Size matters! The joint influence of the size of portion, food item and container on food intake

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“One of the very nicest things about life is the way we must regularly stop whatever it is we are doing and devote our attention to eating.”

Luciano Pavarotti
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I wish you all a Happy New Year 2012!
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Prologue
Christmas and New Year's Eve have just passed. Two “perfect” opportunities to slow down, take a break from work and more importantly to indulge ourselves. Some of us have probably added some weight to their waist line and lost their Hercules or Venus shaped silhouette. When thinking about the menus or when you sat down to eat you probably wondered about what delicacy you would consume. But did you ask yourself how much food you would consume? Similarly, when going out to eat in a restaurant, do you ask the waiter to bring you a 200 ml. mushroom soup, a 250 gr. pork escalope with 150 gr. of French fries? Do we go to the supermarket thinking about how many yogurts, mandarins or chicken nuggets to buy? Generally, food choice is a greater concern to us than food quantity. Consistently, research has allocated a great amount of time and money to understanding the triggers and mechanisms of food choice, but less is known about what drives us to consume a certain amount of food (Hill, 2009; Levitsky, 2008). In particular, the underlying mechanism that governs energy intake when served a specific amount of food is unknown. This dissertation aims to fill this gap.

The desire and/or need to lose weight has become a great concern in developed countries, where the number of overweight and obese people has increased rapidly over the last quarter of century and the number and prevalence of undernourished people has declined. The transition to a more sedentary life has accentuated this phenomenon, driven by urbanization, changes in the food distribution (supermarkets) and processing (convenience food) systems and motorized transportation. Deaths due to over-consumption are beginning to surpass those related to under nourishment (Schmidhuber & Shetty, 2005); by 2030, only 6% of the developing countries’ population are estimated to remain chronically undernourished (Bruinsma, 2003). Given the higher food supply and access, consumers have to choose between what is good for the pallet and what is good for their health and body line. Yet, the major concern is not what, but how much food individuals are consuming. The consumer is left alone between extravagant diets, fears about the content and process of foods, the obsession to be thin and their waist line which plays roller-coaster (i.e., yoyo effect).

Indeed, the 21st century has put a lot of importance in our physical appearance. Fitness studios, diet programs, plastic surgery and other means to attain the perfect body have proliferated in developed countries. Nearly everyone has nowadays followed or will follow a diet. Paradoxically, the number of overweight and obese people has steadily increased in the United
States and now also in other developed countries, threatening to become a global obesity epidemic. The search for the perfect food, one that is tasty, satiating, healthy and nutritional has become the new Holy Grail. We live in a world where physical perfection is not just expected, it is demanded.

Our relation to food has thus become more complicated. While our ancestors had to worry about the risks involved in acquiring food, we now worry about the risks involved in consuming food: Pesticides, hormones, genetic modifications, salt, sugar, cholesterol, salmonella, BSE, e.coli, artificial colorants and counting. The path to an ideal nutrition and diet (good, healthy, holy) entails many efforts and sacrifices. Health policies feed us with an increasing literature about do's and don'ts. We have to eat a bit of everything, to not succumb to salty and sweet snacking temptations, to carefully read labels, to avoid saturated fats, to eat regularly, to not skip breakfast or to eat consciously and avoid distractions. In other words, to have a balanced diet and make rational choices. With the rapid spread of information through a vast number medias, the consumer should not have any problems to develop his personal well structured diet...or does he? The reality seems indeed to be quite different. Consumers seem to be overwhelmed and confused by what is expected from them, especially given the media and societal pressure to appear fit, thin and healthy. The huge amount of nutritional advice and tips can actually be interpreted in many different ways. Diets are a good example of this foggy maze as all advocate or forbid different foods or suggest competing structures of daily intakes (e.g., two, three, four or five meals a day). All these principles are even more difficult to maintain in a modern life where time constraints and food convenience often do not allow allocating much attention to our eating patterns.

The ideal of thinness pressures many individuals to revise their diet, food choices and consumption patterns in order to fit societal standards. Trying to regulate and control our food intake and choices has become such a popular behavior that not being on a diet is seen as abnormal. When thinking of diets, we usually imagine the vast panel of foods that are forbidden to consume. Given the fact that the market introduces nearly 20.000 new food products every year and that new diets are emerging every day, choosing the right food or diet has become as difficult as choosing the right apartment, computer or car. But how pick the most effective one? When looking at statistics, we can notice that none is really successful. Indeed, approximately 5-10% of people following a diet effectively lose weight on the long term (Hill, Peters, Jortberg & Peeke, 2004). The question is then: Would you board a plane that has at most only 10% of landing safely?

Despite efforts from health policies and campaigns, the pressure of a thin ideal and the proliferation of diets, food intake is increasing rather than decreasing. Are we hungrier than several
decades ago? Has our metabolism changed in such a way that we need more energy to survive? It seems implausible that our hunger centers have evolved to drive us to larger intakes of food. Overeating and obesity can be attributed to 4 different causes: metabolic (eg, differences in fat deposition), regulatory (eg, different weight set points), psychological (eg, stress eating) and environmental. Indeed, we are still adapted to our ancestral environment where food deprivation was more common and where we had to produce large efforts to acquire food. By contrast, our contemporary environment offers ubiquitous opportunities to indulge ourselves on high energy dense foods and decreased opportunities to engage in physical activity. Environmental factors seem to exert important pressures on our eating behaviors, but have received little attention (Rozin, 2005).

The study of eating behaviors can in general be summarized in two questions: What and how much do we eat? Food choice is the most investigated behavior, mainly because of economic implications (Wansink, 2004; Rozin, 2005). Weight gain is mainly a result of an exceeding balance between food intake and energy expenditure, with individuals ingesting more energy than they expend. Choosing less energy dense foods and increasing physical activity may help in reducing this imbalance. However, a different explanation of this energy surplus comes from surveys on food consumption and food distribution in the United States, that indicate that individuals are consuming more food than they need (Cutler, Glaeser & Shapiro, 2003). Industrialization of food production has turned our society into one of mass production and consumption. The increased ease and access to low cost but energy dense foods have given us opportunities to indulge ourselves at every hour of the day. Some researchers have defined our current society as a toxic environment leading not only to over consumption but also to decreased physical activity.

Hence, cutting down on the amount of energy ingested would probably be more effective if individuals would just reduce amount of food consumed. Our interest should thus reside in understanding why individuals consume more food, as the current obesity epidemic and the surplus on our waist line may be due less to what we choose to eat than how much. Recently, researchers have started to focus on the mechanisms involved in food intake due to the emergence of the obesity epidemic and the urgency to limit its spread. The rapid changes in weight status that occurred in western societies do not account for an exclusive explanation through metabolic, regulatory or homeostatic explanations. They do not provide information about why humans select certain foods and more importantly why they consume more food. The decision processes that govern food intake in humans are more complex than in any other species and require particular attention. Psychological, economical and social factors play a more important and decisive role in
the response to foods. Food intake is in general the result of responses to stimulation from physiological energy needs and the environment (Basdevant, Le Barzic, & Guy-Grand, 1990). Behaviors involved in food intake encompass the selection (and purchase) of foods, meal structuring and preparation, and finally actual ingestion.

Recently, research has started to focus on environmental influences that may subtly and implicitly determine the amount of food we consume. Recent changes in the food and eating environment may in fact contribute to the obesity epidemic (Hill & Peters, 1998; Young & Nestle, 2002). This observation has led researchers to suggest that our environment helps promoting obesity favoring eating behaviors. The shift to a higher and cheaper dietary energy supply has been linked with a rapidly rising prevalence of overweight, obesity and eating disorders (Hill & Peters, 1998; Rolls, 2003). A particular influence which has received much attention is the portion size of food served. Observational data shows that the size of the food portions suggested in recipes, the package sizes sold in supermarkets, the portions served in restaurants, fast-foods or at home have all increased in recent years (Young & Nestle, 2002; 2003; Wansink & Payne, 2009; Rolls, 2003; Nielsen & Popkin, 2003). In general, food portions are nowadays 2 to 5 times larger than twenty years ago (Young & Nestle, 2003) and when served larger portions, individuals tend to consume 18-25% more food at lunch meals and 30-45% at snacking occasions (Wansink, 2004). Although environmental factors may influence us in subtle and unconscious ways, experiments show that they are so strong that even nutrition experts are unable to prevent them and that individuals forcefully disbelieve that they may be influenced (Wansink & van Ittersum, 2003; Wansink, 2006; Wansink, van Ittersum & Painter, 2006). Yet, the portion size of foods can determine up to 20% of our total energy intake. The ubiquitous effect of oversized portions of food is substantiated by research indicating that portion size effects is indiscriminate of people (e.g., gender, BMI, age, status...), eating location (e.g. supermarkets, restaurants, fast-foods, recipes...) and food type (e.g. burgers, pasta, muffins...; Wansink, 2004; Young & Nestle, 2002). However, the question of why individuals chronically consume more calories than they need when more food is served has remained insofar unanswered (Wansink, 2004; Kral, 2006; Fisher & Kral, 2008; Bellisle, 2009). The aim of this dissertation is to suggest a psychological mechanism that could help explain food intake decisions, and in particular how amount of food influences our energy intake.
Plan of the Dissertation

In order to understand how food intake decisions are taken, a quick overview about how our relation to food has changed is necessary. The introduction of this dissertation will thus review how urbanization and industrialization have changed the relation to food and consumption in developed nations. The shift to mechanized agriculture and industrialized food production have increased accessibility, availability, convenience, storage and preparation facility and decreased the price and cost of food. An illustration of the evolution of eating patterns and the eating situation in order to match this new freedom and power over food will follow next. The last part of the introduction will focus on the changes in the food and eating environment as a result of the revolution of the food production, eating situation and decision process.

The first chapter of the empirical section of this dissertation will focus on the portion size effect and provide a theoretical framework that could explain this influence. As illustrated above, knowing what underlying mechanism governs this influence has become of utmost importance. Although many favorable conditions and potential explanations have been suggested, no research has identified the psychological mechanism that could explain this influence, a gap this chapter aims to fill.

Food comes in many shapes, types, sizes, colors and textures. Hence, a portion of food can be presented in different ways. The second chapter of the empirical section will illustrate how the way a certain food amount is structured may influence food intake. Research has shown that manipulating the structure of foods by increasing the number of food types (i.e., variety), colors or by changing the organization can alter food consumption. However, no research has examined whether increasing the number of food items without altering any other visual aspect (i.e., type or color of food) may also influence food consumption.

Generally, a portion of food is served on a plate, bowl, glass, container or simply in a package. The third chapter of the empirical section focuses on the influence of the size of a container where a certain food amount is served. The amount of food and the container size are generally confounded on the food market and hence in empirical research. Hence, it is unclear whether larger portions of food, larger containers, or their combination influence food intake. This
chapter will answer this question.

The discussion of this dissertation will present the different explanations and favorable conditions that have been identified so far to explain how food amount influences energy intake. These contributions will be contrasted with the theoretical framework suggested in this dissertation to explain the portion size effect. Implications of this framework on dietary prevention strategies to limit influences on food intake will be outlined. Future research directions will be the focus of the last part of this discussion.

In the conclusion, a synthesis of the major results will be presented. Perspectives and implications for nutritional behaviors will conclude the dissertation.


“You can find your way across this country using burger joints the way a navigator uses stars.”

Charles Kuralt
Introduction
Chapter 1

(R)evolution of Food and Eating
(R)evolution of Food Production

Historically, food was secured mainly through two methods: agriculture, and hunting and gathering. The main issue for most people was whether they had enough to eat. The era of industrialization revolutionized food production, leading us to a society of mass production and consumption. This chapter will review the most significant changes.

Cost of Food

Modernization of agriculture played a pivotal role in changing the cost of foods (Smil, 2004). Indeed, an important contribution was achieved by the change from traditional animal-powered agriculture to mechanized agriculture at the end of the 19th century, leading to an increase in productivity. The development of sciences and their practical application, high-yield varieties, expansion of irrigation, the contribution of industrial processes, of international exchanges, of progress in food distribution, of fertilizers, all further contributed to make food available in larger quantities and at a lower cost and price (Bruinsma, 2003; Smil, 2004). Access to the main food trade markets and purchasing power increased for a larger number of people. In industrial countries, growth in production at last comfortably exceeded growth in demand, providing more, better and cheaper food to everyone.

Food Accessibility

Similarly, food itself underwent important changes. New techniques to store and prepare food were developed. For example, Pasteur developed a scientific process to sterilize foods, Nestlé invented condensed milk, Liebig developed beef extracts and dry concentrated soups and Mege-Mouriès mastered the process of producing margarine. Agro-industrial products have replaced agricultural products (eg, industrial butter replaced dairy butter) and ready-made food products (eg, pre-cooked foods, ready to eat or to heat in microwave ovens) have replaced homemade products. Food processing advancements, such as freezing and canning, were first used commercially in the 1930s, when packaged food and also food fortification were introduced (Bente and Gerrior, 2002). Food evolved from raw to canned to frozen to vacuum-packed. Currently, grocery stores sell an
increasingly wide variety of ready-to-eat and prepackaged food. After the Second World War and within a few decades, foods became manufactured, branded products, retailed in vast networks, pushed by massive advertising campaigns, all aimed not anymore to families but at each and every single consumer.

**Role of Food**

This (r)evolution of food production coincided with the changes and needs of the society. Indeed, the general industrialization and development of technology shifted a rural society to an urban one. Historically, families were large and self-sustaining, food was self produced and processed and women were at the core of the household tasks. Besides its primary biological function, eating was also characterized as a social function, since cooperation in food procurement was essential to social organization (i.e., food distribution and sharing) (Bahuchet, 1990; Marshall, 1961). Interaction between technology and society shifted the focus of production away from home and the family. Under industrialization, production fulfilled less and less a function of sustenance. Hence, the role of women changed and more and more of them are seen nowadays in the workforce. This increased activity allowed less time for preparing meals.

**Food Convenience**

Industrialization, by revolutionizing food production and food preparation, led to important changes in food consumption but also to a technological revolution in the home. The twentieth century saw cooking of foods and meal preparations evolve, becoming more convenient and less time consuming. The food industry helped reduce domestic activities and increased storage, preservation and consumption facilities. Hence, food and cooking technology made spending time in the kitchen unnecessary and the food industry lined up by promoting foods ready to consume. Increased cooking technology and consumption of convenience foods are adaptive responses, as they allow food to be prepared in less time. The food industry, operated by multinational corporations and using intensive farming and industrial agriculture, nowadays supplies most of the food energy consumed by the world population. Increased consumption of convenience foods (prepackaged and frozen foods, fast food, and restaurant food) over this century demonstrates a declining amount of time necessary for food preparation, and this trend is viewed as an adaptation to modernization and it is also associated with the increased presence of women in the workforce.
Conclusion

In conclusion, the last century has provided people with more expertise to produce food at lower costs and the income to consume more of them. In addition, foods have become more accessible, easy to store and prepare, and most of all, more convenient to consume in large quantities. Nevertheless, mass consumption means neither equality in food consumption nor satisfactory nutrition. An example of this shift in consumption is the so called McDonaldization of society (Ritzer, 1993, 1998). Fast-food restaurants have increased in number all over the globe, providing people with cheap, ready-to-eat, high energy-dense and nutritionally poor food. This revolution of food production has inevitably led to changes in the way it is consumed. In the next chapter, we will see how the eating situation has evolved in consequence.
We have seen that industrialization made food available in larger quantities and at a lower cost and price. Moreover, progress in food storage (eg, refrigerator) and preparation (eg, cooking) made it possible to spend less time in kitchen activities. Proliferation of ready-to-eat and precooked foods allowed individuals to decide themselves when, where and with whom to consume food. Historically, food required hunting, gathering, growing, storage, distribution, preparation, display, serving, and disposal, all of which are social activities. Nowadays, individuals come to perceive themselves as independent and autonomous (Elias, 1975), a perspective that is reflected in their eating patterns. Under industrialization, a new way of life emerged in Western societies, leading to important changes in the eating situation and the way food is approached. This chapter will review these changes, focusing exclusively on industrialized societies.

**Households**

The urbanization and industrialization of societies led to a multitude of new family structures in Western societies, breaking away from the traditional model of the historical rigid and large numbered unit (Grall, 2009). In the United States for example, the number of parents having four or more children has been downsized by half. The number of divorced parents, of widows and single men and women have largely increased and more than half of the households are nowadays comprised of one or two persons. Hence, around a quarter of households with children are single-parent.

The role of the woman has also drastically changed. Their massive entrance into the work force has reduced the time that was previously allocated to cooking and feeding their children. Since 1900, the number of women working has tripled. However, the collapse of home cooking can also be seen in stay-at-home women, who exchanged this time for example with driving their children to off-school activities. The introduction of school cafeteria indubitably played a big contribution. In western societies, since 1965, the decline of time spent on food preparation is about 40 percent. For example, in 1950, a woman could spend three hours to prepare dinner; nowadays she can do the same in half an hour. In 1900, a woman spent 44h per week for meal preparation and
cleanup compared to less than 10h by the year 2000 (Bowers, 2000). This reduction in cooking and cleaning time has been enabled by the technological progresses of household appliances invading the kitchen. Nearly every household nowadays owns a microwave, a blender, a dishwasher, a freezer or a kettle.

### Meals

In consequence to this reorganization of 'industrial' life, foods, eating locations and situations have adapted, favoring an increased likelihood of a more individualized consumption of food and loosening the social determinants of mealtimes. The number of meals has decreased from five to three per day to the fast sandwich squeezed in between two work-related tasks (Rotenberg, 1981). While in the pre-industrialization era meals at noon were usually large and shared with family, friends and/or colleagues, they soon became more utilitarian and less shared. Nowadays, prepared meals, snacks, sandwiches, nibble and finger foods all foster an individualized consumption, leading to a state of ‘gastro-anomie’ (Fischler, 1988). The composition of meals has been simplified and more and more people tend to order delivery foods or head to take-outs and fast food restaurants. Occupational demands have decreased the prevalence of daytime commensality (Devine, Connors, Sobal, & Bisogni, 2003; Holm, 2001). In a study by Sobal and Nelson (2003) examining eating patterns of 663 adult Americans, over half of the sample ate breakfast alone and almost half ate lunch alone. Individual dinners were attended by about one-sixth of the participants.

Hence, the number of eating locations has increased massively in order to respond to this new trend to eat away from home. In the United States, the number of commercial eating places grew 89% from 1972 to 1995 and fast-food restaurants 147% (National Restaurant Association, 1998). Hence, it is not surprising to see that people spend nearly half of their food budget to eat in restaurants (Schlosser, 2002). Compared to the 1980s, their attendance to consume food at restaurants three or more times a week has increased by 40% (Kant & Graubard, 2004). Consumption of meals and snacks from fast-food restaurants increased by 200% and from other restaurants 150% (National Restaurant Association, 1998).

Urbanization, household composition, the entrance of women in the workforce, a work-oriented society, technological advances in household appliances, purchasing power increases, overall cost of food decreases due to industrialization of food production and multiplication of commercial eating places, all contributed to a shift from less commensal meals to more solo eating,
especially at breakfast and lunch. We are currently witnessing a loss of traditional collective eating and shared meals replaced in our contemporary food culture by a dietary individualization (Bove, Sobal, & Rauschenbach, 2003; Counihan, 1992; Valentine, 1999; Warde, 1997; Warde & Martens, 2000). Family packages have been supplemented by individual portions, single precooked meals, dinners for one and foods sold in large quantities are now more and more packaged into boxes containing single units. Hence, similar to numerous domains of everyday life that have become privatized, food choice and intake have fallen into a private sphere of decision (Fischler, 1979). This can be illustrated by the fact that in 1560, people had to share eating utensils with their eating companions, while nowadays everyone has several knives, forks and spoons at his disposal, each for a specific course of the menu.

