as unhealthier, when compared to the same meal with a non-alcoholic beverage. The results were inconclusive, as the range of beverages in experiment 2 were not sufficient to make this claim. While beer was seen as relatively unhealthy compared to water, it was seen as healthier than a soda drink. In that regard, this hypothesis could only be accepted in terms of alcoholic drinks (beer) being seen as much more unhealthy than water, but this could not be said about some non-alcoholic drinks. Beer did not seem to have a stigma of unhealthiness caused by alcohol content, but this interaction needs to be studied more before reaching any conclusion.

In addition the the specific results outlined above, more general results could be described as follows:

- The primary method for meal estimation seems to rely on food item categorisation techniques. Essentially people have mental estimates of how healthy or unhealthy a food item is perceived to be and then extrapolate this perception on the whole meal.
- An estimation strategy that is based on food item categorisation is rather prone to misestimation, as components that are considerably healthier or unhealthier compared to the rest of the meal cause a large spillover of that perceptual

healthiness category (i.e. the health halo effect). It seems that one healthy or unhealthy item will make the whole dish seem overly healthy / unhealthy.

- It is plausible to describe food perception as an automatic cognitive process dependant on heuristics. The heuristic approach seemed to dominate even with people more sophisticated in nutrition than the average person.

As a whole the results of this study seem to suggest that cognitive bias plays a large role in how meals are perceived. As shown with the large estimation differences with the dish of fries or salad, the quantity played a smaller role than the healthiness classification of the food item. The caloric content estimation was largely higher for the meal with fries in comparison to other meals even though the caloric content was the same. However, it is worth to note that many people pointed out that there was feta cheese in the salad, which seemed to invoke a unhealthy feeling about the salad, rather than a pure healthy feeling. This could have played an important role in caloric estimations.

The comparison experiment had quite a few interesting results. There were significant differences between the factors when comparing for meal healthiness but not for the preference of the meal. Water was seen as by far the strongest factor in influencing meal health perception towards healthier, while the soft drink was seen as even less healthy than beer. Fries made the meal seem less healthy compared to the dish without fries. This means that simply including water with a picture of a meal will make the meal perceptually healthier, even though it has no bearing on the nutritional value whatsoever. No significance between results were found when comparing the preferences of the whole sample. No significance likely means that people are too different in their tastes and have different palettes. However, when examining preferences in cross reference with the gender of the participant, men preferred beer greatly over any other drink, while women preferred water over beer. The differences in preference of women for beer over a soda drink were not significant. The differences in health perception were largely similar between sexes, suggesting that people of different genders are more or less on the same page when it comes to categorizing food items towards healthier or unhealthier.

In regards to the choice experiment with the diabetic sample, it is worth to note that diabetic people reacted differently to the stimuli provided. Health halo effects could be demonstrated to be even more compelling when using foods that are perceived as healthy, as shown in the comparison between the CBS sample and the diabetic sample. However, when using unhealthy food items, many diabetic people showed complete avoidance of the food, even to the point of not wanting to estimate the caloric content of the meal since they would never consume those food items. This indicates a strict food categorisation heuristic - in a way showing not actual better prowess at meal estimation, but rather a developed avoidance system towards some foods that the person has deemed inedible for them. It is easier to not think about the food items at all to avoid being tempted.

4.2 Implications

The implications of these findings are twofold. The first are direct implications regarding the perception on the meals. If we accept that categorisation of food items in a meal is the primary strategy for most people, choosing how to present meals so that they would contain the least amount of unhealthy items could result in a large increase in perceived healthiness, even though the nutritional (caloric) content would remain largely unchanged. This also implies that using small doses of perceptually very healthy items can improve the overall perception of the meal. Perhaps placing a hamburger on a leaf of salad would make the difference in favour of a purchase decision for health conscious people.

The second part of implications could be considered more general. The findings in this thesis have implications on further dietary education campaigns and for facilitating better public knowledge on healthy eating. While it is correct that not all people have to eat less, it is still arguably sensible that we ought to be aware of how much we actually eat. Since awareness and attention is taxing other necessary tasks, perhaps it is better to take on a normative change instead. The food categorization method for meal estimation is not an optimal strategy since it is too malleable by environmental factors and prone to cognitive bias. As shown in experiments 1 and 2, it is relatively easy to make use of cognitive biases to make a meal be perceived as healthier, simply by adding a glass of water or some salad.