**Conclusion**

Along history, eating behaviors have changed congruent with the type of foods consumed. Where, when, how and with whom we eat has mainly lost its cultural significance and eating is more often than not a mere act of food absorption dictated by individual choices and decisions. Given the greater affordability of food which is not seen any more as a luxury product (i.e., a lower percentage of income is spent nowadays for food), lesser thought is put in food-related decisions (Dyson, 2000). The next chapter will address in more details on what grounds our decisions are mostly based and how this process is now characterized.
(R)evolution of the Eating Decision

We are currently witnessing a new generation of consumers. Social changes led to modifications of eating behaviors, from a commensal to an individualized conception of food choice and consumption. The consumer traded cultural and family rituals and rules for more individual freedom. He has now the opportunity to tailor his consumption according to his unique preferences, needs and requirements. He can make decisions on a rational basis, defined by scientifically and economically informed grounds. In other words, he bears the main, if not the sole responsibility of his health, nutrition and body.

Foods

The food industry has accordingly “helped” the consumer to enforce his newly found nutritional freedom. Industrialization of food production has created an incredible diversity of food options and menus in order to extend and match everybody’s needs. Supermarkets offer traditional, exotic, fat-free, organic, processed or dietary products. When going for an ice cream or a bowl of cereals for example, a customer can now choose among more than 30 different flavors and counting. Raw foods have been supplemented by processed (and more technical) products. In order to help the consumer make informed choices, food labeling has provided more information on food content (lipids, carbohydrates, proteins), on ingredients, on recommended intakes, on nutritional values (kcal), on preparation and usage instructions or serving tips.

At the same time, the government has tried to sensitize individuals to healthy eating choices. The social aspect has thus been replaced by a medical view of food: guidelines, food pyramids, health and nutrition claims have been published, supposed to direct choices based on health contribution rather than pleasure. Focus has shifted from the social and pleasure aspects of eating to considerations and concerns on nutrients, calories, physiology and body weight. On the other hand, messages proliferated by the media and food companies through advertising have reached exponential levels, with solicitations being found on every media, but usually competing with public health policies. The constant promotion of energy dense foods is contrasted with warnings to reduce levels of sugar and fat. To increase confusion, information on the content and practice of eating has evolved over time depending on current health concerns, advances in food science and
technological progress. While we are constantly solicited in a food abundant society offering 24/7 consumption opportunities, we must paradoxically aim for the thin body ideal. Hence, the downside of this plethora of goods, information and stimulation is an increased confusion, uncertainty and complexity of food decisions. Nowadays a customer's enthusiasm for eating has made way for lethargy and bafflement in front of the overwhelming (mis)information on food. People live in a 'nutritional cacophony' (Fischler, 1993) urging them to make informed and healthy choices in order to live longer and stay in shape (Counihan, 1992). Then, on what grounds are food-related decisions based?

**Physiology vs. Environment**

In a food abundant society, where food is available all the time, easily and conveniently accessible at a low cost, genuine hunger and satiety are extremes that are rarely experienced. Studies show that in controlled environments, where participants consume different amounts of food (due to manipulations of the environment), their ratings of satiety are similar (Rolls, Morris & Roe, 2002; Marchiori, Waroquier & Klein, 2011). Hence, food-related decisions are not based on physiological signals anymore. We tend to be in a zone of biological indifference, where individuals are more concerned with what to do while they eat than eating itself (Herman & Polivy, 2005). The presence of eating companions has often been replaced by an environment shifting focus away from food to distractions like television, reading, listening to radio or work related tasks. Individuals spend more and more time multi-tasking while eating, which has mostly become a consequence of habit and environmental influences rather than hunger (Wansink, 2004). A distracting environment reduces intake monitoring and awareness of hunger and fullness signals. Research shows that amount of food consumed is strongly correlated to the amount of time and attention paid to monitoring this behavior (Arkes, 1991; Polivy, Herman, Hackett & Kuleshnyk, 1986). Indeed, eating is multidimensional and difficult to monitor. Consistently, initiation and cessation of eating is mainly a result of food salience, seeing other people eat, a mean to avoid boredom or the ending of a TV show or book (Tuomisto, Tuomisto, Hetherington & Lappalainen, 1998; Schacter & Gross, 1968; Rozin, Dow, Moscovitch & Rajaram, 1998).

Physiological signals are thus mainly ignored and distractions complicate food intake monitoring. Moreover, frequency of eating behaviors, time, effort, cognitive resources and motivation needed to make responsible choices are not compatible with an informed perspective of nutrition anymore. Hence, individuals have abdicated from trying to take informed food-related
decisions. The eating situation has been simplified with an important reliance on consumption norms and cognitive short-cuts to help determine food choice and intake amount. Indeed, when people are overwhelmed with information and stimulation, they usually resort to processes that simplify the situation. Hence, for many individuals, eating may then be seen sometimes as a low-involvement (mundane) behavior and routine activity, more of a nuisance or necessity than a pleasure, which may occur automatically and outside of conscious awareness (Cohen, 2008; Cohen & Farley, 2008; Wansink, 2004). Research suggests that individuals make twenty times more food-related decisions than they are aware of (Wansink & Sobal, 2007). Hence, environmental influences may influence food-related decisions of mindless and unaware consumers in a subtle and unconscious way (i.e., third person effect; Wansink, 2004, 2006). For example, when individuals are shown that larger portion sizes of food may influence intake by as much as 20%, they still believe that they are unaffected while acknowledging that others might be (Wansink, 1996; Wansink, Kent & Hoch, 1998). On a more peculiar note, researchers showed that amnesic patients did not mind to consume a second complete meal 10 to 30 minutes after their first, if they were told that it was dinnertime (Rozin, Dow, Moscovitch & Rajaram, 1998).

**Conclusion**

Mass production has lowered the cost and the amount of time necessary to obtain foods. Society offers many opportunities to indulge ourselves impulsively and to be influenced by environmental factors. A large scale environmental influence on food intake and dietary patterns refers to the number and types of food outlets available (eg, supermarkets), the mere existence of fast-food restaurants or the presence of vending machines (Morland, Wing, & Roux, 2002; Morland, Wing, Roux, & Poole, 2002; LaVeist & Wallace, 2000). On a smaller scale, eating alone may expose an individual to unhealthy eating behaviors and potential diet-related illnesses, as he becomes more susceptible to influences stemming from the environment (Sidenvall, Nydahl, & Fjellstroem, 2000; Torrez, McIntosh, & Kubena, 1992). In the discussion of this dissertation we will address in more detail what mechanisms and assumptions have been put forward to explain how these food and eating related environmental factors may affect food intake. For now, the next chapter will just introduce and describe the vast panel of factors from a large scale environment before addressing specifically the factors from the eating and food context that may influence food intake of mindless consumers. Research shows the number of daily food-related decisions that individuals are not aware of exceeds 200 (Wansink & Sobal, 2007), and each of them is a favorable ground for environmental cues to influence unknowing individuals.
Chapter 2

(R)evolution of the Large-Scale, Food and Eating Environment
(R)evolution of the Large-Scale Environment

The previous sections illustrated the evolution of food production, of the eating situation and decision. This has led to a greater availability and convenience of food and individuals have now the opportunity to consume food when, how and with whom they want. This new freedom and power is made possible by an environment providing plenty of incentives to indulge ourselves. It is thus not surprising that environmental factors can influence our food choices and intakes. In this chapter, the consequences of these factors on eating patterns and physical appearance will be described and explained.

Obesity Epidemic and Eating Disorders

Besides agricultural policies (Critser, 2003), food supply trends (Nestle, 2002), food distribution and marketing practices (French, Story & Jeffery, 2001), environmental influences are one of the major culprits of the obesity epidemic (Hill & Peters, 1998). Obesity can arise when energy intake exceeds energy expenditure, resulting in high levels of stored body fat. Although the prevalence of overweight and obese people is highest in the United States (about 60 % of individuals with a BMI over 25, the accepted boundary for the designation “overweight”), the rest of the developed countries are catching up rapidly (in France around 40 % of individuals with a BMI over 25): Obesity is threatening to become a global epidemic (World Health Organization, 2003; De Saint Pol, 2010; Drewnowski & Specter, 2004; Lobstein, Rigby & Leach, 2005). It is not so much the high ratio of overweight and obese people that is alarming, it is the rapid increase of these numbers during the last 30 years.
In the USA, the percentage of obese Americans increased from 14% to 32% in the last quarter of century (Ogden, Carroll, Curtin, Lamb & Flegal, 2010). In China for example, after 20 years of a strict one-child policy and a booming economy, family structures described as “4:2:1” (i.e., 4 grandparents, 2 parents, 1 child) are focusing much of their attention on the family’s only child and feeding the child is considered an important “investment”. In consequence, China has seen a sharp increase in overweight and obesity, with a whole generation of overweight children being “produced” (Shanghai Preventive Medical Association, 2002).

Similar to the shift of eating patterns observed in develop countries and especially the USA, developing countries are currently undergoing equivalent changes in nutrition and lifestyles as a consequence of a declining share of expenditure on food, urbanization and a shift in diet towards more animal products. Authors estimate that developing countries are threatened to reach similar levels of overweight and obesity over the next 30 years (Schmidhuber & Shetty, 2005). Even more alarming however is the fact that in these countries people will not be able to afford the medical treatment to cover health-related problems due to the obesity epidemic, and transition from food-poverty to health-poverty. Obesity represents a serious threat to health as it increases the risk of developing (among the most serious) diabetes, cardiovascular diseases, high blood pressure, arthritis and some cancers (Salans, 1979; WHO, 2003)

The abundance of foods and the availability of super foods (i.e., foods richer in fat, salt or sugar than any natural food, such as chocolate) have favored the emergence of an obesity epidemic.
Ironically, at the same time, the modern Western society has also promoted the appearance of eating disorders like anorexia and bulimia (Bordo, 1993). Cultural and social values have fostered an increasing obsession with health and fitness, affecting in great part our eating behaviors. The development of a cultural ideal of thinness has contributed to change the nutritional profile of what we eat, especially among women. In the 1950s the ideal female body type was a curvaceous, fuller figure (Fulcher & Scott, 2007) as represented by Marilyn Monroe. Today, slenderness and a thin female ideal body type are being glamorized and promoted by the media (Bordo, 1993) and advertisers use slim models to sell products (Fulcher & Scott, 2007). The connotations attached to having a slender silhouette in today's society create a desire to be thin, as it represents independence (Fulcher & Scott, 2007) and freedom (Bordo, 1993) for women. Hence, in order to achieve the cultural ideal of thinness, many women alter their eating habits. This results in abnormal eating patterns as being overweight is viewed negatively and as a self inflicted state (Ogden, 2010). Dieting and eating disorders appear to be logical consequences of these aesthetic standards for thinness. The pharmaceutical, cosmetic and fashion industries all contribute to reinforce and normalize slimming pills, diet drinks and restrictions of the amount and type of food to consume as good tools for weight loss (Fulcher & Scott, 2007), while a food abundant environment encourages opportunities to indulge in unhealthy energy dense foods. Between making healthy choices and satisfying cravings, food has become an ambivalent entity and eating often results in guilt feelings. In short, cultural ideals of thinness and an obesogenic environment have contributed to promote increasing rates of overweight and eating disorders in recent years.

Authors have identified several conditions that may contribute to a positive energy balance and thus weight gain. Some authors estimate that the current obesity epidemic could be due to a daily excess of only 100 to 150 kcal (Cutler, Glaeser & Shapiro, 2003). Indeed, indulging ourselves every day with only an extra hard-boiled egg, a small banana or a glass of white wine (150 ml), all containing 100 kcal, can lead to yearly weight gains of 5 kg. The prevalence of overweight and obese people may just be a normal adaptive response to an abnormal obesogenic environment offering a wide array of intake-promoting stimuli. Indeed, in order to restore energy balance, body mass increases.

Environmental determinants

Technological progresses and industrialization have produced an environment where food is not scarce anymore or limited in variety, but also where foods have much higher fat content and
sweetness. An example of this shift is the abundance of chocolate, a super food that matches our predisposition for sweet foods. Indeed, humans develop easily preferences for foods that are rich in energy, such as high-sugar and high-fat foods. Although most taste preferences and aversions are learned, the preference for sweets foods is innate in humans (Sclafani, 2004; Steiner, 1977). Indeed, examination of 'gusto-facial reflexes' in never-fed human newborns suggests an innate mechanism to accept sweet foods and to reject bitter foods. Hence, in an environment where foods with high energy density are ubiquitous, it is not surprising that individuals indulge themselves with these foods and in consequence gain weight. In developed societies, the food environment has changed drastically compared to ancient times. Taste preferences, motivations and predispositions have however remained unaltered, still adapted to a less favorable environment of uncertain food supply. However, although a food abundant environment and mixed media and cultural values do not explain the emergence of an obesity epidemic and eating disorders, they do represent favorable conditions.

Western societies have changed to promote heightened exposure to food and intake opportunities resulting in food abundant environments. In addition, messages that encourage food consumption have increased as well, especially through television, which is considered as largely responsible for richer diets and excess intakes (Hill & Peters, 1998; Jeffery & French, 1998). Consumers’ choices are constantly challenged and influenced by adverts towards convenience, high-energy and fast-foods (DuRant, Baranowski, Johnson & Thompson, 1994; Kotz & Story, 1994; Tucker, 1986). In the US, Coca Cola spent $277 million on advertising in 1997 (Jacobson, 1998), and in 1998, McDonald’s spent $571.7 million and Burger King $407.5 million (Kraak & Pelletier, 1998). By contrast, in 1999 the ‘5 fruits and vegetables a day' message by the American National Institutes of Health/National Cancer Institute had a budget of $1 million (Gallo, 1999). In the USA, the most heavily advertised foods are snacks, prepared convenience foods, soft drinks and alcoholic beverages, while fruits and vegetables are at the bottom end (Gallo, 1999; Kotz & Story, 1994). The prevalence of TV sets at home not only contributes to an increased exposure to adverts for energy dense foods, it also contributes to higher energy or fat intake due to snacking in front of the TV (Maras, 1997).

This “programming” has been followed by increasing opportunities to buy and consume foods. An excess intake favoring condition for example has been the increased availability of soft drinks vending machines. The consumption of these drinks has increased more than any other food group in the United States (Tippett & Cleveland, 1999). Foods have not only increased in availability and convenience, but also in energy density (i.e., kcal/g; sugars, fats) and palatability.
The increased consumption of milk and meat are associated with intake of higher levels of saturated fats and cholesterol above the recommended maxima (Schmidhuber & Shetty, 2005). In short, many modern foods have replaced traditional diets and are well-advertised, flavor-and color-enhanced, more processed, sugary, fatty, highly palatable, energy dense, easy available, and often cheap. These favorable conditions for a rich and energy dense diet are especially encountered when eating out.

Urbanization, the entrance of women in the work force and the less time devoted to cooking at home has led to increased eating away from home. In response, society has provided an increased number of access to restaurants, fast-food outlets, take away and home delivery services. Foods eaten away from home nowadays comprise an ever increasing part of individuals' diet and data suggests that these foods have higher levels of energy and fat than at-home foods (Biing-Hwan, Guthrie & Frazao, 1999). For example, a longitudinal study of American women (n = 891) showed that their increased rate of visits to fast-food restaurants resulted in increased intake of hamburgers, french fries and soft drinks, leading to increased total energy and fat intakes and to 43% weight gain over a 3-year period compared to women who did not increase their intakes from fast-food restaurants (French, Harnack & Jefferey, 2000). Foods rich in fat and salt are evolutionary more appreciated and provide a more desirable taste and mouth feel (Smil, 2000). Hence, it is not surprising to observe that the most popular food items (hamburgers, pizza, fried chicken, ice cream) have also more than 30% of their food energy in fats.

**Energy Expenditure**

In western societies, the obesity epidemic is not only linked to a food abundant environment promoting excess intake, but also to a society limiting opportunities for energy expenditure and promoting a more sedentary life style (Drewnowski, 2004; Hill & Peters, 1998). While in ancestral environments, humans hunted, foraged and worked to gather food, nowadays it is only a mouse click or a phone call away. Work-related (eg, e-mails instead of mails), transportation-related (eg, driving instead of walking) and leisure-related (eg, television instead of exercise) physical activity has largely decreased (Jacobs, Sprafka, Hannan, Ripsin, McGovern et al, 1999). It is suggested that urbanization reduces energy expenditures by about 10-15% (Ferro-Luzzi & Martino, 1996). For example, television, computers and video games are all leisure activities that require a low amount of effort.
Conclusion

This review has illustrated some of the favorable conditions that can lead to excess intake and direct our food choices. Besides these more general environmental influences, our environment presents several proximal factors that affect more directly our eating behavior. The next chapter will introduce and describe the vast panel of factors from the eating and food environment that may influence food intake of mindless consumers.
(R)evolution of the Food and Eating Environment

The environment we live in has drastically changed since industrialization and the revolution of food production. Storage facilities (eg, refrigerator), long-term conservation products (eg, canned foods) and shops open 24/7 give opportunities to consume food at every hour of the day. Factors that are related to the built environment, referred to as room-scapes, kitchen-scapes and table-scapes, can for example also influence what and how much individuals consume (Stroebele & de Castro, 2004; Sobal & Wansink, 2007). The higher availability and the different processing of food have produced new ways to influence our consumption. Sensory cues (eg, taste, smell) have an important impact in food choices and intake, as shown by our innate preference for sweet and aversion for bitter foods (Sclafani, 2004; Steiner, 1977), but they are not the purpose of this dissertation. This chapter will focus on environmental factors that influence our food intake, namely those related to the eating and to the food environment. We will overview the factors that compose both environments, before focusing more specifically on one of the most prominent influence of the food environment on intake volume, which constitutes the purpose of this dissertation.

Eating Environment

The eating environment refers to factors independent of food and that surround the eating situation: atmospherics, effort, social interactions and distractions.

Atmospherics

An effective way for restaurant owners to influence our food intake would be to take control of the atmosphere of the eating room. For example, hot temperatures do not invite consumption of large quantities of food but mostly of liquids, in order to cool the body's core temperature (Murray, 1987). Conversely, when the air is cooling down, the body needs to restore its core temperature and larger quantities of food are therefore needed and consumed (Brobeck, 1948). Soft music and lighting relaxes consumers, leading them to eat more slowly and to prolong their meal, thereby increasing consumption (Caldwell & Hibbert, 2002; Lyman, 1989; Ragneskog, Brane, Karlsson & Kihlgren, 1996), in contrast to bright illumination (Sommer, 1969).
Social interactions

Although more and more people are consuming foods alone, social dinners with family or friends can have a considerable impact on food intake volume. Friends and family members may contribute to render meals more relaxing, enjoyable and long, while also diminish our ability or motivation to monitor how much food we are eating. This influence is referred to as social facilitation and may encourage healthy but also unhealthy food choices (McIntosh, Shifflett, & Picou, 1989; Torrez, McIntosh & Kubena, 1992; Blum-Kulka, 1997; McIntosh, 1999) and may also lead to more extensive eating and drinking in the presence of others (de Castro & Brewer, 1992; Sobal, 2000). Research showed that compared to solo eating, consuming food with one person may increase food intake by 33%, while every additional person joining the table may lead to increases of 47%, 58%, 69%, 70% and 72%, with an increase of 96% of food intake when seven or more people are present (de Castro, 2000; de Castro & Brewer, 1992).

Effort

Although industrialization and food production improvements have generally and widely decreased the effort to acquire and consume any food by improving ease, access and convenience, the effort it takes to obtain food remains a powerful influence on food intake (Levitsky, 2002; Wansink, 2004; Wing & Jeffery, 2001). For example, leaving the lid of an ice cream cooler open drove cafeteria customers to consume more than when it was closed (Meyers, Stunkard & Coll, 1980). Similarly, reducing the distance one has to travel, for example by putting a milk dispenser close to the dining room, also increases consumption (Lieux & Manning, 1992).

Distractions

Consumption monitoring is often impaired (i.e., physiological signals of satiation are ignored) by external distractions accompanying the eating process as individuals tend to consume food while attending to other activities such as work, reading, listening to the radio or watching television (Bellisle, Dalix & Slama, 2004; Poothullil, 2002). In this view, a study showed that food intake increased by 15% when listening to a detective story compared to eating lunch in silence (Bellisle & Dalix, 2001). Another study confirmed this tendency in a natural setting, where
consumption of popcorn increased converging with amount of time and attention paid to the movie (Wansink & Park, 2001).

Food environment

The food environment refers to factors associated with the structure and presentation of food, namely salience, stockpiling, amount of food, structure and packaging.

Salience

An important influence on eating is the presence of the food itself. Given that it attracts attention, that it is easily accessible and that it provides cues to eat, a salient food is consumed more often and in greater quantities (Boon, Stroebe, Schut & Jansen, 1998; Cornell, Rodin & Weingarten, 1989; Engell, Kramer, Malafi, Salomon, & Lesher, 1996; Wansink, Painter & Lee, 2006). For example, leaving candies on our desk will let us consume 2.9 more candies than when they are placed in our desk and 5.6 more than when we have to walk two meters to reach them (Painter, Wansink & Hieggelke, 2002). Similarly, making chocolate candies (i.e., Hershey's kisses) visible (i.e., clear jars) accelerates their consumption by 46% compared to when they are less visible (i.e., opaque jars; Wansink et al., 2004).

Stockpiling

Salient and visible products are thus consumed more and faster. This effect is often enhanced by stockpiling products in salient areas. In a kitchen, numerous areas are available for storing foods (eg, shelf, pantry, refrigerator) that offer easily accessible consumption opportunities and may increase intake (Chandon & Wansink, 2002). Individuals are also subjected to a certain stock pressure, leading them to accelerate consumption of stockpiled products due to storage costs. Indeed, given that we tend to buy foods in large quantities due to their lower price, these products are usually left in salient places to stimulate their consumption until they reach more manageable levels to be stored (Chandon & Wansink, 2002; Wansink & Deshpande, 1994).

The last three influences related to the food environment all pertain actually to the food
itself, namely its size, structure and packaging. The amount of food is one of the most pervasive influences on food intake volume and constitutes the main interest of this dissertation. However, food does not influence us solely by the amount served, but also through its structure and packaging. These last two influences have therefore also been investigated in the subsequent chapters and empirical studies described in this dissertation.
Empirical Section
Chapter 4

Food Item Size
Introduction

We have seen that when consuming foods, their amount can greatly influence food intake volume. Another important aspect in determining consumption is the way food is structured (i.e., type and variety of food and the way of presentation).

Type of foods range from solid (e.g., steak, bread), to liquid (e.g., soup, water) and amorphous (e.g., rice, salad). Amorphous foods have no distinct shape and assume the shape of the container. Research has shown that quantity estimations can be very inaccurate and are the least precise when amorphous foods are considered (Hernandez, Wilder, Kuehn, Rubotzky, Moser-Veillon, Godwin, Thompson and Wang, 2006; Slawson & Eck, 1997; Harnack, Steffen, Arnett, Gao, & Luepker, 2004; Wansink, Painter, & Lee, 2006). Indeed, they provide nearly no delimitation points to monitor or guide food intake compared to unit or solid foods (Wansink, 2004; Marchiori, Waroquier & Klein, 2011). An aspect of this latter type of food that can lead to misinterpretations is the way these foods are structured. When foods are presented in a disorganized structure, individuals tend to believe that there is more variety (Kahn & Wansink, 2004). Moreover, this affects consumption, as shown in a study where participants consumed 69% more food when offered a disorganized assortment of six flavors of 300 jelly beans compared to an organized assortment (Kahn & Wansink, 2004).

Consistently, research has shown that variety of food influences consumption for amorphous and liquid foods. One has just to think about buffets that offer an abundant and wide array of different foods and that foster a motivation to try and thus consume more food (Maykovich, 1978; Stunkard & Mazer, 1978). The more choice there is, the more an individual consumes, independently of age and gender (Rolls & Dermott, 1991; Rolls, Andersen, Moran, Mc-Nelis, Baier & Fedoroff, 1992; Rolls, Castellanos, Halford, Kilara, Panyam, et al., 1998). For example, when offered an assortment with three different flavors of yogurt individuals consumed 23% more than when only a single flavor was offered (Rolls, Rowe, Rolls, Kingston, Megson & Gunary, 1981). Similarly, when offered a bowl of 300
M&M's in ten different colors, participants consumed 43% more than when only seven different colors of M&M's were present (Kahn & Wansink, 2004). Variety (perceived or actual) may delay sensory-specific satiety (Rolls, 1986; Miller, Bell, Pelkman, Peters & Rolls, 2000), but also habituation effects by making us believe we will enjoy the assortment more.

These studies manipulated the structure of foods by increasing the number of choices or colors or by changing their organization. These effects may be explained by decreased satiety sensations (Rolls, Rolls, Rowe & Sweeney, 1981; Snoek, Huntjens, van Gemert, de Graaf & Weenen, 2004; Rolls, Rowe, Rolls, Kingston, Megson & Gunary, 1981). Sensory-specific satiety refers to satiety induced by monotony. An individual feels sated not because he is really full, but because he has grown tired of consuming the same food. Increasing variety may alleviate this sensation. This raises the question whether increasing the number of food items without altering any other visual aspect (i.e., type or color of food) may also influence food consumption. What happens when food amount, energy density, color, taste, texture and variety remain unchanged, and only the number of food items is altered? In other words, how much will you consume when offered a plate of 126g of cookies and will this amount differ if the cookies are left entire (18 in total, 7g each) or are cut in half (36 in total, 3.5g each)?

This chapter will feature the following two articles:

**Article 4**


**Article 5**

Article 4
“Split them!” Smaller item sizes of cookies lead to a decrease in energy intake in children

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ABSTRACT

Objective: Examine the influence of altering the size of snack foods (i.e., small vs. large cookies) on short-term energy intake.

Methods: First and sixth graders (n = 77) participated in a between subjects experimental design. All participants were offered the same gram weight of cookies during an afternoon tea at their school. For half of the participants, foods were cut in two to make the small item size.

Analysis: Food intake (number of cookies, gram weight and energy intake) was examined using analysis of variance.

Results: Decreasing the item size of foods lead to a decrease of 25% in gram weight intake, corresponding to 68 kcal. Appetitive ratings, subject and food characteristics had no moderating effect.

Conclusions and Implications: Reducing the item size of foods could prove a useful dietary prevention strategy based on decreased consumption, aimed at countering obesity-promoting eating behaviors favored by the high availability of large food portions.

Keywords: dietary strategy; snack foods; energy intake; food item size; cognitive bias

Word Count: 150
INTRODUCTION

In the past 30 years, the size of foods (in individual portions, restaurant dishes and recipes) has gradually increased.\(^1\) This abundant environment is believed to favor obesity-promoting eating behaviors in young children.\(^2\)\(^-\)\(^3\) Studies show that children (two years or more) consume more food when larger amounts of food are served and that by the age of four, they have definitely adapted their eating behaviors to these food-related visual cues.\(^4\) When amorphous foods (i.e. that assume the shape of the container, such as tossed salad, soup and rice) are considered, prevention strategies suggest using portion size measurement aids such as a measuring cup or diagrams to assess appropriate quantities of food.\(^5\) However, food form and food item size (FIS) are important determinants of the amount of food consumed.\(^6\) Indeed, when foods characterized by distinct parts, such as cheese cubes are considered, the appropriate amount is usually represented in numbers (e.g. 12 chicken nuggets) and authors suggest that people tend to consume the same number of food items regardless of their size.\(^7\)\(^-\)\(^9\) Hence, focusing on FIS would be a more appropriate prevention strategy than focusing on the whole amount of food.

Up to now, only few studies have examined the effect of FIS on snack food intake, all with adult samples. In a study offering familiar snacks differing in air content, participants offered more aerated snacks consumed a greater volume, but less weight and energy.\(^10\) However, as the FIS variations were confounded with variations in energy density and participants were not offered an equivalent weight of food, it is unclear which cue affected energy intake. In a study keeping the total amount of food constant, intake ratio for the larger items (entire pretzel or Tootsie Rolls) was 1.67 and 2.27 times bigger than for the smaller items (half pretzels or quarter Tootsie Rolls).\(^7\) However food selection rather than food consumption was assessed and measures were based on aggregated scores rather than on
separate ratings of individual consumption. In a study examining individual consumption, participants were offered nibble- vs. bar-size snacks and received either no instruction or had to pay attention to their consumption. Small FIS led to a decreased gram weight intake in the control condition. However, participants were not free to choose whether to consume or not and were aware of the food-related purpose of the experiment as no other distraction was provided. Indeed, snack (or item) foods are usually consumed on a voluntary basis when individuals are distracted by other activities.

This is the first paper examining the effect of modifying FIS (i.e. small vs. large cookies) on children's food and caloric intake in a typical and familiar eating environment. Children were exposed to a free consumption situation, at a location and time when they usually have an afternoon snack. The hypothesis is decreased food intake will occur with smaller pieces of snack foods, regardless of age.

**METHODS**

**Participants and Recruitment**

Recruitment was performed in an elementary school attended by one of the experimenter's children. School director and legal guardians (i.e. mother/father) gave all written informed consent and both 1st and both 6th grade classes participated voluntarily. The experimental protocol was approved by the Ethical Committee of the Faculty of Psychological Sciences of the *Université Libre de Bruxelles*.

**Study Design and Materials**

Type of food (cookies) and food amount (126 g portion) were determined via a pilot
study (n = 10). Amount was increased by 50% in order to ensure that food intake would not be limited by amount of food. Cookies were rectangular shaped and consisted of several layers of wafers filled with milk chocolate topping (Cent Wafers, LU, Herentals, Belgium). A between-subjects randomized design with two experimental conditions was used: half of the children (n = 40, 21 girls) received always 36 half-sized cookies (3.5 g each) and the other half (n = 37, 21 girls) always 18 normal-sized cookies (7 g each). Normal-sized cookies were 7.4 cm long (2.9 in), 2.3 cm large (0.9 in) and 1.1 cm high (0.4 in). Half-sized cookies had the same width and height, but were 3.7 cm long (1.45 in). No other modification was performed, so that food amount, energy density and taste remained unchanged. Children received no other foods or drinks. This design was applied to children of both age groups.

**Procedures**

The purpose of the study was referred to guardians as examining their children's food preferences and eating habits with no mention on assessing food intake. The experiment was carried out during children's usual snack time (2:45 pm, spring 2008) and run in two rooms (each corresponding to one cookie size condition), on the same day and time of two consecutive weeks, in order to have two standardized sessions and identical hunger levels. Age groups were not mixed, first graders participating the first week. Kids were called up in alphabetical order, reported pre-study hunger (4-point scale labeled ‘not at all’, ‘a little’, ‘fairly’ and ‘a lot’) and were randomly assigned to a room and table. Children were seated in front of square tables. Individual plates were used in order to stick to maximize external validity, as all children bring their own afternoon snack. For first graders, nine tables were filled with four and one with three children. For sixth graders, ten tables were filled with four and two with three children. Children were told they could eat as much or as little as desired and were informed they would be given a refill if they liked to. They were allowed to talk but
not to share their food. Experimenters ensured that the foods were not shared and if not consumed, were left on the table.

**Measures**

Questionnaires were sent home to guardians where they reported the following variables regarding their children: gender, birth date, nationality, weight, height, dieting behavior (“Is your child currently on a diet to lose weight? (Y/N)”), food intake control, possible food allergies or weight problems and child’s preferred afternoon snack. BMI percentile was calculated with age- and gender-specific reference data. Overweight was defined according to CDC guidelines as BMI ≥ 85th percentile (n = 4). Restrained eaters have different eating patterns and norms than unrestrained eaters, and eating behaviors of overweight children tend to be affected by social context (i.e. eating alone vs. group). Exclusion criteria were determined in view of the moderating effect of these variables: presence of food allergies, overweight, weight problems, dieting behavior, food intake control in order to gain / lose weight and not hungry. As a result, data of 77 children (out of 85) were analyzed (cf. Table 1). Based on the effect size of similar studies analyzing FIS variations, a sample size of 56 or more participants is sufficient to obtain a power of more than 0.8 when assessing energy intake, at alpha = .05. On-site, children rated liking of the cookies (3-point scale labeled ‘not good’, ‘ok’, ‘good’), habit to eat cookies as afternoon snack (Y/N) and exercise frequency (hours/week). Amount/number of cookies consumed were assessed by subtracting the amount/number of cookies left from the initial count. Energy intake was determined by data from manufacturer.

- Insert Table 1 here -

**Data Analysis**
One-sample Kolmogorov-Smirnov was used to examine normality of data distributions and chi-square tests to analyze the independence of the sampling distributions for the habit to eat cookies. Analysis of variance was used to examine the main outcomes of food intake (number of cookies, gram weight and energy intake) based on the total amount/number of cookies provided. Fixed factors in the model were FIS, gender and age. As expected, age exerted no influence on the relation between FIS and intake and was removed from analysis. Analysis of covariance was used to examine the influence of participant characteristics on the relationship between FIS and food intake. All tests were performed with SPSS for Windows (release 14.0.0, 2005, SPSS Inc, Chicago, IL). An alpha level of .05 was used for all statistical tests.

RESULTS

Distributions of main outcomes did not violate normality assumptions ($z = 307.04, p > .2$). Results show that children were accustomed to link cookies to an afternoon snack. Indeed, guardians reported that their children's preferred afternoon snack was cookies (65%) or a similar food (18%). More specifically, most of the children were familiar with eating cookies (68%) as afternoon snack and liked the cookies (84%) they were offered, rating them to be good or okay. Twelve participants disliked the cookies. Inclusion or omission of these participants did not change significance. Participants had a mean age of $9.2 \pm 2.5$, a mean BMI Percentile of $41.12 \pm 20.88$ (range: 12 – 84) and gender was equally distributed (55% girls). There were no significant differences across conditions of FIS, gender and age ($p > .4$) in ratings of hunger, liking of the cookies and habit to eat cookies as afternoon snack. No participant asked for a refill.
Children offered the smaller cookies consumed a greater number of cookies than children offered larger cookies (14.6 ± 5.8 and 9.2 ± 3.5 respectively; F(1,70) = 20.21, p < .001). However, results show that this difference did not prevent FIS to influence gram weight intake (F(1,75) = 4.52, p < .04). Children in the large item condition consumed 25% more gram weight of cookies than the children in the small item condition, resulting in an increase of 68 kcal (cf. Figure 1).

- Insert Figure 1 here -

Consumption of the full snack was assessed in order to evaluate if the quantity of food served may have been limiting. FIS still significantly influenced food intake when removing these participants (n = 2) from the analysis (p < .02). Analysis of covariance showed that the relationship between FIS and gram weight intake was not influenced by any of the participant characteristics (height, weight, BMI, age, exercise or hunger (p > .1). Gender significantly influenced gram weight intake (F(1,64) = 4.89, p < .04) but did not significantly interact with age (p > .6) or FIS (p > .2). Boys consumed 24% more food than girls.

DISCUSSION

This paper analyzed the effect of modifying FIS of cookies on children's portion and caloric intake. Although all participants were served equivalent amounts of food, children offered small cookies consumed a significantly lesser gram weight than children offered large cookies, resulting in a 'loss' / 'gain' of 68 kcal. These findings support previous studies on the FIS effect\(^7,11,16\) and generalize this prevention strategy to children as young as six years.

Covariance analysis showed that when controlling for age, BMI, hunger, food intake
control and exercising, participants still decreased food intake when served smaller cookies. Consistently, studies have shown that when short-term intake is measured, cognitive processes and visual cues are more important than post-ingestive signals or participant characteristics. In this view, the “unit bias” claims that “people have a sense that consuming one unit of food is the appropriate amount to consider or consume”. In the case of foods characterized by distinct parts, one unit corresponds to a number of food items rather than to a gram weight. Hence, given that people tend to focus on consuming an appropriate number of food items rather than on their size, reducing the size of the cookies in our study led children to decrease food intake. However, participants did not increase consumption proportionally to FIS variation. Besides the fact that multiple factors and factor combinations influence consumption, a possible explanation for this discrepancy could be the food type or actually the FIS variation, as the larger cookies were twice as big as the smaller cookies. Future research could focus on determining the appropriate threshold for food size variations not to be noticed.

Although studies show that eating alone or in groups has no differential impact on eating behaviors of normal-weight children, the eating situation used in this study reproduced a natural eating environment in order to improve external validity (e.g. dining halls). Moreover, children were randomly assigned to chairs/tables in order to control for social facilitation, which is known to lead people to eat more with familiar companions and to eat less with strangers. Thus, group dynamics may influence eating behavior and would be worth considering in future research. Specifically, it may induce distraction: Studies show that eating while doing another activity (work, television) is a significant predictor of over-weight and obesity. Being in a group may also induce eaters to use impression management strategies: eating less or being thin is strongly associated with appearing feminine.

This study sample was controlled for several characteristics, which could represent a
limitation to the findings. Overweight and restrained eaters were screened and focus was on short-term intake of cookies. Future research should investigate how FIS affects intake of a wider array of foods in the long term considering subsequent meals both over the day and on other days. This convenience sample was confined to Belgian first and sixth graders of one school. The findings of this pilot study on the influence of FIS on children’s dietary intake should be investigated in individuals of all ages, gender and BMI groups living in varied geographic locations. Although precautions were made that all children were equally replete, future studies should assess post-intake hunger/satiety as an appropriate control. Finally, assessment of weight and height was based on parental reports. Although correlations between self-reported weight and height and body measurements are usually high, people tend to overestimate height and underestimate weight, leading sometimes to inaccurate detection of proportions of overweight and thus limiting generalization.22

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

Studies suggest that around the age of four years, cultural consumption norms are internalized and can impede awareness of physiological cues.4,8,12,23 The findings of this study are aimed to help counter these obesity-promoting eating behaviors facilitated by the high availability of large portions of energy-dense foods.1-3 They suggest that reducing the size of cookies (without altering total amount of food) decreases children's short-term energy intake: a further 'dietary strategy' for guardians to decrease gram weight intake discretely and without altering appetitive and physiological sensations. Reducing FIS alters the perception of the appropriate quantity of food to consume by providing more cut off points at which a person can reassess his consumption. Food manufacturers are already applying this principle by
making packaging changes (e.g. subpackaging, multipacks) that increase the number of food items in a serving (i.e. 100-calorie snack packs).