The author would suggest the following awareness methods:

1. Since people are poor at estimating caloric content based on the food group, perhaps using a caloric density description could prove useful. This is obtained dividing the amount of calories by the volume or weight of the item. Colour coded markings could be used on food packaging to indicate caloric density: green = low density (packaged celery), yellow = medium density (granola bars), red = high density (nuts and candy). A similar colour coded marking system is used in the UK (NHS 2018). It would make it easier to distinguish between objectively healthy and just perceptually healthy foods, resulting in healthier decisions.
2. Suggest diets to people that are not restrictive on different food items, but based on eating any category of food items in a sensible amount. This was actually started in Estonia in 04.2019.
3. While beer was seen as relatively unhealthy, many of the participants still mentioned that they had no idea about the nutritional value of that particular drink. Nutritional information on the packaging would be sensible in alleviating this, as alcohol is dense in calories.

5.1 Conclusion

The goal of the study was to explain the role of cognitive bias in meal perception. The goal was achieved by demonstrating systematic misestimation of meals in choice experiments, signifying a cognitive bias pattern, specifically the health halo effect. The results of the study indicate a significant use of heuristics involved in the evaluation of a meal, which further suggests that the appraisal of caloric content takes place at an unconscious level, autonomously. The food item categorization method is likely to be the dominant strategy in meal perception and nutritional content evaluation. However, this categorization strategy is malleable by combining perceivably healthy food items with the meal, influencing the perception of the meal to be healthier than it really is. A caloric density appraisal method was offered as an alternative.

The findings importantly show that it is very easy to misestimate the healthiness of a meal. Since people often don't realize they have eaten enough from their internal cues, the perceptual caloric content of the meal has a large role in how much is actually consumed. The misestimation can lead to either overeating or malnutrition. Thus the results have implication for both public policy and for adjusting personal perspectives. Furthermore, according to the results of the diabetic sample, additional education did not have much of a positive effect on the estimation quality, but rather further enforced the food item categorisation strategy used. Nutritional interest in food or the personal skill in caloric content evaluation of the participants did not correlate with the estimated amount, indicating that a "nudge" approach would be more successful in balancing unintended consumption.

By using novel statistical methods in the experiments conducted, the study seeked to improve the understanding of cognitive bias. The research gap of cognitive bias effect on the perception of food items, specifically drinks, and caloric content estimation was addressed. Further research could carry out a lab experiment with similar meals present instead of photographs. Since the main method of extracting information here was visual, other forms of sensory methods could provide interesting results. Similar research could be conducted in a larger variety of countries and income levels. The author also sees testing these findings out in reference to the personality type of the participant as an interesting venture. This could help illuminate whether some people are less or more susceptible to such influences. Finally, including other groups with strict nutritional guidelines such as dieters, athletes or people with an eating disorder could provide interesting results.

5.2 Limitations

Since most of the research is based on Danish university students and diabetic Estonians, the results are limited due to sample size. More experiments in different age groups, education levels and countries are required to make better claims. Furthermore, since this type of classification is done in Denmark, which has one of the best living standards in the world, the results can vary when conducted in less well-off countries in Europe and are most likely to differ in areas, where there's higher poverty or lack of food. The experiment done in Estonia had a very specific sample group, for which the sample size was relatively low. Then again, with the sample restriction of only diabetic people as participants, it is difficult to include a much greater amount without conducting an international study. Research with diabetic people in other countries than Estonia or perhaps with other motivated groups such as dieters or athletes could be an interesting future research avenue.

As the research was carried out using pictures of meals, it is possible that more accurate outcomes could be reached with actual physical meals in a lab setting. That however would compromise integrity through the inclusion of a more artificial setting where the study is being carried out. It is also possible that the selected cognitive bias could not be separated from other contextual and normative effects at work, resulting in a systematic flaw in the research. The amount of factors in the studies and the questions asked in the survey were specifically designed to counter this possibility, but the validity is difficult to measure. The author considered different research methods, but choice experiments seemed to provide most accurate results. Using comparative experimental designs (as done with experiment 2) could provide better results compared to between subject designs and should be used in future research.

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7. Appendices

7.1 Experiment 1 questionnaire (English)

How many calories does this meal contain? __________________kcal

How healthy do you think this meal is?

1	2	3	4	5	6
Very unhealthy					Very healthy

How much would you be willing to pay for this meal? ____________dk

How well do you think you estimate caloric content?

1	2	3	4	5	6
Very poorly					Very well

Do you have any training in foods and nutrition?