ACKNOWLEDGMENTS

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REFERENCES


FIGURE LEGENDS

Figure 1
Mean gram weight and energy intake (kcal) of cookies consumed by children offered small vs. large cookies in equal sized portions (n = 77).
Gram weight and energy intake

- Small cookie size
- Large cookie size

* P < .05
Table 1

Means (SD) of anthropometric and demographic data for children enrolled in a study to test the effect on food intake of small vs. large cookies in equal sized portions (n = 77)

<table>
<thead>
<tr>
<th></th>
<th>Small Cookie Size</th>
<th>Large Cookie Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>9.3 (2.5)</td>
<td>9.1 (2.5)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>30.1 (8.9)</td>
<td>29.7 (9.1)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>137.7 (15.3)</td>
<td>135.6 (15.8)</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td>43.9 (20.9)</td>
<td>38.1 (20.8)</td>
</tr>
<tr>
<td>Exercise (h/week)</td>
<td>3.7 (2.1)</td>
<td>3.8 (1.9)</td>
</tr>
<tr>
<td>Belgian Nationality (%; n)</td>
<td>94; 35 out of 40</td>
<td>86; 31 out of 37</td>
</tr>
</tbody>
</table>

Analysis of variance was used to examine differences between conditions. No statistically significant differences were observed.
Article 5
Smaller food item sizes of snack foods influence reduced portions and caloric intake in young adults

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ABSTRACT

Studies considering the impact of food size variations on consumption have predominantly focused on portion size, while very little literature investigated variations in food item size, especially at snacking occasions which yielded contradictory results. This study evaluated the effect of how altering the size of food items (i.e. small vs. large candies) of equal sized food portions would affect short-term energy intake while snacking. The study used a between subjects design (n=33; spring 2008) in a randomized experiment. In a psychology laboratory (separate cubicles), participants (undergraduate psychology students, 29 of 33 female, age 20.3 ± 2 years, body mass index 21.7 ± 3.7) were offered candies to free consumption while participating in an unrelated computerized experiment. For half of them, items were cut in two to make the small food item size. Food intake (grams, kcal and number of food items) was examined using analysis of variance. Results showed that decreasing the item size of candies led participants to decrease by half their gram weight intake, resulting in an energy intake decrease of 60 kcals. Appetitive ratings, subject and food characteristics had no moderating effect. A cognitive bias could explain why people tend to consider that one unit of food (e.g. ten candies) is the appropriate amount to consume, regardless of the size of the food items in the unit. This study suggests a simple dietary strategy: decreasing food item size without having to alter portion size may reduce energy intake at snacking occasions. Smaller food item sizes of snack foods influence reduced portions and caloric intake in young adults.
INTRODUCTION

The effects of food portion size variations on the volume of food consumed (1-4) are usually analyzed without taking into account the determinants of portion size (5-7). A food unit corresponds to the amount of a certain food usually consumed at one eating occasion (i.e. portion). A unit can correspond to a single food item (pizza) or to several food items (cookies). Portion size studies keep item size constant and manipulate the size of the overall amount of food (e.g. a 10-oz vs. 20-oz bucket of chicken nuggets, with each nugget weighing 1-oz) whereas food item size (FIS) studies keep the overall amount of food constant and manipulate the size of food items (e.g. a 10-oz bucket of chicken nuggets, containing ten 1-oz chicken nuggets vs. twenty 0.5-oz chicken nuggets). Until now, studies have predominantly focused on manipulating portion size due to their preference to serve amorphous shaped foods. Amorphous foods assume the shape of the container, such as tossed salad, soup and rice, where a FIS manipulation is technically impossible. Prevention strategies therefore suggest educating people in assessing appropriate portion sizes or on reducing them, in order to overcome their difficulties in estimating the portion size of amorphous foods (4,8). However, some authors have suggested that when clearly shaped foods are served (strawberries, cookies), people estimate their consumption in numbers rather than in quantities (7,9).

Investigating this influence at snacking occasions is of utmost importance with regard to prevention strategies, since weight loss programs target specifically snack foods (3) due to their poor consumption regulation (10). Surveys conducted in the US between 1978-2006 reveal snacks have increased in energy density, frequency and contribution to daily caloric intake (11). Furthermore, 2005 Dietary Guidelines for Americans reported that energy intake from snack consumption significantly exceeded the recommended quantity (12).

Studies by Osterholt, Roe and Rolls (13) offered two types of a similar familiar snack which differed in air content and found that participants consumed a greater volume, but less weight and energy of the more aerated snack. However, due to the differences in energy density and total gram weight, differences in energy intake could be due as much to the food characteristics (e.g. the
altered energy density) as to the visual cue (e.g. the altered FIS). In contrast, experiments by Geier, Rozin and Doros (7) specifically manipulated the item size of snack foods. Containers of a specific snack food were placed in building entry halls, varying FIS each day of the week while leaving the total amount of food constant. The intake ratio for the larger items (entire pretzel or Tootsie Rolls) was 1.67 and 2.27 times bigger than for the smaller items (half pretzels or quarter Tootsie Rolls). However food selection rather than food consumption was assessed and measures were based on aggregated scores rather than on separate ratings of individual consumption. In a study examining individual consumption, participants were offered nibble- vs. bar-size snacks and received either no instruction or had to pay attention to their consumption (14). Small FIS lead to a decreased gram weight intake in the control condition. However, participants were not free to choose whether to consume or not and were aware of the food-related purpose of the experiment as no other distraction was provided. In contrast, snack foods are usually consumed on a voluntary basis when individuals are distracted by other activities such as work or watching television (15).

Compared to previous studies, this is the first study examining the effect of modifying food item size of snack foods on subsequent portion and caloric intake, in an individualized (increasing internal validity) and free consumption setting (increasing ecological validity). The hypothesis is greater food intake will occur with larger pieces of snack foods.

METHODS

Participants

Undergraduate psychology students obtained two course credits of the six required annually in exchange for their participation in the study (computerized and candy experiment, both conducted in a psychology laboratory at the Université Libre de Bruxelles). Students were aware that they could refuse participation once they had signed up for an experiment provided they had valid ground. Exclusion criteria were: presence of food allergies, weight problems, overweight (BMI > 25kg/m²), dieting behavior and food intake control in order to gain or lose weight. Based on
the effect size (means and standard deviations) of similar studies analyzing FIS variations (6,13,14), a sample size of 30 participants or more is sufficient to obtain a power above 0.7 when assessing energy intake, at alpha = 0.05 (16). Subjects gave their written, informed consent to participate in this study approved by the Ethical Committee of the Faculty of Psychological Sciences of the Université Libre de Bruxelles.

Materials

Foods offered were cherry shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). The USA Food and Drug Administration defines a serving of candy as 40g (1.41oz). This amount was increased in order to ensure that the amount of candies served would not be limiting. Consequently, a 90g (3.17oz) portion was served to each participant. Total possible calorie content was 318 kcals (1341Kj).

Design

The study used a between-subjects design with two experimental conditions. In the first condition, candies were left unchanged, resulting in 10 normal-sized red candies and 10 normal-sized cherry candies. In the second condition, all candies were cut in half: 20 half-sized red ribbon candies (2g each) and 20 half-sized cherry shaped candies (2.5g each). In contrast to the experiments by Geier et al. (7), the FIS effect was analyzed in a randomized experiment, providing a control for food and participant characteristics as well as ascertaining that different hunger levels were evenly distributed across conditions.

Procedure

The experiment was carried out during an unrelated computerized experiment (decision making task about four objects after sequential information presentation), which lasted from 12pm
to 5pm. Each experimental session lasted 30 minutes and participants were seated in individualized cubicles. Next to each computer screen was a plate containing candies. Participants were told that the candies were offered for free consumption in recognition for their participation and that they could eat as much as they wanted. Participants were asked to not take any food out, which was further ensured by experimenter. After the conclusion of the experiment, they were given a questionnaire in which they were told that the candies were actually part of an experiment about eating habits.

Data Collection

Consumption was not experimentally induced nor were pre-meal hunger ratings assessed in order to avoid cueing participants to the issue of food intake. However, a retrospective measure of pre-study hunger was taken and used as a covariate in the analyses (17). Moreover, individualized consumption measures were taken in order to avoid a measure confound of the number of items consumed by each individual and the number of individuals who consumed at least one item. Participants rated their pre-study hunger, their liking of the candies, the extent to which they consumed candies on regular basis, and the extent to which they controlled their food intake on seven point Likert scales. These questions were validated in preliminary studies with identical populations. The distribution of the responses are congruent with similar measures found in portion size studies (2,3). Finally, they reported exercise frequency (hours/week) and assessed the cost and the energy content (kcal) of the entire plate. Demographic measures were: age, gender, nationality, weight, height, mother tongue and dieting behavior. The candy plate was weighed before and after the experiment (Digital Kitchen Scales, Brabantia Solid Company, Valkenswaard, Netherlands) to determine the amount consumed (within 0.1g). Energy intake (kcal) was determined by data from manufacturer. The number of candies consumed was assessed by subtracting the number of candies left from the initial count.
Statistical Analyses

Analyses of variance were used to analyze the main outcomes of food intake (number of candy items, gram weight and energy intake). FIS was entered as fixed factor. Analysis of covariance was used to examine the influence of participant characteristics on the relationship between FIS and gram weight intake. The analyses were performed with the statistical software SPSS for Windows (release 14.0.0, 2005, SPSS Inc, Chicago, IL). An alpha level of .05 was used for all statistical tests.

RESULTS AND DISCUSSION

Thirty-three out of 54 participants consumed candies (19 in the large and 14 in the small candy condition). Participants (M_{age} of 20.3 ± 2; range 18-27) were mostly female (29 of 33) and of Belgian nationality (27 of 33) and all were normal weight (M_{BMI} = 21.7 ± 3.7; range 18.8 – 23.88). There were no significant differences across conditions of FIS in ratings of hunger, liking of the candies, eating candies on a regular basis and estimates of the price and energy content (kcal) of the entire plate (p_s > .3), which suggests that random assignment was successful (see Table 1).

Participants with the smaller candies consumed approximately as many candies (6.2 ± 7.2) as the participants with the larger candies (6.9 ± 4.1; p > .7). Despite variations in food item size, participants served the smaller candies did not compensate the difference by consuming a greater number of candies.

In studies in which ad libitum consumption is measured over a short period of time, intake is likely to be influenced more by cognitive and visual cues (15). In this regard, larger portion sizes have been suggested to influence food intake because of their lower unit cost (18). However, as the food was offered for free, this explanation could be ruled out. Additionally, participants estimated a similar price for their respective plate of candies. Differences in energy intake could be explained by individuals taking larger bites when larger sized foods are served, leading to a reduced oral sensory stimulation and thus a reduced sensory specific satiety (14). However, considering our 66
small FIS ratio (2.25g vs. 4.5g), this explanation can not account for the large differences in intake, in contrast to Weijzen et al.'s (14) FIS ratio (1.45g vs. 16g).

A more relevant explanation is given by Herman and Polivy (9), who suggest that people tend to be in a “zone of biological indifference”, where they are neither genuinely hungry nor genuinely satiated. The decision about the appropriate amount of food to consume is then not a response to a basic homeostatic physiology, but is (mainly) based on food characteristics, norms and cognitive biases. This approach to regulating food intake may be a consequence of people's poor ability to rely on physiological cues (9) and to accurately estimate energy intake (2). It has therefore been suggested that people have a sense that consuming one unit of food is the appropriate amount to consider or consume (7,9), regardless of the size of the food items. Consequently, when consuming candies, a possible norm (or unit) would be to consume a handful (e.g. five to ten candies). With the appropriate quantity to consume expressed numerically, excess energy intake is then a consequence of the manipulation of the FIS.

Given the similar number of candies consumed across conditions, participants offered the larger candies consumed twice as much gram weight of candies (30.7 ± 18.2 vs. 16.3 ± 20.3) as participants offered the smaller candies ($F(1, 31) = 4.6, p = .04$; Figure 1), resulting in an increase in nearly 60 kcals (109.04 ± 64.5 vs. 49.22 ± 57.2, respectively). This influence was generalized across participants, thereby supporting Geier et al.'s (7) findings when controlling for individual food intake and Weijzen et al.‘s (14) findings in a free snacking context and extends them to candies.

Analysis of covariance showed that the relationship between FIS and gram weight intake was not influenced by any of the measured participant characteristics (age, food intake control, pre-study hunger, height, weight, body mass index or time spent exercising). When controlling for these variables, FIS still influenced food intake ($p = .016$). No participant asked for a refill or consumed more than 95% of the food. This restriction was probably due to a conscious choice to not “clean the plate” in an attempt to probably avoid looking too greedy. Food intake was also examined after
excluding data from participants who were over-weight or obese (n=4) and after excluding participants who disliked the candies (n=5): FIS still significantly influenced gram weight intake (\( p = .048 \) and \( p = .025 \), respectively). These results are consistent with portion size studies (2,3) in which this environmental influence seems to have a general effect, which can stretch even beyond the food's taste (19). This further shows how a food abundant environment can promote excess energy intake and and thus, the importance of designing appropriate prevention strategies.

This study sample was controlled for several characteristics, which could represent a limitation to the findings. It was screened for overweight participants, was mostly confined to Belgian female first-year college students and focused on short-term consumption of candies. Although studies report that an increase in energy intake due to size manipulations of foods is not well compensated in subsequent meals (20,21), future research should investigate how FIS affects energy intake of a wider array of foods in the long term considering subsequent meals both over the day and on other days. In addition, future research should investigate whether the FIS could decrease energy intake of individuals of all ages, gender and BMI groups living in varied geographic locations. Studies show that overweight people tend to be more sensitive to external cues, like labels (22). Finally, assessment of weight and height was based on self-reports. Although correlations between self-reported weight and height and body measurements are usually high, (female) college students tend to overestimate height and underestimate weight, leading sometimes to inaccurate detection of proportions of overweight (23).

Conclusion

This is the first study analyzing, in a free and individualized snacking context, whether altering the size of foods (e.g. candies) of equal sized food portions would affect short-term energy intake. The present findings suggest that reducing the size of candies would lead to a decreased gram weight intake, without altering appetitive and physiological sensations. By focusing on a portion size determinant, this study highlights a source of influence that has so far been overlooked,
namely FIS (5,7) and opens up new research perspectives in areas like dieting and body weight management. An evident barrier to food intake regulation is consumers' difficulty in accurately estimating portion size (8) and in interpreting label information (24). By contrast, a prevention strategy based on varying FIS requires no special ability or knowledge and could be more easily applied. The observation that food items are considered and consumed regardless of their size should also be considered in research areas like dietary recall and portion size evaluation. Health concerned food manufacturers could help consumers by making packaging changes (e.g. subpackaging, multipacks) to reduce FIS and thereby increase the number of food items in a serving. This would alter the perception of the appropriate quantity of food to consume and provide more cut off points at which a person could reassess his energy intake.
REFERENCES


Table 1. Differences between characteristics of first-year university students (n=33) and mean estimations of price and nutritional content of equal sized portions of candies

Figure 1. Differences between mean number of candy items, gram weight and energy intake consumed by first-year university students (n=33) offered equal sized portions of candies
<table>
<thead>
<tr>
<th></th>
<th>Small Candy Size</th>
<th>Large Candy Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20.2</td>
<td>20.4</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.4</td>
<td>60.4</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.64</td>
<td>168.47</td>
</tr>
<tr>
<td>Body Mass Index²</td>
<td>22.4</td>
<td>21.2</td>
</tr>
<tr>
<td>Belgian Nationality (%)</td>
<td>71.4</td>
<td>73.7</td>
</tr>
<tr>
<td>Exercise (h/week)</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>Food Intake Control³</td>
<td>3.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Liking of the candies³</td>
<td>3.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Pre meal hunger³</td>
<td>3.3</td>
<td>3.7</td>
</tr>
<tr>
<td>Eating candies on regular basis³</td>
<td>3.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Entire portion (kcal)</td>
<td>348</td>
<td>389</td>
</tr>
<tr>
<td>Price of the portion (€)</td>
<td>2.16</td>
<td>2.17</td>
</tr>
</tbody>
</table>

¹ Candies were cherry shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). Candies were cut in half to make the small candy size. Participants were offered small vs. large sized candies in a free and individualized consumption setting.

² Body mass index (BMI) was calculated as weight (kg) divided by height squared (meter²). Body mass index was defined as BMI ≤ 18.5 underweight; BMI 18.5 – 24.9 normal weight; BMI 25.0 – 29.9 overweight; and ≥ 30.0 obese.

³ Food intake control, liking of the candies, pre meal hunger and eating candies on regular basis were assessed on 7-point Likert scales.
Candies were cherry shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). Candies were cut in half to make the small candy size. Participants were offered small vs. large sized candies in a free and individualized consumption setting.

Number of candy items refers in the large candy size condition to the number of whole candies consumed by participants and in the small candy size condition to the number of half candies consumed by participants. Gram weight intake refers to number of grams of candies consumed. Energy intake refers to number of kcal consumed.

Analysis of variance was used to examine differences between Candy Size conditions (e.g. small vs. large candies).
Chapter 5

Container Size
Introduction

Most (manufactured) foods are usually sold in packages. Besides being an effective way of preservation, it is also a great mean for food companies to attract customers' attention to their product. While a large amount of research focuses on how labels and package design may influence choice and purchase, less attention is devoted to how shape and size of packages and containers may influence food intake. However, more than 70% of total energy is consumed out of a container (eg, plate, bowl, glass, bottle or jar) and nearly 30% of foods are consumed directly from packages (Wansink, 1996). This chapter will review how shape and especially size of containers can affect food intake.

The shape of containers has important effects on volume estimations and may thus influence how much food or beverage is scooped or poured (Raghubir & Krishna, 1999). For example, a study shows that individuals tend to pour more juice or soda into short, wide glasses than into tall, narrow glasses, volume of both containers being identical (Wansink & van Ittersum, 2003). This is explained by the vertical-horizontal illusion, claiming that individuals focus more on height than width of cylindrical objects, overestimating it by 20% even when both are of identical length (Krider, Raghubir & Krishna, 2001). Hence, volume estimations of beverage poured into wide glasses are usually inaccurate by 50% (Wansink & van Ittersum, 2003). These estimations inaccuracies led participants to consume 88% more juice or soda out of wide glasses. Surprisingly, even professionals are subjected to this effect. Veteran Philadelphia bartenders poured 26% more beverage (eg, gin, whiskey) when given short wide glasses than tall narrow ones (Wansink & van Ittersum, 2003).

Similar to the shape of containers, their size may also influence food intake. Parallel to the recent trend regarding portion sizes of foods, volume of containers has largely increased (Young & Nestle, 2003). For example, the surface area of a typical American dinner plate has increased by 44% in the last quarter of century (Klara, 2004). Food consumption is usually proportional to amount served, with individuals generally consuming approximately 92% of what they put on their plate or in their bowl (Levitsky & Youn, 2004; Rolls, Roe, & Meengs, 2006; Young & Nestle, 2002; Wansink & Cheney, 2005). Investigating this effect is thus of utmost importance, given that
individuals serve themselves more food in larger containers. For example, sip volume increases when food is served in larger bowls or cups (Lawless, Bender, Oman, & Pelletier, 2003). Moviegoers consume more popcorn when offered large containers (i.e., 240 gr.) than medium containers (i.e., 120 gr.) of free popcorn (Wansink & Kim, 2005). Large bags of potato chips (170 gr.) lead women to consume 18% and men 37% more than when served small bags containing 85 gr. of chips (Rolls, Roe, Kral, Meengs & Wall, 2004). Individuals serve themselves 53% more snacks and consume 59% more when given large (4 quart) than small (2 quart) bowls (Wansink & Cheney, 2005). When using 34-oz bowls, participants serve themselves 31% more ice cream than when using 17-oz bowls (Wansink, Van Ittersum, & Painter, 2006). Similar to the container shape effect, individuals generally tend to disbelief that bowl size may influence their intake.

A higher usage volume of products in larger packages has been observed across several foods and other products (eg, shampoo, detergent) (Wansink, 1996). Several explanations may account for this effect. Larger packages and containers may promote larger consumption norms or anchors, increasing amount of food that is usually considered appropriate to consume. An alternative but not exclusive explanation would suggest that products in larger containers have a lower unit cost. Containers may also provoke a size-contrast illusion, where a similar amount of food is perceived to be smaller in volume on a large than a small plate. Finally, larger packages or containers may suggest that serving ourselves and consuming a large amount of food is appropriate, especially given that the unit cost may be lower and that this amount may perceived as small.

An interesting question that arises is whether container size may influence consumption even when food amount is held constant. Indeed, most studies insofar have confounded container size with portion size, for example when offering large buckets containing more popcorn than their smaller counterparts or when asking participants to serve themselves, as more food is put in a large than small container. It is thus unclear whether larger portions, larges containers or both affect consumption. Hence, it is unclear whether container size may influence food intake independently of portion size. In other words, while watching a TV show, how many M&M's would you consume when served a 200g portion and more importantly, will this amount differ if the M&M's are served in a small container exactly the size of the portion or in a large container three times as large?
This chapter will feature the following article:

**Article 6**

Article 6
Container Size influences Snack Food Intake Independently of Portion Size

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Abstract

While larger containers have been found to increase food intake, it is unclear whether this effect is driven by container size, portion size, or their combination, as these variables are usually confounded. The study was advertised as examining the effects of snack food consumption on information processing and participants were served M&M's for free consumption in individual cubicles while watching a TV show. They were served (1) a medium portion of M&M's in a small ($n = 30$) or (2) in a large container ($n = 29$), or (3) a large portion in a large container ($n = 29$). The larger container increased intake by 129% (199 kcal) despite holding portion size constant, while controlling for different confounding variables. This research suggests that larger containers stimulate food intake over and above their impact on portion size.

Keywords: container size; portion size; short-term food intake; snacking occasion; dietary strategy
Introduction

Recent changes in the food and eating environment contribute to the obesity epidemic (Hill & Peters, 1998; Young & Nestle, 2002). Observational data shows that the size of the food portions suggested in recipes, the package sizes sold in supermarkets, the portions served in restaurants, fast-foods or at home have all increased in recent years (Young & Nestle, 2002; 2003; Wansink & Payne, 2009; Rolls, 2003; Nielsen & Popkin, 2003). In general, food portions are nowadays 2 to 5 times larger than twenty years ago (Young & Nestle, 2003). And, when served larger portions, individuals tend to consume 18-25% more food at lunch meals and 30-45% at snacking occasions. The food market tends to use larger containers (Young & Nestle, 2003) to accommodate larger portions, usually rich in calories, thereby leading to excess energy intake (Ledikwe, Ello-Martin & Rolls, 2005; Rolls, Morris & Roe, 2002; Wansink, 2004). For example, in a study by Wansink and Kim (2005), moviegoers ate 33.6% more popcorn when offered large containers (i.e., 240 gr.) than medium containers (i.e., 120 gr.) of free popcorn. The ubiquitous effect of oversized portions of food is substantiated by research indicating that portion size effects are indiscriminate of people (e.g., gender, BMI, age, status...), eating location (e.g. supermarkets, restaurants, fast-foods, recipes...) and food type (e.g. burgers, pasta, muffins...; Wansink, 2004; Young and Nestle, 2002).

However, as illustrated in the above example, studies on the effect of portion size (PS) on food consumption tend to confound container size (CS) with PS. Insofar, no study has varied CS independently of PS. Therefore, it is unclear whether larger PS, larger CS, or their combination influence food intake. In particular, it is unclear whether CS may influence food intake independently of the served portion. The main goal of this paper was to examine this question. That is, does CS influence food intake despite holding PS constant?

Two predictions can be made. First, individuals may exclusively rely on consumption norms that make them think they are served adequate portions (Wansink, 2004; Herman & Polivy, 2005). Individuals are generally uncertain as to how much to eat on a given occasion and the amount of food subtly suggests a cue to gauge or determine how much they should consume. In the study by
Wansink and Kim (2005), participants adapted their intake to the portion served by consuming more when more food was offered, regardless if the popcorn was fresh or stale (i.e., 14 days old). Hence, people may rely on the offered PS of snacks to adjust their food consumption and remain relatively unaffected by CS variations when PS is held constant. In this view, increased food intake is expected when PS increases, but not necessarily when only CS increases.

Alternatively, larger containers may provoke a size-contrast illusion, where a similar amount of food is perceived to be smaller on a large plate or in a large container. For example, the amount of mashed potatoes is underestimated when served on a 12-inch compared to an 8-inch plate (van Ittersum & Wansink, 2007). This “perceptual contrast” may decrease consumers' feelings of guilt towards food consumption or elicit psychological reactance if they think they are served inadequately small food portions. If so, increased food intake may be observed when snacks are served in a larger CS, independently of PS.

In the present study, participants took part in a typical snacking situation (Wansink, 2004): They were served M&M's for free consumption in individual cubicles while watching a TV show. Participants were served either a medium portion of M&M's in a small container (condition 1), a medium portion in a large container (condition 2) or a large portion in a large container (condition 3). We examined whether greater food intake would be observed with larger containers despite holding food portion constant (i.e., comparison between first and second condition). In addition, we examined whether further increasing food portion would further increase food intake. (i.e., comparison between second and third condition).

Method

Subjects and Experimental Design

88 undergraduate students ($M_{age} = 20.1 \pm 2.1; M_{BMI} = 22 \pm 3.8$; 61 Belgians, 26 male participants) were recruited in exchange for course credits, on condition that they regularly
consumed a snack in the afternoon (Osterholt, Roe & Rolls, 2007). Subjects provided written, informed consent to participate in the study reviewed and approved by the Ethical Committee of the Faculty of Psychological Sciences of the Free University of Brussels. Participants were randomly assigned to three conditions: medium PS/small CS (n = 30), medium PS/large CS (n = 29) and large PS/large CS (n = 29). The third condition was included in order to explore whether a larger PS would further increase food intake independent of CS. A fourth condition with a small CS and large PS was not included due to physical constraints (i.e., containers cannot contain food that exceed their volume).

Procedure

The study was advertised as examining the effects of snack food consumption on information processing. It was run from 2pm to 6pm in individual cubicles in a psychology laboratory. Participants were ensured of their anonymity by being identified solely by a 3-digit code. As a commonly consumed snack food, M&M's (Mars Inc., Virginia, USA) were chosen, with portion sizes of 200 gr. vs. 600 gr. for the medium and large PS conditions, respectively. Food amount was purposely selected to be larger than average intake in order to avoid artificially inducing restriction in this experimental setting. The volume (and dimensions) of the aluminum containers (Fun Favours, N.V. Copimex S.A., Halle, Belgium) was 250 ml. (6.5cm wide, 9cm long and 3.5cm deep) for the small container size and 750 ml. (9.9cm wide, 16.3cm long and 4.3cm deep) for the large container size. Hence, in condition 1 and 3, containers were stuffed, while in condition 2 containers were approximately half-full. Before and after consumption, participants used visual analog scales (VAS) to rate their hunger, prospective consumption (how much food they thought they could eat) and fullness (Rolls, Roe & Meengs, 2007). For example, subjects answered the question “How hungry are you right now?” by marking a 100-mm line that was anchored on the left by “not at all hungry” and on the right by “extremely hungry.” Scores regarding hunger were aggregated (α = .82 and .83 for before and after consumption, respectively). Liking of foods was
also assessed before and after consumption with VAS by having participants take one M&M and rate pleasantness of taste, appearance and quality (Rolls et al., 2007). Scores regarding liking of foods were aggregated ($\alpha = .93$ and .9 for before and after consumption, respectively).

Participants then watched a 22-minutes TV show (Scrubs, Season 1, Episode 1) while snacking. This setting was chosen because snack foods are usually consumed on a voluntary basis when individuals are distracted by other activities such as work or watching television (Wansink, 2004). Snack food was removed when the TV show ended. Plate cleaning tendency was assessed with the same question used by Rolls, Roe, Kral, Meengs and Wall (2004) and the two questions used by Wansink and colleagues (2005). Answers to these questions were aggregated into a single score ($\alpha = .93$). Consumption monitoring was assessed consistent with Wansink et al. (2005). Mood was measured with the two items used by Wansink and Kim (2005) and the four items used by Reinbach, Martinussen and Møller (2010). Answers to these questions were aggregated into a single score ($\alpha = .7$). Plate cleaning tendency, consumption monitoring and mood were translated into French and assessed on agreement scales anchored (-3) strongly disagree and (+3) strongly agree. Dieting behavior was assessed with the French translation (Leichner, Steiger, Puentes-Neuman, Perreault & Gottheil, 1994) of the Eating Attitude Test (EAT-26; Garner, Olmsted, Bohr & Garfinkel, 1982). Binge eating was assessed by a question from the Eating Disorders Examination (Fairburn & Cooper, 1993) asking: “Have there been any times when you have eaten a large amount of food in a short amount of time and you had a sense of loss of control about your eating?”

Demographics measured were: age, weight, height and conjecture about the purpose of the experiment. Foods were weighed before and after food intake to determine gram weight consumed (within 0.1g; Digital Kitchen Scales, Brabantia Solid Company, Valkenswaard, Netherlands).

**Statistical analysis**

One-sample Kolmogorov-Smirnov test was used to examine deviations from normality. Analysis of variance followed by pairwise comparisons with Bonferroni corrections was used to
examine differences between conditions regarding gram weight intake and participant characteristics. Analysis of covariance was used to examine the influence of participant characteristics (hunger, liking of the M&M’s, plate cleaning tendency, mood, consumption monitoring, dieting (EAT-26), binge eating, age and BMI) on the relationship between portion and container size and gram weight intake. Analyses were performed with the statistical software SPSS for Windows (release 14.0.0, 2005, SPSS Inc, Chicago, IL).

**Results**

No participant asked for a refill or consumed more than 95% of the food. Distributions of food intake did not violate normality assumptions ($z = .9$, $p > .2$). There were no significant differences across conditions in ratings of participant characteristics ($ps > .07$; see Table 1). When controlling for these characteristics, PS and CS still significantly influenced gram weight ($F (2,69) = 6.26, p < .005, \eta^2 = .15$). Therefore, these variables are not further discussed.

- Insert Table 1 about here -

The experimental condition significantly influenced food intake ($F (2,85) = 7.93, p < .005, \eta^2 = .16$). Participants in the medium PS/small CS condition consumed significantly less M&M’s ($M = 30.4 \text{ gr.}, SE = 5.3; 155 \text{ kcal}, 0.65 \text{ MJ}$) than participants in the medium PS/large CS condition ($M = 69.5 \text{ gr.}, SE = 8; 354 \text{ kcal}, 1.48 \text{ MJ}; p < .005$) and participants in the large PS/large CS condition ($M = 59.8 \text{ gr.}, SE = 8.2; 305 \text{ kcal}, 1.28 \text{ MJ}; p < .02$), who did not differ from each other ($p > .9$). In other words, a larger container increased intake by 129% when PS was kept constant, and by 97% when it was also associated with a larger PS.

- Insert Figure 1 about here –

**Discussion**
The important message emerging from this research is that CS influences food intake for high-energy food even when PS is kept constant. Hence, not only do people serve themselves larger food portions in larger plates, bowls or containers (Wansink & Cheney, 2005; Wansink, van Ittersum & Painter, 2006), they also eat more when they are served food portions of similar sizes in larger containers. As a matter of fact, calories intake increased by more than 100% when increasing CS by 300%. Food consumption did not further increase when additionally increasing PS by 300%, presumably because of a ceiling effect. In other words, the selection of a somewhat smaller food portion for the large PS condition may have resulted in a PS effect independent of CS.

PS and CS are generally confounded on the food market. Therefore, although theoretically stimulating, one may question the societal implications of the present finding. These should become obvious when considering that consumers ultimately face medium quantities of food in larger containers as they are progressively emptying large food packages. For instance, a remaining 75 gr. of M&M or potato chips may stimulate more food consumption when appearing at the bottom of a 350 gr. than in the middle of a 150 gr. bag.

It is unlikely that a CS effect emerged here due to the perception that products in larger containers have a lower unit cost (Wansink, 1996). In the present study, M&M’s were delivered for free and placed in experimental containers rather than in their usual commercial packaging. It seems more reasonable to assume that the size of containers or packages activate implicit consumption norms against which consumers calibrate their food intake (Herman & Polivy, 2005; Wansink, 1996; 2004). Although restrained eaters and dieters have personal norms to determine their intake, unrestrained eaters usually enter a consumption situation without any specific knowledge or intended food intake amount (Herman & Polivy, 2005). This may be due in part to individuals being unable to accurately estimate actual portion sizes of foods (Hernandez, Wilder, Kuehn, Rubotzky, Moser-Veillon, Godwin, Thompson & Wang, 2006). Consistently, when food amount was increased by stuffing the small and large containers, participants relied on the PS served (and/or the CS, as both were equivalent) to estimate food intake, falling prey to the PS effect. When PS was held
constant however by filling only half of the large container, energy intake did still increase with CS. A given amount of food is usually perceived as smaller in a large than a small plate. The perception of half-filled portions (i.e., a medium portion in a large container) may have led participants to conclude that they were offered a more than reasonable (or possibly an unreasonably small) food portion, thereby motivating increased food consumption. Admittedly, consumers' reliance on consumption norms may be particularly effective in conditions of diverted attention, such as when snacking while watching TV, because of decreased consumption monitoring (Higgs & Moodward, 2009; Wansink, 2004).

A caloric increase caused by a CS variation may have important implications for body weight regulation, especially given that snacks have increased in energy density, frequency and contribution to daily caloric intake (Piernas & Popkin, 2010). In this view, researchers, health organizations and dieting programs have all recommended the use of smaller containers (Weight Watcher; National Institutes of Health, National Heart, Lung, and Blood Institute, 1999; U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, 2002). The present findings suggest that this recommendation indeed is very sensible indeed, not only because larger containers usually come with larger food portions, but also for another reason established here: Larger containers, per se, stimulate food intake.

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Declaration of Conflicting Interests

The authors declare that they have no conflicts of interest with respect to their authorship or the publication of this article.
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References


Figure Legends

Figure 1. Differences in mean energy intake (i.e., kcal) across conditions of different portion sizes (PS; 200 vs. 600 gr.) and containers sizes (CS; 250 vs. 750 ml.)
Figure 1

Bar chart showing the amount of Kcal for different conditions:
- Medium PS – Small CS
- Medium PS – Large CS
- Large PS & CS
Discussion
Chapter 6

Food Intake Regulation
In contrast to other species, human food intake is a complex behavior (Bellisle, 2009). Social, psychological, economical, metabolic, regulatory and environmental factors all can contribute to initiate food consumption and to determine how much food will be consumed. An environmental influence that largely contributes to the amount of food consumed is the size of the portion. Indeed, the impact of the amount of food served on food intake is suggested to range from 18-25% in lunch meals and 30-45% in snacking situations (Wansink, 2004). Although research has provided unanimously evidence of this influence, it usually is limited to its description (Wansink, 2004; Kral, 2006; Fisher & Kral, 2008; Bellisle, 2009). This dissertation aimed at unraveling the psychological mechanism that explains this effect, namely by presenting a theoretical framework that may explain how this behavior is regulated and why individuals consume an increased amount of food when served enlarged portions.

Preliminary results shown in the empirical part of this dissertation suggest that individuals determine their food intake by using an anchoring and adjustment heuristic (AAH). In this view, the portion size served is used as an anchor whereas other influences (i.e., economical, metabolic, regulatory, physiological, sensory, social and environmental) may further contribute to adjust total amount of food consumed.
Individuals usually use cognitive short-cuts to simplify a situation or to reach an estimate without having to engage in extensive efforts and thinking. Hence, several assumptions to account for this use have been put forward. A necessary condition is that individuals do not know the correct answer or behavior to display. A second assumption refers to the fact that individuals do not have the time, motivation or resources necessary to allocate much effort in their decision process. Finally, individuals are not always aware of how they reached their estimate or that a trivial anchor may have biased their judgment. Although a well-documented phenomenon, no research has provided a conclusive theory as to why individuals consume more food when more is served. However, authors have put forward several widely accepted assumptions that may help understand the portion size effect. Interestingly, these assumptions relate perfectly to a use of an AAH. They are the focus of this chapter. It will provide a description of the most advocated assumptions and show how they support or complement an explanation by the AAH. Starting with the supporting assumptions, we will review individuals' physiological and cognitive state when entering an eating situation, as well as the norms that may provide cues to determine food intake volume.
Supporting Assumptions

**Physiological State: Satiety**

A first assumption made by authors is that our intake is not entirely based on physiological needs, but mostly on external factors, visual and cognitive norms (hence, such as the AAH for example). Indeed, if we would consume food out of genuine hunger and stop eating out of genuine satiety, portion size effects would probably not occur.

Satiety is not an all-or-nothing process, a state of inhibition of hunger following food intake. In our ancestral environment, opportunities to consume food were quite rare. When food was present, humans had to ingest as much as possible in order supply for food-deprived periods. The satiety limit is thus quite flexible, as shown by research on amnesic patients for example, who are able to ingest three entire meals in a short period of time. Indeed, individuals can always make room for more (Rozin, Dow, Moscovitch & Rajaram, 1998; Berry, Beatty & Klesges, 1985; Herman & Polivy, 2005). Hence, with food retailers doing incredible efforts to promote increasingly palatable foods, it is normal to succumb to the temptation to eat another snack, to have seconds and even thirds or to add a dessert to a four-course meal. Another consequence of the changes in the food environment to our satiety centers is the increased variety of foods. Compared to our ancestors, we can nowadays choose what type of food or cuisine we want to consume. Sensory-specific satiety is a psycho-physiological mechanism that induces eating cessation due to food monotony (Rolls, Rolls, Rowe & Sweeney, 1981; Snoek, Huntjens, van Gemert, de Graaf & Weenen, 2004; Hetherington & Rolls, 1996). However, the abundance of foods in our refrigerators or in restaurant menus bypasses this mechanism. Indeed, while the appeal for a eaten food declines, the attractiveness and pleasantness of other foods remains unchanged or even with a greater hedonic value and desirability (Hetherington, Rolls & Burley, 1989). A child that is not hungry anymore and is sated because he consumed too many vegetables will still find some room for a dessert. Sensory-specific satiety occurs mainly because of a sensory habituation, an attentional disinterest and a reduction in the reward value of the food (Raynor & Epstein, 2001; Rolls & Rolls, 1997).
Physiological State: Hunger

Authors consider that there should be made a clear distinction between the notion of appetite and hunger, given that they are often used interchangeably (Herman & Vaccarino, 2000). Hunger results out of physiological signals that reflect the current nutritional status (e.g., food deprivation) and is really a need for food. In contrast, appetite refers to a desire for food due to the attraction it projects. In short, hunger is mainly a physiological based response, whereas appetite is mainly a psychological based response. Compared to our ancestors, in developed nations food deprivation periods have nearly completely disappeared and no one is really starving.

Physiological State: Appetite

Hence, it is common to assume that social constraints mostly determine fixed eating schedules, the size and number of daily meals. We consume food more likely because it is lunch time than because we are genuinely hungry. Studies asking participants to report daily intakes show that the size of meals and the frequency of snacking do not allow a moderate level of hunger to return before it is time for the next eating occasion (Bellisle, Dalix, Mennen et al, 2003). In this view, food intake can be understood as a continuum ranging from hunger to perfect satiety. However, in our food abundant society, these extremes are being rarely experienced as most of the time and for most people, intake onset and cessation are not due to genuine hunger or satiety. Individuals tend to be in a “zone of biological indifference”, where they are neither really sated nor really hungry (Herman & Polivy, 2005). In this view, food intake is the result of external factors and not of basic homeostatic physiology. Hence, it is argued that food intake increases are mainly due to the higher attractiveness, palatability and convenience of foods that constantly trigger our appetite. Studies show that increasing the size of food portions leads to food intake increases but not do differences in ratings of after-meal hunger and fullness (Kral, Roe & Rolls, 2004; Rolls et al, 2002; Marchiori, Waroquier & Klein, 2011).

In conclusion, for most individuals, our eating behaviors are not determined by internal cues of satiety and hunger, but by food cues in the external environment. Rather than being the outcome of physiological signals, authors argue that the decision process regarding the appropriate amount of
food to consume could be compared to an evaluative judgment situation, mainly determined by cognitive shortcuts, visual biases and consumption norms (Herman & Polivy, 2005; Wansink, 2004, 2010; Wansink et al., 2004). Hence, the assumption that, in food abundant societies, physiological signals have relatively no impact on food intake support an anchoring and adjustment perspective of eating. If individuals were perfectly aware of their hunger and satiety, they would know how much food to consume. Intake onset would be solely determined by hunger, whereas meal cessation would reflect genuine satiety. Hence, there would not be a need to simplify a situation or for help to estimate intake, as an individual would know the correct answer. However, research has shown that this zone of biological indifference or appetite can be extremely wide in humans (Rosenthal & McSweeney, 1979; Herman & Polivy, 2005; Goldman, Herman & Polivy, 1991), suggesting a high level of uncertainty.

A biological indifference perspective of eating by contrast reflects an uncertainty that fits adequately an anchoring and adjustment perspective of eating. Influences on food intake can be numerous and very strong, often overriding the physiological signals of satiety and hunger. This perspective of food intake helps to understand why environmental influences can have such an importance and why it is necessary to identify them. However, it does still not explain why they influence the amount of food we consume. Indeed, if the limit to food intake quantity is very large, why do not individuals ask for seconds when served smaller portions of food, as they are usually given this possibility in experiments (Rolls et al., 2002)? This question is answered by the second assumptions authors have put forward, namely the cues individuals rely on to determine food intake.