Yes _________ , if so, what kind ____________________________

No __________

Are you male __________ female __________

Are you below 20 _________ 20-24 ________ over 25___________

7.2 Experiment 1 questionnaire (Estonian)

Kui palju selles eines kaloreid on? ________________________kcal

Kui tervislik see eine Teie arvates on?

1 2 3 4 5 6

Väga ebatervislik Väga tervislik

Kui palju te oleksite nõus sellise eine eest maksma? ____________€

Kui hästi Te leiate, et oskate üldiselt toidu kalorite sisaldust hinnata?

1 2 3 4 5 6

Väga kehvasti Väga hästi

Kas Te olete osalenud toitumisalastes loengutes või olete läbinud muid toitumisalaseid kursuseid?

Jah _________ , milliseid? __________________________________

Ei __________

Te olete mees __________ naine __________

Teie vanus _____________

7.3 Sample of a comparison in experiment 2.

Which meal is healthier?

The left meal is much healthier | The right meal is much healthier

Which meal would you prefer?

I prefer the left meal very much | I prefer the right meal very much

7.4 ANOVA test for experiment 1

Table 7.4 ANOVA test for experiment 1

Source	Type III Sum of squares	df	Mean Square	F	Sig
Corrected model	2054995.29[a]	1	2054995.29	6.67	.01
Intercept	78197958.93	1	78197958.93	254.05	.00
Group	2054995.29	1	2054995.29	6.67	.01
Error	30471973.83	99	307797.71		
Total	111549526.00	101			
Corrected Total	32526969.12	100			

a. R Squared = .063 (Adjusted R Squared = .054)

Source: authors calculations

7.5 Overview of modificators and comparison structure for experiment 2

Table 7.5.1. Experiment 2 meal modificators

Factor / Factor	Water	Soft drink	Light beer
With fries	Picture 4	Picture 5	Picture 6
Without fries	Picture 1	Picture 2	Picture 3

Table 7.5.2. Experiment 2 comparisons

Comparison #	Left picture	Right picture
1	1	6
2	6	2
3	2	4
4	4	3
5	3	5
6	5	1

7.6 Reference table for meal perception in experiment 2

Table 7.6 Comparison analysis for dependent variable y1 and y2

Parameter y1	**B**	**Std. Error**	**t**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
b1	37.98	2.52	15.03	.00	33.01	42.9
b2	-5.72	2.52	-2.26	.02	-10.69	-.75
b3	0	.	.	.	.	.
c1	11.93	1.78	6.68	.00	8.42	15.44
c2	0	.	.	.	.	.
Parameter y2						
b1	3.46	4.02	.86	.39	-4.44	11.38
b2	-4.75	4.02	-1.18	.23	-12.67	3.15
b3	0	.	.	.	.	.
c1	-4.59	2.84	-1.61	.10	-10.19	1.00
c2	0	.	.	.	.	.

Source: authors calculations

7.7 Reference table for gender influences in experiment 2

Table 7.7 Gender cross-referenced comparison analysis for dependent variable y1 and y2

					95% Confidence Interval	
Parameter y1	**B**	**SD**	**t**	**Sig.**	**Lower Bound**	**Upper Bound**
[Male] * b1	39.61	3.91	10.12	.00	31.92	47.30
[Female] * b1	36.80	3.32	11.07	.00	30.26	43.34
[Male] * b2	-4.03	3.91	-1.03	.30	-11.73	3.65
[Female] * b2	-6.94	3.32	-2.08	.03	-13.48	-.40
[Male] * b3	0[a]	.	.	.	.	.
[Female] * b3	0[a]	.	.	.	.	.
[Male] * c1	13.59	2.76	4.91	.00	8.15	19.02
[Female] * c1	10.74	2.35	4.56	.00	6.11	15.36
[Male] * c2	0[a]	.	.	.	.	.
[Female] * c2	0[a]	.	.	.	.	.
Parameter y2						
[Male] * b1	-16.15	6.08	-2.65	.00	-28.12	-4.18
[Female] * b1	17.63	5.17	3.41	.00	7.46	27.80
[Male] * b2	-18.46	6.08	-3.03	.00	-30.42	-6.49
[Female] * b2	5.13	5.17	.99	.32	-5.03	15.30
[Male] * b3	0[a]	.	.	.	.	.
[Female] * b3	0[a]	.	.	.	.	.
[Male] * c1	-3.59	4.30	-.83	.40	-12.05	4.87
[Female] * c1	-5.32	3.65	-1.45	.14	-12.51	1.86
[Male] * c2	0[a]	.	.	.	.	.
[Female] * c2	0[a]	.	.	.	.	.

Source: authors calculations

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