**Norms**

Cognitive shortcuts such as heuristics are usually used because people are uncertain about the true estimate. Similarly, it is generally assumed that individuals are also uncertain as to how much to eat on a given occasion (Wansink, 2004; Herman & Polivy, 2005). Moreover, individuals tend to not be very involved in their food-related decisions, which may be seen as a nuisance for some individuals (Herman & Polivy, 2008). Given that intake onset and cessation do not stem from genuine hunger and satiety, cues suggested by the eating environment can help to gauge how much food to consume (Herman & Polivy, 2005). These cues are referred to as consumption and social norms. A consumption (or regulatory) norm determines the quantity of food that is appropriate to
consume or how an individual should behave when eating. Authors have identified several norms that may affect energy intake, but argue that the portion size is the most prominent (Herman & Polivy, 2005; Wansink, 2004). Consistently, in an anchoring and adjustment perspective of the portion size effect, it is the amount of food that is used as an anchor.

The Portion Size Norm

Unless one asks for a second serving, the amount consumed can never exceed the amount served. Hence, besides palatability and genuine hunger, the amount of food available is perhaps the major determinant of food intake (Wansink, 2004; de Castro, Bellisle & Dalix, 2000; Herman & Polivy, 2005). The portion of food suggests a situational consumption norm, an authoritative judgment as to how much is appropriate, typical, normal and reasonable to consume. In general, the amount of food present on a plate is determined by an authority figure (e.g., mother, restaurant chef) and individuals tend to heavily rely and accept this external judgment as shown by the “effectiveness” and prevalence of the portion size effect. In most experiments, participants have the opportunity to ask for seconds when served smaller portions, yet they refrain from doing so (Rolls et al., 2002). It seems like the amount of food served defines once and for all that no more than this quantity should be consumed. In other words, a hypothesis confirmation process may be taken place where the anchor suggested by the portion size of food is eventually believed to be accurate.

The perception of the appropriateness of the portion size may be affected by cues of the amount of food itself. In the empirical section of this dissertation we have seen how two little adjustments to the food portion can alter intake patterns. Increasing the size of food items in a portion or the size of a container can lead to excess intakes compared to the control conditions. These portion-related factors may be affecting the hypothesis confirmation process. When confirming the adequacy of a food portion, the structure of food and the container size add valuable information. Among the environmental factors described in the introduction of this dissertation, food variety, container shape and distractions would be other potential candidates to influence how a food portion is perceived and judged, and thus the anchoring process.

Why do consumption norms, and especially the one suggested by portion size, influence so markedly our energy intake? We may be unsure about how hungry or sated we are and need to rely on external help to guide our intake; it still does not explain why individuals do not reflect about the appropriateness of enlarged portions. Moreover, why do individuals not use for example personal...
norms to gauge their food intake or why do they not try to make informed judgments about how much food would be appropriate to consume? Is our health not a good enough reason to allocate energy and attention to this decision process? Restrained eaters and dieters do in fact try to thoughtfully engage into their food intake (e.g., Weight Watcher points; Herman & Polivy, 2005; Wansink & Van Ittersum, 2007; Wansink, 2004). Why do unrestrained eaters do not do the same? The literature on decision heuristics claims that such informed decisions require motivation, time, effort and cognitive resources. Heuristics are used to speed up the decision process while allocating the lowest amount of effort possible. Hence, an anchoring and adjustment perspective of eating is bound to the condition that individuals are not motivated to engage a large amount of effort in their food-related decisions. May this be also the case for eating situations and unrestrained eaters?

Knowledge, Time and Resources

Individuals' cognitive processing capacities are quite limited and being able to assign routine tasks to lower-level brain involvement helps them to adapt to situations where stimulation is high, like in eating situations (Bargh & Ferguson, 2000; Bargh & Chartrand, 1999). Eating situations may well represent such situations, as it would enable us to focus on the TV show or on the current topic of discussion.

Another assumption made by authors is that unrestrained eaters enter an eating situation without prior knowledge or certainty about neither how much they will consume nor what quantity would be appropriate (Herman & Polivy, 2005). Among individuals' difficulty in interpreting food labels (Rothman, et al., 2006), their inability to estimate calorie content (Wansink & Chandon, 2006; Hernandez, wilder, Kuehn et al., 2006), their lack the motivation to implement recommendations (Trottier, Polivy & Herman, 2009; Dickson-Spillmann & Siegrist, 2011) and their low knowledge about appropriate intake and nutritional values (Thakur & D’Amico, 1999), one would not have to search far to find reasons as to why deciding about appropriate intakes may require a lot of effort, time and knowledge. This may not be surprising as even experts (i.e., nurses and dieticians) are inaccurate in estimating calories form large portions of food (Chandon & Wansink, 2007). A major reason to the little knowledge individuals display in eating situations may be due to their low-involvement, as food intake is usually accompanied by a (more important) secondary activity (Wansink, 2004). Indeed, eating is often of little concern compared to external distractions accompanying the eating process as individuals tend to consume food while attending 105
to other activities such as work, reading, listening to the radio or watching television (Bellisle & Dalix, 2001; Bellisle, Dalix, & Slama, 2004; Wansink, 2004). Hence, individuals may be quite overwhelmed by the amount of information and stimulation stemming from an eating situation and furthermore be more motivated by the choice of their secondary activity than by determining the food intake amount itself. This view is even more accentuated by another final assumption of the conditions presiding eating situations. It highlights how individuals are quite unmotivated and unaware when it comes to eating, further supporting the use of an AAH when determining food intake amount.

**Mindless Eating**

An exhaustive line of research in eating behaviors has put forward that consumers are quite mindless when it comes to food-related decisions (Wansink & Sobal, 2007; Wansink, 2010; Wansink, 2006; Cohen & Farley, 2008; Cohen, 2008). Distractions during meals further enhance their inability to monitor their eating decisions or to estimate the amount of food they consume. Several experiments highlight this perspective by showing how unaware consumers are when it comes to estimate food intake amount consumed (Wansink, 2004; 2010; Wansink et al., 2004). When served soup in self-refilling bowls (the tubes refilling the bowl were hidden under the table), participants consumed 73% than when served normal bowls (Wansink et al., 2004). This was due to the fact that their consumption was based mainly on visual than physiological cues, as a common response to the question if they were full, was: “How can I be full, I still have half a bowl left?” This unawareness and inability to monitor food intake was further tested in a experiment where the bones form the chicken wings participants consumed were tossed regularly so that the visual cue of food already consumed was not present (Wansink & Payne, 2007). They consumed 34% more food compared to the control condition, yet maintained it was not true. Moreover, research shows that participants are sometimes aware of portion size differences or that the larger portion is bigger than their usual portion (Kral et al, 2004; Rolls et al, 2004). Nevertheless, they still consume more when served more. More surprisingly, even unpalatable food (i.e., 14 days old popcorn) does not spark attention to food intake, as it is over-consumed when individuals are served larger quantities (Wansink & Kim, 2005). Some studies even show that some individuals stop eating when the TV show is over, when they have no time to continue eating or simply because no food remains (Tuomisto, Tuomisto, Hetherington & Lappalainen, 1998).
Authors argue that food-related decisions are of little concern to most individuals and that their involvement is very low. Research shows that individuals take 20 times more decisions than they are aware of (Wansink & Sobal, 2007). This frequency is not compatible with the efforts required to make informed decisions. Hence, it seems quite inevitable to rely on consumption norms in order to have some control in an uncertain situation. This explanation of the use of consumption norms is thus perfectly in line with an anchoring and adjustment perspective of eating. Indeed, this uncertainty principle, reinforced by a low motivation to disentangle it, is a necessary condition in the AAH and other heuristics and knowing the right answer (i.e., dieters) would not require the use of cognitive short-cuts. Hence, using an intuitive decision process like the AAH does fit quite well such a mindless, uncertain and unmotivated state of mind.

The most surprising observation is that individuals tend to deny that they may be influenced by environmental factors (Wansink & Sobal, 2007) and even when knowing this relationship, they are still influenced (Hetherington, 2007; Leone, Pliner & Herman, 2007). Studies show that when participants in the large portion size condition are shown that they consumed more than the control group, usually half of them still deny having consumed more food when asked why this was the case (Wansink & Cheney, 2005; Wansink & Park, 2001; Wansink & Kim, 2005). Even tangible evidence cannot persuade individuals that external cues are as much responsible for their intake as internal ones (de Castro, 2000). It is argued that environmental factors influence food intake at a basic level of which we may not be aware of (Vartanian, Herman & Wansink, 2008). Consistently, individuals usually are not even aware of the decision process they used to reach an estimate (Nisbett & Wilson, 1977), or that anchors may have influenced their judgment, as even experts can fall prey to their subtle influence (Englich, Mussweiler & Strack, 2006). The very definition of heuristics is that they are intuitive decision making processes (Tversky & Kahneman, 1974).

**Conclusion**

The amount of food served is one of the most prevalent and pervasive cues in our eating environment. Unfortunately, the assumptions put forward by authors to understand this effect do not explain what underlying psychological mechanism is responsible. The AAH accommodates and integrates authors' most advocated assumptions to understand the portion size effect, namely consumption norms, limited resources, motivation, time and knowledge, mindless processes and a biological indifference towards food. These assumptions all document how the portion size of food
may be chosen as a guide to determine food intake amount. According to the AAH, a hypothesis confirmation process leads individuals to eventually accept that the food amount they were served is appropriate. This process is strengthened by several anchor consistent information. These factors will be presented next.
Reinforcing Assumptions

**Plate Cleaning Phenomenon**

A very strong reinforcement of the belief that the portion of food served represents an appropriate amount to consume is a hard-wired learned behavior from education: Plate cleaning tendency (Birch, McPhee, Shoba, Steinberg & Krehbiel, 1987; Wansink & Payne, 2008). Research shows that children younger than four years are not subjected to the portion size effect as they tend to rely mainly on physiological cues to determine food intake volume (Rolls, Engell & Birch, 2000). They are quite efficient at responding adequately to their satiety and hunger cues. After the age of five however, children start losing their ability to regulate food intake according to their energy needs and become influenced by the portion size of food as they consume more when more food is served. Hence, forcing a child to clean his plate can be very harmful as it fosters intake responses based on external cues such as the size of a portion or plate. This diminished capacity to rely on internal cues can in turn trigger body weight control problems (Birch & Davison, 2001; Birch & Deysher, 1986). Our tendency to clean our plate can thus be seen as a favoring condition of the portion size effect when food is served to us like in restaurants.

Possible solutions could focus on limiting parental interventions on their child's intake, on re-educating ourselves to rely on internal cues or when possible, to serve ourselves less in the first place. The plate cleaning phenomenon may play an important role in the anchoring process involved in the portion size effect. According to Strack and Mussweiler (1997), anchoring effects are the result of individuals believing that the anchor may actually be the correct response. Information supporting the veracity of the anchor is made easily available. Being educated to accept the whole portion (or plate) as an adequate amount to consume in its entirety may consequently just help acknowledging the anchor and reinforce this hypothesis confirmation process.

**Food Price**

Another valuable reason to accept enlarged portions as appropriate is their lower unit cost. In developed countries income is associated with type and quality of food consumed and less with
total quantity (Jekanowski & Binkley, 2000). Nevertheless, the economical value of foods plays an important role at the individual level in food choice and consumption (French, Jeffery, Story, Hannan & Snyder, 1997; Huang, 1999). Lowering the price of low-fat snacks in vending machines by 10%, 25% and 50% can lead to increased sales of 9%, 39% and 93%, respectively (French, Jeffery, Story et al, 2000). In contrast to the real world, most laboratory experiments do not (yet) require participants to pay for their food. In the first study presented in the empirical section of this dissertation, participants presented foods differing in size and their price estimations were assessed. In the small portion size condition, they were presented half a grapefruit, one bar of a Twix and a 25cl Coke while participants in the large portion size condition were presented the same foods, but twice the size. Price estimations did not differ significantly (2.61 vs. 2.74 €, respectively). These findings may be a result of our expectations of a better price when buying larger amounts of goods.

Given the importance of cost in food-related decisions, the question arises whether portion size effect do occur when individuals have to pay for their meal? A study run in a natural setting (i.e., cafeteria) confirmed that the amount of food can increase consumption independently of price (Diliberti, Bordi, Conklin, Roe & Rolls, 2004). The portion size of a pasta entrée was increased from 248 gr. to 377 gr. while keeping price constant. Food intake increased by 43% and participants all rated their respective portion size to be appropriate and similar to what they usually consume. Interestingly, participants served the larger entrée perceived to have received a better ‘value for (their) money’ than those served the smaller portion.

It makes sense that people would consume more from a larger than a smaller portion, especially if the price for the former is cheaper. The portion size effect may thus be mediated by monetary considerations. Considering that food manufacturers and restaurants who offer family- or super-size packages and promotions (e.g., 3 for 2) do not only increase portion size but also lower unit cost, individuals are really challenged to limit their food intake. Hence, expecting a cheaper price for larger quantities and our quest to always get the best deal, may very well lead us to choose larger amounts of food in order to maximize the value of our money. The price of food may thus be associated with greater anchoring effects (or energy intakes) through the selection of larger anchors (or portions).

**Social Norms**

Social norms may also add to the propensity to accept large portion sizes as adequate
servings. Satiety cannot be defined as an entirely “psycho-physiological” mechanism, as exigencies of cultural history, lifelong personal development and interpersonal relationships may also be contributing factors (Bellisle & Tremblay, 2011). For example, besides physiological signals (e.g., sensory-specific satiety, stomach distension), social norms may also contribute to consumption cessation (Mori, Chaiken & Pliner, 1987). Besides uncertainty of appropriate nutritional intakes, individuals use norms in order to consume a socially acceptable quantity. We have seen, on the example of amnesic patients, that individuals can always make room for more food and that the upper limit of satiety is quite flexible (Rozin et al., 1998; Berry et al., 1985; Herman & Polivy, 2005). Yet, it would be socially unacceptable to go for second servings, as no one wants to appear greedy. Hence, even if they could indulge themselves at every eating occasion, they would be subject to other people's judgment, in the perspective of “you are what you eat” (Bock & Kanarek, 1995).
Complementing Assumptions

In classical AAH paradigms, once the final estimate is produced, the task ends. In eating situations however, individuals' final estimate may still vary. Prior to food intake, individuals undergo a hypothesis confirmation process in order to decide whether the amount of food served is appropriate. This is when the portion size effect (or the anchoring effect) kicks in. Education, social and monetary determinants might reinforce this process. However, given that afterwards they still have to consume their meal, other influences and factors (e.g., sensory-specific satiety or level of consumption monitoring) might still affect their food intake and change the final estimate. Hence, it might be argued that food intake may involve a complementary adjustment process. While the portion size effect might reasonably be explained by the Selective Accessibility Model, it is only a part of the whole food intake process. Hence, in order to grasp a full comprehension of food intake, other factors have to be considered that determine food intake besides environmental influences. The next section will focus on the norms and determinants that may further affect food intake in eating situations including more than one person.

As most research on the portion size effect, this discussion has focused on individual eating situations. This eating context is especially susceptible to enable portion size effects. Although this eating situation is becoming more and more frequent, other norms than the one suggested by the portion size of food may determine or adjust food intake in commensal eating situations.

**Impression management**

Eating in social circles may not only consolidate the appropriateness of the served portion, it may sometimes also suggest amount of food to consume, by setting situational specific consumption norms. Individuals tend to use impression management strategies in order to display a particular image. Self-presentation determines to some extent a person's eating behavior and eating less or being thin is strongly associated with appearing feminine (Chaiken & Pliner, 1987). The
social norm of self-presentation of femininity may thus contribute to adjust intake, by suggesting that a lower percentage of the portion of food should be consumed. The current trend of Western societies promoting an idealization of thinness can define what and how much to eat, and eating lightly is associated with a normal eating pattern, especially for women.

**Modeling**

Centering our consumption on other people is also a way to appear socially acceptable (Goldman et al., 1991). After being deprived of food during 24h, participants were invited to consume food ad lib with an unknown eating companion. Instead of indulging themselves given their hunger and the highly palatable rated food, they modeled their consumption on their eating companion, who consumed a very little amount of food. This modeling effect has been shown in several studies and authors argue that participants, instead of relying on physiological cues, use the social norm set by others to determine their intake (Rosenthal & McSweeney, 1979; Herman & Polivy, 2005; Goldman et al., 1991).

**Social Facilitation**

Another norm stemming from the social environment (i.e., when eating with friends and/or family members) is the amount of food consumed by other people. This influence is called social facilitation (Clendenen, Herman & Polivy, 1994; de Castro & Brewer, 1992; de Castro, 1994). This social norm may affect as well the anchoring as the adjustment process of food intake. Regarding the first process, the amount of food eating companions choose or serve themselves may affect how much food we decide to put on our plates. Regarding the adjustment process, the presence of other may increase the time spent eating and thus the time available to still consume another bite. The probability that one of the eating companions is a big consumer (e.g., habitual plate cleaner, goes for seconds or dessert) is relatively high and may influence us to indulge ourselves a little more than usual. The distraction and enjoyment of a family dinner for example decreases consumption monitoring. In consequence, fewer resources are available to produce information that may dismiss the appropriateness of the size of the portion of food and lead us to unconsciously accept the portion of food as being adequate.
**Meal time**

Eating with multiple eating companions occurs usually on weekends or evenings. Weekends are usually synonym with a more relaxed and indulging approach of the day. Hence, it is not surprising that individuals tend to consume 20% more food than on weekdays (de Castro, 1991). Similarly, considered that evenings are more constraint free than the rest of the day, research has shown that individuals consume 150% more food than at breakfast and 46% more than at lunch. Although the recommendation is to eat breakfast like a king, lunch like a prince and dinner like a pauper, constraints and cultural norms of our contemporary society tend to favor a greater allocation of time to the latter meal. Another explanation for this increase in energy intake is that evening and weekend meals are usually consumed in the presence of others compared to the quick lunch sandwich at work (Sobal & Nelson, 2003). Hence time constraints and the greater number of eating companions may favor bigger meals and less attention to monitor our intake. In other words, time of the day and of the week may affect how much food is served (i.e., anchoring) and consumption monitoring (i.e., adjustment) may lead to increased energy intakes.
Non Environmental Determinants

Although social and environmental factors play an important role in determining food intake, our waist lines and eating patterns are still for the most part determined by non environmental factors, namely genetic, metabolic and regulatory. Indeed, cognitive processes do not account for an entire model of food intake. Although in a food abundant society environmental factors mainly influence food choice and intake, these explanations and factors have to be considered in a wider model of food intake regulation. Genetics, culture, food price, social norms and biological mechanisms account for individual susceptibility and differences in response to food cues. The last part of this discussion will take into consideration the relative importance of these non environmental determinants and how they complement food intake regulation.

**Heredity**

An obesogenic environment favors increased energy intake and decreased energy expenditure. Although we are all exposed to the same stimuli, there are individual differences in the response of the body to these stimuli. Large family and twin studies in different populations show that BMI, body fat, weight and height are largely inherited (50-80%: Korkeila, Kaprio, Rissanen & Koskenvuo, 1991; Stunkard, Foch & Hrubec, 1986; Bouchard, Savard, Depres, Tremblay & Leblanc, 1985). Hence, our genetic pool determines a certain body level that may remain relatively stable throughout our lives. However, we have witnessed during the last decades how in developed countries, and especially in the United States, people's body weight has increased markedly. Mutation or selection pressures cannot account for the magnitude and pace of these changes.

In conclusion, while the environment we live in has considerable impact on our eating behaviors, the fact that we may become obese may also be due to our genetic pool and the way our genes programmed our body to deal with excess energy intake. When an individual is genetically predisposed to become obese, a food abundant environment may only trigger and accelerate sharp increases in body weight (Ravussin & Bouchard, 2000). It is indubitable however, that our genes are still largely adapted to the nutritionally restrictive environment of our ancestors and that they are challenged by a food rich and abundant environment, promoting moreover decreasing opportunities

**Compensation**

Several other non environmental conditions may also contribute to understand the increase in weight gain. Biological mechanisms of homeostasis are very effective to warn an individual to compensate for deprivations of food by inducing larger intakes at the subsequent occasions (Caputo & Mattes, 1992). In contrast however, following overfeeding they are less responsive and efficient to induce compensatory under-eating (McKierman, Hollis & Mattes, 2008). In other words, while the human organism has excellent physiological defenses against depletion of energy, it is weak to guard against accumulation of excess energy, leading to excess energy storage (and obesity) in a food abundant environment. Indeed, most genes identified to play a role in human obesity mostly influence food intake rather than energy expenditure (O'Rahilly & Farooqi, 2006).

**Pregnancy**

It has been shown that under-nutrition during certain stages of pregnancy can result in intra-uterine growth retardation (Hales & Barker, 2001). As a consequence, the human organism is programmed to store energy from food more efficiently and low birth weight babies may develop obesity at adult life, especially in food abundant societies. This is especially the case in developing countries where individuals were born in food scarce environments and are at increased risk to become obese given the prospect that these countries (South Pacific region, Brazil, China, many countries in the Near East and North African region) will transition to rapid income growth and falling real prices for food (Schmidhuber & Shetty, 2005).

**Homeostasis**

Although we tend to be in a zone of biological indifference, food intake is also in part the result of homeostatic processes. Consuming food provides the necessary energy to cover energy and nutrient needs, required for a normal functioning of the body. In the early history of intake regulation, simplistic models promoting only a single factor to be responsible for food intake have been suggested (see de Castro & Plunkett, 2002). Although the suggested factors were all valuable, the peripheral model of Walter Cannon, the glucostatic model of Jean Mayer, the lipostatic model of
Kennedy and the thermostatic model of Brobeck did not cover food intake regulation in its entirety. These models posited that food intake was controlled by a negative feedback loop from physiological factors and hormones, like leptin, levels of blood glucose or ghrelin (Campfield, Smith, Rosenbaum & Hirsch, 1996; Friedman & Halaas, 1998). A change in the level of these factors leads to energy intake in order to restore the homeostatic balance. Genes are argued to affect the defended level of these factors. The positive aspect of these models is that they are parsimonious and have received empirical support in animals (Bray & York, 1979; Williams, Bing, Cai, Harrold, King & Liu, 2001). However, food intake is much more complex in humans (Prentice, 1998; Yao & Roberts, 2001). According to these models, body weight and food intake should remain relatively stable over long periods of time, and increased intake at one meal should lead to decreased intake at subsequent meals. Observational data shows however no such meal-to-meal compensation and the obesity epidemic is a witness that changes in body weight are not compensated (de Castro & Kreitzman, 1985). Indeed, although there is no dispute that physiological factors do signal to the individual that an energy deficit is present and contribute to energy intake (Friedman, 1999; Fan, Boston, Kesterson, Hruby & Cone, 1997), these homeostasis-type models do not explain however why food intake has increased in recent years nor why individuals consume more food when faced with larger quantities. Therefore, it is necessary to understand how the changes in the environment are able to override and combine with the homeostatic body weight and food intake regulation system (Yeomans, Blundell & Leshem, 2004; Lowe, van Steenburgh, Ochner & Coletta, 2009).

**Stomach Size**

Research has shown that gastric capacity is greater in bulimic and obese patients who binge eat relative to controls and those who do not binge eat (Geliebter, Melton, McCray et al, 1992). However, it is unclear whether binge eating is a cause or a consequence of a larger stomach size and lower sensitivity to satiety. Yet, frequent binge eating can foster a higher capacity of the stomach to stretch and in consequence lessen negative feedback from the stomach, thereby increasing intake volume in general and during these episodes, while also promoting further binge eating (Geliebter et al, 1992). Research has shown that food amount ingested is significantly correlated with emptiness of the stomach (de Castro, McCormick, Pedersen & Kreitzman, 1986). Moreover, it is established that genetic factors play a certain role in the degree of stomach filling (de Castro, 1999). In other words, heredity determines in part how hungry an individual feels. In consequence,
tendencies to binge eat and a genetic susceptibility to feel rarely sated may be a very explosive duo.

Given that genes and an increased gastric capacity can delay satiety responses, enlarged portions of food may be more easily accepted as appropriate and lead to increased energy intake. Binge eating may delay the adjustment process in an anchoring perspective of food intake and reinforce the hypothesis confirmation process regarding the veracity and appropriateness of the food portion. This may be especially harmful when served and used to consume frequently oversized portions as it may add to the information rendered accessible during the hypothesis confirmation process and increase familiarity with inappropriate large amounts of food.

**Stress**

With years passing by, people have better education, civilized living, social life and more exciting hobbies. Through progress of technology life has become easier. Nevertheless, in our contemporary society, individuals may be “sometimes” under stress due to multiple pressures (e.g., work performance, success, perfect fitness, immaculate appearance) often demanding to achieve the impossible. Stress is a factor that can trigger consumption, over-eating or food intake cessation (Cartwright, Wardle, Steggles et al., 2003; Oliver & Wardle, 1999; Oliver, Wardle, & Gibson, 2000). Unrestrained eaters tend to limit their intake when stressed. By contrast, highly restrained eaters tend to overindulge with high-fat, high-sugar and highly palatable foods. This craving for comfort foods is suggested to be a bio-physiological response to neutralize increased levels of (glucocorticoids and corticotrophin-releasing) hormones, that affect reward and emotional processing in the amygdala and other cortical areas (Dallman, Pecoraro, Akana et al., 2003; Dallman, Pecoraro & la Fleur, 2005). This “coping” strategy may however have more detrimental than beneficial effects, as recent research shows that stress-associated hormonal troubles may facilitate the development of overweight and obesity due to fat deposition in the abdominal region (Pasquali, Vicennati, Gambineri, & Pagotto, 2008). Besides stress, lack of adequate sleep may also favor increased appetite and snacking during nighttime.

In conclusion, stress plays an important role in food choice as well as in food intake. Regarding this last behavior, stress-associated eating may contribute to adjusting intake in a perspective of an anchoring and adjustment process of food intake. While the portion size of food can be viewed as an anchor, we assume that the decision whether the whole portion (or less or
more) will be consumed may depend in part by the level of stress an individual is subjected to. Further research is necessary to determine whether stress decreases consumption monitoring and facilitates the hypothesis confirmation process.

Conclusion

There is no doubt that food intake is regulated at a basic homeostatic level. However, the sharp increase in overweight and obese people cannot be explained by sudden changes in these regulation processes or by genetic mutations. Our internal processes are still adapted to an ancestral environment of food scarcity and are being challenged by our contemporary food abundant environment. It is therefore urgent to understand how environmental factors influence our food intake and moreover how we may prevent these influences. The next chapter of this discussion will focus on dietary prevention strategies, based on an anchoring and adjustment perspective of eating.
Chapter 7

Practical Implications
Anchor-Based Prevention

The scientific contribution of this dissertation was to unravel the underlying mechanism that determines why our food intake is influenced by enlarged portions of food. Unrestrained individuals consume more food because they anchor their energy intake on the amount of food that is served to them and believe that this quantity is an appropriate and normal amount to consume. The ubiquitous effect of oversized portions of food is substantiated by research indicating that portion size effects are indiscriminate of people, eating location and food type (Wansink, 2004; Young and Nestle, 2002). This raises the question whether portion size effects can actually be prevented. Providing individuals with more information on nutrition aspects does rarely help to regulate food intake or lead to healthier food choices. Research has shown that portion control and calorie counting is difficult to sustain (Herman & Polivy, 2003), and while only 1 in 20 dieters successfully maintains weight loss (Hill, Peters, Jortberg & Peeke, 2004), people also do not recognize the relevance of some weight loss tips or lack the motivation to implement them (Trottier, Polivy & Herman, 2009; Dickson-Spillmann & Siegrist, 2011). These observations are consistent with research showing that anchoring effects are very difficult to prevent and usually result in failures (Wilson, Houston, Etting & Brekke, 1996). Do these findings imply that no dietary prevention strategy can limit the effect of enlarged portions on food intake? This chapter aims at providing a practical contribution to this dissertation, by presenting potential strategies to prevent portion size effects. Understanding how environmental influences work and can be prevented is important for academic, health-related and consumer welfare reasons (Wansink, 2004; Cutler, Glaeser & Shapiro, 2003). Indeed, moving from basic to translational research can be very valuable for individuals on a day-to-day basis (Wansink, 2010).

Discrediting the Anchor

Literature on decision heuristics shows that being aware of this influence or knowing that the anchors are chosen randomly does not diminish its impact (Tversky & Kahneman, 1974; Mussweiler & Strack, 1999). Even experts are not protected against its influence (Englich, Mussweiler & Strack, 2006). Similarly, individuals noticing that the amount of food that is served to them is different and larger than their usual portion do not adapt their food intake accordingly (Kral,
Roe & Rolls, 2004; Rolls, Roe, Kral, Meengs & Wall, 2004). Dieters, trained nurses and nutrition experts are also influenced by these subtle environmental cues (Chandon & Wansink, 2007; Wansink & van Ittersum, 2003; Wansink, 2006; Wansink, van Ittersum & Painter, 2006). For example, they serve themselves and consume more ice cream when given larger bowls. Hence, information on this influence may not be the best solution to prevent portion size effects. By contrast, the literature on decision heuristics has put forward several practical strategies that may help to reduce anchoring effects. Although they work effectively in classical anchoring paradigms where individuals have to produce estimates of heights, freezing points of beverages, car prices or length of rivers, no research has applied them yet to nutritional behaviors. The goal of these strategies is usually to find a way to discredit the belief that the suggested anchors are accurate.

In this view, research has shown that inducing individuals to consider that initial beliefs are incorrect improves human judgements (Lord, Lepper & Preston, 1984). Before and during the hypothesis confirmation process, anchor congruent information is rendered available and more easily accessible compared to incongruous information. Implementing strategies that could render anchor conflicting information more available to balance out or discredit the available information on the accuracy of the anchor is thus critical to prevent biased estimates (Mussweiler, Strack & Pfeiffer, 2000). This has been shown in a study where participants were anchored with the last two digits of their phone number to estimate the likelihood a republican candidate would win the next presidential election. No anchoring effects were found when participants were asked, before giving an estimate, to list one reason why the candidate may not win, in the cases where this contradicted the anchor implications (i.e., when the probabilities/digits were over 50%; Chapman & Johnson, 1999). Hence, only considering a single reason that was inconsistent with the anchor was enough to lead to estimates that were unbiased towards the anchor and thus reduce its influence. Another way to balance out the information on which an estimate is based could be to ask individuals to consider the opposite, namely that the anchor is incorrect. For example, auto mechanics were asked to estimate the value of a car (Mussweiler, Strack & Pfeiffer, 2000). Before giving their final estimate, they were asked to produce reasons either as to why the suggested anchor (i.e., price) was acceptable or inappropriate. Anchor effects were only found when they were asked to produce congruent information (i.e., that the price was acceptable). The effectiveness of this strategy has been shown in laboratory and natural settings.

A similar strategy is an approach called ‘dialectical boot-strapping’ (Herzog & Hertwig, 2009). It suggests to make a first estimate, to pause, to assume that this first guess was off the mark,
to consider why and then to use this new perspective to make a second estimate. Averaging both estimates increases the chances that this newly calculated estimate will be more accurate than the original answer. Consistently, averaged judgements of a group of independent individuals will generally outperform the judgement of a lone individual, regardless of her or his expertise (Carpenter, 2011).

Discrediting the appropriateness of an anchor is thus an effective strategy to reduce anchor effects when estimating for example car prices or election probabilities. Applied to food intake situations, individuals would have to consider that the enlarged portion they were served is inappropriate. In this view, information about appropriate amounts of food to consume might come in handy. Indeed, individuals have become quite familiar with large food portions and containers and tend to misinterpret hefty portions as appropriate individual servings (Herman & Polivy, 2005; Wansink, 2004, 2010; Geier, Rozin & Doros, 2006; Schwartz & Byrd-Bredbenner, 2006). Yet, further research is needed to accredit these strategies in eating situations. Indeed, a wider array of factors is involved in food intake compared to verbal judgements. It is improbable that individuals take into account for example the sensory properties of a car when estimating its value. Moreover, we tend to strive for the best monetary value and larger portions usually have a lower unit cost. Future studies should examine what amount of information and conditions are necessary to reverse beliefs that the portion served is inadequate.

**Self-Generating the Anchor**

The above mentioned strategies are based on the assumption that individuals do enter into contact with anchors. Hence, they might be applied when not seeing a portion of food before deciding amount of food to consume is impossible. In other words, an individual might try to consider that the portion of food served is inappropriate when he has not had the opportunity to produce a food intake estimate before entering the eating situation (i.e., seeing how much food he was served).

A different line of prevention strategies is based on the assumption that an individual can gauge how much he will consume before sitting down to eat. Unrestrained consumers do not enter an eating situation with a clear consumption norm as to how much food to consume, in contrast to dieters who use personal norms (usually based on diet programs or nutrition experts recommendations) to determine their food intake (Herman & Polivy, 2005). Inducing unrestrained
consumers to formulate concrete food intake intentions would emulate dieters' eating behaviours. In other words, individuals would self-generate an anchor (i.e., consumption norm or portion size). Activating self-regulatory concerns has been shown to lead to reduced intakes with large packages as they elicit more deliberation compared to smaller ones which remain relatively undetected (Coelho do Vale, Pieters & Zeelenberg, 2008). Research on children's intake (3-5 years) has shown that they consume less food when allowed to serve themselves than when served large portions (Fisher, Rolls & Birch, 2003). Consistently, we showed that undergraduate students consumed 82% less from enlarged portions of snacks when they determined intended food intake amount beforehand compared to participants entering the eating situation without a consumption norm. Instead of relying on the norm set by the portion of food, they complied with their self-generated norm. Hence, the present findings point out that taking control of one’s eating behavior by formulating concrete intentions could be an antidote to limit the portion size effect. Indeed, goal-setting can be effective in changing eating behaviors and consumption (Schnoll & Zimmerman, 2001). Interestingly, some effective prevention strategy aimed at reducing food intake and body weight can actually be interpreted in terms of replacing the norm set by the amount of food served by providing new anchors (i.e., structured meals, meal replacements, plate models, portion size measurement aids, Weight Watcher: Wing, Jeffery, Burton, Thorson, Nissinoff & Baxter, 1996; Noakes, Foster, Keogh & Clifton 2004; Anderson, Freeman, Stead, Wrieden & Barton, 2008; Byrd-Bredbenner & Schwartz, 2004).
Anchor-Based Similar Prevention

These strategies all require that an individual mindfully takes control of his eating behaviours. They entail a great amount of effort and responsibility, as food-related decisions are made on a daily basis. A cutoff from hard-wired routines where we were used to mindlessly or intuitively accept the amount of food served as being appropriate requires awareness of our energy intake and of the factors might influence us. In this view, authors suggest to change our food and eating environment as a more effective strategy (Hill & Peters, 1998), as relapses and slippage are quite common. This is an important observation, as it might be useful for individuals to know that they can act on a personal level and that small changes in the environment can help to control food intake without the burden of constant monitoring. Indeed, relying only on willpower and cognitive control may sometimes not be enough (Bell & Marshall, 2003; Boon, Stroebe, Schut & Jansen 1998; Lowe, 1993). Therefore, acting on the environment may alleviate some cognitive burden and help avoiding relapses. The environment can work for or against us. The last part of this chapter will review some of these recommendations and how they relate to an anchoring and adjustment perspective of eating.

Commensal Eating and Attitude towards Food

In Western societies, opportunities and conditions for independent life styles are more and more made possible and individual eating situations can be seen as a good example of this culture. Individuals have now the opportunity to embrace nutritional freedom, but also have to take responsibility for their (informed) food-related choices. This has led to different eating situations and attitudes towards food.

Commensal Eating

Research shows that more and more individuals are eating alone (Sobal & Nelson, 2003). This individuality of eating is more exacerbated in the United States than in Europe. France for example is the country where time spent eating has declined the least and where most meals (80%)
are consumed with one or more eating companions (Warde, Cheng, Olsen et al, 2007; Poulain, Romon, Barbes et al, 2003; Poulain, 2002). Yet, the obesity epidemic is more accentuated in the US than in France. Hence, authors suggest that commensal patterns of eating may be as effective (if not more) than increasing information on nutrients, energy and exercise in regulating food intake and lowering obesity levels (Fischler, 2011). This perspective is substantiated by the fact that family dinners are associated with fewer social, educational and nutritional problems in adolescents (Ackard & Neumark-Sztainer, 2001; Allen, Patterson, & Warren, 1981).

However, this assumption is not shared by research showing that food consumption increases proportional to the number of eating companions (de Castro, 1994; 2000). It may be argued that other eating companions provide further information about the accuracy or appropriateness of the amount of food one was served. In large groups, there is always an increased possibility of the presence of a big eater. This may give even more credit to the appropriateness of the own food portion and lead to excess intake. By contrast, an eating companion eating lightly may act like information inconsistent to the own anchor and force an individual to rethink the appropriateness of his meal. Indeed, individuals consume more food when alone than in company of a companion eating minimally (Pliner & Bell, 2009). Eating together may thus help to reinforce or discredit the accuracy of the portion size of food served.

**Attitude towards Food**

In conclusion, it may probably not be just the number of eating companions that may explain the differences in overweight and obesity rates between both continents. Indeed, there are marked differences between how food and eating is perceived in the United States and in Europe, like Italy or France for example. While the former nation focuses on health concerns and nutrients, in Italy or France individuals focus on the quality (e.g., freshness, taste) and variety of foods (Fischler & Masson, 2008). A multinational study has shown that, compared to French men and women, a higher percentage of Americans would prefer consuming an inexpensive nutrient pill to eating or would prefer for the same price to spend a week in a luxury hotel with average food over a modest hotel with gourmet food (Rozin, Fischler, Imada, Sarubin & Wrzesniewski, 1999). The French tend to experience less stress and more pleasure when eating, as they focus more on the experience of eating compared to Americans who focus on the consequences. This is substantiated by the fact that Americans eat faster as observational data shows that they spend an average of 13.2 minutes eating at McDonald’s compared to the French who spend an average of 22.3 minutes
(Rozin, Kabnick, Pete, Fischler & Shields, 2003). In another study, when Parisians were asked how they knew when they were “through eating dinner”, they responded when they felt full or the food did not taste good anymore, hence two internal cues of meal cessation, satiety and sensory-specific satiety (Wansink, Payne & Chandon, 2007). Chicagoans by contrasted responded with two external cues: when their plate was empty or when the TV show ended.

Indeed, this health vs. pleasure opposition has been shown when individuals were asked how they would like to settle the bill of a dinner with friends. Half of the Americans wanted to pay only for what they ate and drank, while two thirds of the Italians and French preferred to divide the bill equally. Despite being more knowledgeable about food content and more concerned about their health when eating, a higher percentage of Americans are however overweight and obese. Hence, in nations where the pleasure of food and sharing and eating together is more widespread, lesser health related problems due to obesity are observed (De Saint Pol, 2010).

In conclusion, further research is needed to understand whether it is commensal eating or the attitude towards life and food of Italians and French that help them regulate food intake and have smaller waist lines than Americans. Interventions should probably focus more on changing our approach to life than to our nutrition. Promoting commensal eating may not only benefit our nutrition, but also our knowledge of different cultures and promote intercultural contact.

**Energy density**

Commensal eating and finding pleasure in food may also get us in touch again with our physiological signals and needs. Indeed, we have seen that internal cues are generally less important than cognitive and visual norms to determine food intake (Herman & Polivy, 2005). Hence it is not surprising that studies show that energy intake of individuals increases when foods are more energy dense (Kral et al, 2004). This increased amount of energy is not noticed by our body as we do not compensate with decreased intake when served food high in energy compared to a same amount but less energy dense. Physiological signals do not respond to increased energy-density, but to the (visual) amount of food served. This has been further shown in a study where volume of foods was manipulated by varying air content while keeping however weight, energy density and fat constant (Osterholt, Roe & Rolls, 2007; Rolls, Bell & Waugh, 2000). Logic (and physiological signals) would suggest that food intake should be identical across conditions. Results show however that participants served the larger amount of food consumed more than their counterparts, suggesting
that the decision about food intake was based on volume (i.e., the visual consumption norm or anchor) rather than on gram weight. Internal cues were overridden by the visual cue referring to the amount of food, on which participants 'anchored' their consumption.

Implications for dietary prevention strategies aimed at reducing energy intake would be to decrease energy density of foods. This can be achieved personally by adding water or by food manufacturers by developing calorie or energy reduced foods, or simply by buying water rich foods (e.g., cucumber, tomato) instead of high fat foods (e.g., pizza, milkshakes). Given that individuals base/anchor their consumption on volume rather than on energy density, they would continue to consume same amounts of food, but less energy. The effectiveness of reducing energy density was shown in a study where a popular fish dish was substantially reduced in fat and energy (Stubenitsky, Aaron, Catt, & Mela, 2000). Participants not only consumed less energy, but ratings of liking, palatability and appearance expectations and intended purchase did not differ from the control condition. Research shows that vegetables, fruits and broth-based soups significantly help body weight regulation (Rolls & Barnett, 2003; Rolls, 2005). In short, this strategy would fool the eye and the stomach by believing we consume our typical portions of food while substantially reducing calorie intake. Moreover, it might be a better strategy than relying on diets foods as research shows that individuals tend to over-consume healthy and diet foods and in consequence ingest more calories compared to regular foods (Smeets & van der Laan, 2011; Provencher, Polivy & Herman, 2009; Wansink & Chandon, 2006; Roberto, Larsen, Agnew, Baik & Brownell, 2010). For example, when served snack foods labeled as “low fat”, participants consumed 34% more calories (even after having subtracted calorie reduction) than when no label was applied (Wansink & Chandon, 2006).

Cooking

Finally, on a more comical note, one could advocate that the obesity epidemic has started since we are spending less time cooking and preparing food. Given that food has become more convenient and accessible, we do not need to spend much effort to eat (e.g., microwaves, delivery). Hence, making a point that we will only consume food that we prepared ourselves may help to reduce indulging ourselves on every food opportunity we come across. In other words, eat everything you want as long as it was you who prepared or cooked it. This would force us to self-generate our own portion sizes and to not rely on suggested (and potentially biasing) consumption norms.
Conclusion

The studies presented in this dissertation suggested that it might be helpful to reduce container sizes and/or adapt them to the size of portions. Indeed, a small quantity of food appearing at the bottom of a large bag is over-consumed compared to the same quantity appearing in the middle of a smaller bag. Reducing food item size when possible is also an effective prevention as it alters the perception of the appropriate quantity of food to consume and provides more cut off points at which a person could reassess his energy intake. Other environmental interventions may think of reducing portion sizes and limiting access to convenient foods, at home, schools or workplaces. As with every change in life, the decision to take control of our food intake should probably not be based on an external motive to conform to a culturally and socially set body ideal, but preferably on a desire for a healthy body weight. However, clarity has to be made that taking control of our nutrition is not a substitute for achieving control in our life in general (i.e., anorexic).
Chapter 8

Limitations and Future Research
Directions
The behavior under investigation in this dissertation concerned food intake. For humans, this behavior is much more complex than in any other species. It involves psychological, metabolic, physiological, sensory, genetic, social and environmental factors. Laboratory studies usually standardize the eating situation and control for concurrent influences in order to isolate the effects of one or more factors. However, it is important to acknowledge that eating is not an isolated act. Although we tried in most of our studies to reproduce a natural eating environment, there will always be limitations when investigating food consumption. This chapter will discuss some of them and suggest directions for future research.

**Anchoring and Adjustment Heuristic**

An anchoring and adjustment perspective of eating suggested in this dissertation certainly warrants further evidence, given that the classical AAH paradigm was applied to a food intake intentions situation. Although, the present findings were congruent with existing research examining whether the removal or modification of portion size would lead to food intake changes in actual consumption settings (Barkeling, Linné, Melin & Rooth, 2003; Linné, Barkeling, Rössner & Rooth, 2002; Osterholt, Roe & Rolls, 2007; Rolls, Engell & Birch, 2000; Raynor & Wing, 2007), the absence of actual food intake might still represent a limitation. Participants' difficulties in estimating what they would eat in an imagined lunch might be greater than their already existing inabilities to accurately estimate portion sizes and food intake (Schwartz & Byrd-Bredbenner, 2006; Hernandez, Wilder, Kuehn et al., 2006; Godwin, Chambers & Cleveland, 2004). Although it has been shown that sensory and physiological sensations that arise when consuming food are not as important as cognitive factors (Herman & Polivy, 2005; Wansink, Painter & North, 2004; Wansink & Kim, 2005), future research should try to apply the anchoring paradigm in a real food intake setting.

Future studies might consider blindfolding participants in order to remove the visual influence of the size of the portion. This would replicate the control condition in classical AAH paradigms, where participants are not presented with any anchor and are only asked to produce and
estimate. However, given that this situation might be a little unnatural for participants, researchers should consider blindfolding all participants in order to standardize the eating context. In this view, two thirds of the participants would be served either a small (condition small portion) or a large portion (condition large portion) before being blindfolded, while the other third of participants would be served a large portion of food after being blindfolded (condition unknown portion).

**Restrained Eaters**

An anchoring and adjustment perspective of eating is based on the assumption that individuals are uncertain about their food intake and do not have personal consumption norms of intake. Hence, they rely on visual cues and cognitive short-cuts to determine the amount of food they will consume. Consistently, our studies and most research on the portion size effect usually exclude individuals that are restrained eaters or on a diet to lose or gain weight. These individuals bring personal norms or dietary recommendations (e.g., an upper limit to energy intake) into the eating situation in order to gauge and regulate their food intake (Herman & Polivy, 2005). Given that our samples were limited to unrestrained eaters, it is not possible to generalize our findings to all consumers. Future research might consider whether the size of food portions influences food intake of restrained eaters and dieters. It would be interesting to examine how these consumers would deal with information that should be inconsistent with their personal consumptions (i.e., enlarged portions vs. calorie controlled portions). A further step would then be to also take into account anorexic and bulimic people.

**Physiological State**

This uncertainty principle is based in part on the fact that individuals tend to be in a zone of biological indifference, where they are neither genuinely hungry nor sated (Herman & Polivy, 2005). Hence, eating behaviors are more a result of environmental influences than of physiological needs. Food intake may then be influenced by the portion size of foods through an anchoring process. Our findings might thus well be generalized across individuals living in food abundant societies, but might also be limited to these environments. This raises the question whether this influence and decision process might still be operational when individuals are genuinely hungry.
Although there might be some ethical implications to ask people to deprive themselves of food for a longer period of time, it would be interesting to examine whether this cognitive short-cut would still override physiological signals.

**Food Supplier**

Another assumption of an anchoring and adjustment perspective of eating is that individuals undergo a hypothesis confirmation process in order to validate the appropriateness of the amount of food served. In this view, the person serving or preparing the food as well as the eating location should provide valuable information for this process. Similarly, in laboratory studies, the experimenter is viewed as “the cook” and should contribute to a participant's search for confirmatory information. Indeed, if it is our mother, a restaurant chef or a researcher, they are all assumed to be maximally informative (see Grice’s, 1975, maxim of quantity). Indeed, individuals generally believe that the amount of food that is served to them is appropriate (Wansink, 2004). Hence, it would be interesting to examine whether manipulating the validity of this source of information could lead participants to disbelief in the appropriateness of the amount of food served and prevent anchoring effects in eating situations.

**Food Type**

This trust that restaurant chefs or experimenters will know how much food is appropriate to serve and consume extends to the type and quality of foods. Indeed, there is always a kind of obligation to serve high quality, highly palatable and tasty foods. In our studies, we did not budge from this (implicit) expectation and served participants cookies, candies or M&M's. Although one study showed that participants food intake increases even when large quantities of unpalatable food (i.e., 14 days old popcorn) are served (Wansink & Kim, 2005), it may be argued that portion size effects could be limited to convenient and tasty foods. Indeed, individuals have an innate preference and acceptance for sweet foods (Steiner, 1977). Future studies could focus on examining whether utilitarian foods (e.g., bread), bitter foods (e.g., lemon juice) or spicy foods (e.g., chili con carne) might elicit an anchoring process to determine energy intake.
Long-Term Consumption, Age and BMI

Finally, all our studies focused on short-term energy intake, undergraduate or elementary school students and on normal-weight participants. Although portion size effects are sustained as long as 11 days (Rolls, Roe & Meengs, 2007) and occur in natural settings (i.e., movie theater; Wansink & Kim, 2005), further research might want to replicate findings for long-term energy intake in individuals of all ages, gender and BMI groups living in varied geographic locations. Research has shown that in elderly subjects sensory acuity is decreased (Murphy, 1993; Schiffman & Zervakis, 2002) and that overweight individuals are more sensible to external cues than normal-weight individuals (Herman, Olmsted & Polivy, 1983; Johnson, 1974; Nisbett, 1968). Finally, it is important to acknowledge that consumption involves as much food quantity as eating frequency, and that both need to be assessed (Sudman & Wansink, 2002). A larger intake due to increased portion sizes might be compensated not only in a subsequent intake, but also in the number of subsequent eating occasions.
“Liberté, égalité, fraternité, manger”.

Paul Rozin
Conclusion
In ancestral environments, food scarcity was a major issue. In contemporary societies by contrast, food abundance is the new ordeal. Industrialization, the modernization of agriculture, food distribution, storage and marketing has brought along a surplus of food, produced at a lower cost and energy need (Bruinsma, 2003; Smil, 2004). Food has become available in larger quantities, can be accessed with lesser effort and consumed at lower prices. Opportunities to consume food have become ubiquitous and individuals are challenged to not succumb to these temptations (Hill & Peters, 1998).

The recent increase in overweight and obese people questions whether this epidemic might be the result of changes in our eating behaviors and food intake regulation. Should our food intake not be entirely determined by physiological cues like stomach content, energy needs, glucose level or simply hunger and satiety? If this was the case, then the increased consumption of food would be caused by a genetic mutation or by a change in the neural and hormonal hunger centers. However, this explanation is not scientifically plausible. The rapid emergence of this increase in body weight cannot be explained by changes in genetic, metabolic or regulatory factors. While our metabolic and neural systems are very effective to defend the lower limit of body weight and adiposity, they are relatively ineffective in defending an upper limit (Caputo & Mattes, 1992; McKierman, Hollis & Mattes, 2008; O’Rahilly & Farooqi, 2006). Indeed, we are witnessing since a few decades a rapid and nearly global increase in energy intake as shown by the increasing percentage of overweight and obese people (World Health Organization, 2003; De Saint Pol, 2010; Drewnowski & Specter, 2004; Lobstein, Rigby & Leach, 2005).

Authors argue that major changes in the food and eating environment may play a decisive role in leading people to excess energy intake and decreased physical activity (Drewnowski & Rolls, 2005; Hill & Peters, 1998). Research has identified many environmental factors that subtly influence our food intake, with the portion size of foods being one of the most prominent (Wansink, 2004). Increases in food portion sizes can be seen in restaurant and home meals, supermarkets and recipes (Young & Nestle, 2002; 2003; Schwartz & Byrd-Bredbenner, 2006; Wansink & Payne, 2009; Rolls, 2003; Nielsen & Popkin, 2003; Smiciklas-Wright, Mitchell, Mickle, Goldman, & Cook, 2003). The ubiquitous effect of oversized portions on food intake is substantiated by research indicating that portion size effects are indiscriminate of people (e.g., gender, BMI, age, status...),
eating location (e.g. supermarkets, restaurants, fast-foods, recipes...) and food type (e.g. burgers, pasta, muffins...; Wansink, 2004; Young and Nestle, 2002). Yet, although the effect of enlarged portions is a well-documented phenomenon, no research has provided conclusive evidence of the underlying mechanism that may explain this effect (Wansink, 2004; Kral, 2006; Fisher & Kral, 2008). This dissertation aimed to fill this gap.

Generally, an individual takes a decision (consciously or unconsciously) in order to determine food intake volume. Literature on decision making processes has provided a lot of insight into individuals' cognitive processes. Some of this research has suggested that people tend to use cognitive short-cuts in order to simplify a situation, where too much stimulation and information is present and costs of an informed decision are too high (Tversky & Kahneman, 1974). The eating context may well be compared to such a situation. While restrained eaters have personal norms (e.g., Weight Watcher points...), unrestrained eaters, in contrast, do not tend to put much thought into their food intake (Herman & Polivy, 2005; Wansink & Van Ittersum, 2007; Wansink, 2004). Given the eating frequency, health policies and recommendations, difficulty in interpreting food labels, distractions (TV, chat...), uncertainty about nutritional needs, ability to compensate under- but not over-nourishment, complexity and abundance of nutritional knowledge, such decisions require motivation, effort, time and cognitive resources (Rothman, Housam, Weiss et al., 2006; Hill & Peters, 1998). Contemporary societies have produced a nutritional cacophony, where diet recommendations, proscribed and prescribed foods, nutritional information and labels, health policies and advertisements are mainly contradictory, leading individuals do not have a clear understanding and view of what and how much food they should consume (Fischler, 1990; 1993). Relying on cognitive short-cuts (heuristics) may simplify food-related decisions of overwhelmed consumers, especially given the time-cost efficiency and people's tendency to be satisfied with an approximate rather than optimal solution (Gigerenzer, Hertwig & Pachur, 2011). Hence, the decision process regarding the appropriate amount of food to consume may be compared to an evaluative judgement situation, mainly determined by cognitive short-cuts, visual biases and consumption norms (Herman & Polivy, 2005; Wansink, 2004, 2010; Wansink, Painter & North, 2004).

In an eating situation, the size of the portion is considered valuable information regarding the amount of food to consume (Wansink, 2004; 2010; Herman & Polivy, 2005). In this view, this
dissertation suggests that the decision process involved in food intake (and particularly the portion size phenomenon) is maybe best interpreted in terms of an anchoring and adjustment heuristic/process (AAH). The AAH is a cognitive bias or shortcut that influences the way people intuitively assess probabilities thereby simplifying otherwise difficult problems or tasks (Tversky & Kahneman, 1974). A person begins with an implicitly suggested reference point or a first approximation (i.e., the anchor) and makes adjustments to reach an estimate based on additional information. Although this heuristic has been applied to many domains like negotiations, purchases or jury convictions, no research has tried to apply it in food intake decisions. Yet, evaluating food quantities involves an uncertainty that can be resolved by relying on accessible cues, such as others’ eating behaviors or the quantity of food served, which may function as anchors and guide people’s decisions. In this view, the portion size served could be used as an anchor whereas other influences (i.e., economical, metabolic, regulatory, physiological, sensory, social and environmental) could contribute to adjust total amount of food consumed.

In classical experiments involving anchoring effects, participants first respond whether their final estimate is lower or higher than the anchor (i.e., comparative task). Only then they produce their final estimate (i.e., absolute task). Insofar, research supports that the best explanation of the AAH is the Selective Accessibility Model (Strack & Mussweiler, 1997). According to this model, individuals generate information semantically congruent with the anchor (comparative task), try to confirm it and eventually believe in the accuracy of the anchor (absolute task). Since this information is biased towards the anchor, so will be the estimate. The effects of large portions can thus be explained in terms of inflated perceptions of ‘normative’ or ‘appropriate’ intake that are conveyed by visual cues: consumers believe these larger portion sizes to be appropriate or an appropriate amount to consume at a single eating occasion (Geier, Rozin & Doros, 2006; Wansink, 2004; Herman & Polivy, 2005). Moreover, familiarity with large single-unit food containers and restaurant portions adds to the misinterpretation of hefty portions as appropriate individual servings (Schwartz & Byrd-Bredbrenner, 2006; Wansink & Chandon, 2006). For example, in a study where participants were offered single dishes containing 1000g of macaroni and cheese, they still did not question the appropriateness of the dish and increased their consumption in comparison to smaller dishes (500g, 625g and 750g; Rolls, Morris & Roe, 2002). This is congruent with AAH literature, where research shows that individuals are even influenced when implausible anchors are given (Chapman & Johnson, 1994; Strack & Mussweiler, 1997). Believing that food amount served is appropriate regardless of size could then explain why this excess intake due to increased portion
sizes is not compensated on subsequent days and is sustained over periods as long as 11 days (Rolls, Roe & Meengs, 2007).

This dissertation has provided empirical evidence of the use of such a decision heuristic in food intake. The perception of the appropriateness of the portion size may be affected by cues of the amount of food itself. Besides the effect of portion size, it illustrated two further environmental influences on food intake volume. Results have shown that increasing the size of food items and containers, while holding portion size constant, leads individuals to consume more food. This is consistent with existent literature (Wansink, 2004). Importantly, this excess energy intake was not moderated by any participant characteristics (BMI, age or hunger) and did not affect satiety or sensory factors. Similar to other environmental influences, the factors examined here seem to influence us without physiological warnings. These portion-related factors may be affecting the hypothesis confirmation process. When confirming the adequacy of a food portion, the structure of food and the container size add valuable information. The size of portions, food items and containers has steadily increased in the last 30 years parallel to the number of overweight and obese people. Hence, this dissertation supports the assumption that we live in an obesogenic (Swinburn, Egger, & Raza, 1999) and toxic food environment (Brownell & Horgen, 2004).

Research has shown that portion control and calorie counting is difficult to sustain (Herman & Polivy, 2003), and while only 1 in 20 dieters successfully maintains weight loss (Hill, Peters, Jortberg & Peeke, 2004), people also do not recognize the relevance of some weight loss tips or lack the motivation to implement them (Trottier, Polivy & Herman, 2009; Dickson-Spillmann & Siegrist, 2011). These observations are consistent with research showing that anchoring effects are very difficult to prevent and usually result in failures (Wilson, Houston, Etling & Brekke, 1996). The practical contribution to this dissertation suggests that strategies aimed at preventing anchoring effects may be applied to food intake decisions, in order to limit portion size effects. Such a strategy was tested empirically and findings showed that self-generating a consumption norm (i.e., intended food intake) before having access to information on portion size is an effective intra-individual strategy to limit the portion size effect in snacking situations. Instead of mindlessly relying on the suggested portion size, participants formulated a concrete intention about how much food they would consume. In other words, by making “mindless” eating “mindful”, people ate less. Identifying effective strategies such as self-generated consumption norms is of utmost importance.
given the recent obesity epidemic and its health consequences (Hill & Peters, 1998), and moreover
given that snacks have increased in energy density, availability, contribution to daily caloric intake
and eating frequency (Piernas & Popkin, 2010).

Although further research is needed to ascertain the generalization and the moderating
factors of the AAH, this dissertation made a first step into unraveling and understanding the
underlying psychological mechanism. Insofar, no research has provided a sound theoretical
framework, and mechanisms that may explain the portion size effect are poorly understood
(Wansink, 2004; Kral, 2006; Fisher & Kral, 2008; Bellisle, 2009). Aiming for a better
understanding of food intake behavior is critical in order to develop interventions and dietary
strategies to reduce excess energy intake and thereby regulate food consumption. Indeed, obesity
may be seen as a normal reaction to an abnormal environment, and while changing the environment
is highly advocated, understanding why and how it influences us can only be beneficial at an
individual level and for consumer welfare (Cutler, Glaeser & Shapiro, 2003). Indeed, the
determinants of energy intake are 100% behavioral and are thus (mostly) under our control (French,
Story & Jeffery, 2001). Biology and genetics may help identify the processes of the digestive tract
and homeostasis, but psychological sciences may help determine the decision making process in
food intake.

In order to understand individuals who struggle with maintaining healthy eating patterns and
waist lines, it is important to understand all the factors which contribute to eating behavior. This
dissertation focused on the food and eating environment, and especially on the effects of enlarged
food portions. The environment can work for people or against people. As obesity specialist George
Bray (2003) said: “Genes load the gun, the environment pulls the trigger”. When it comes to portion
size, the gun may be in our hands.


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