

Short Report

Mindful Eating Applied to Snacking: A Promising Behavioral Approach Supported by Research. Summary of the Symposium Held at the 21st International Congress of Nutrition (IUNS 2017)

Jean Kristeller¹, Yann Cornil², France Bellisle³, and Sophie Vinoy^{4*}

¹Department of Psychology, Indiana State University, United States

²Sauder School of Business, University of British Columbia, Canada

³Nutri Psy Consult, France

⁴Department of Nutrition, Mondelez Int R&D, France

***Corresponding author**

Sophie Vinoy, Department of Nutrition, Mondelez Int R&D, 6 Rue Rene Razel, FR-91400 Saclay, France,

Email: sophie.vinoy@mdlz.com

Submitted: 26 March 2020

Accepted: 08 April 2020

Published: 10 April 2020

ISSN: 2333-6706

Copyright

© 2020 Kristeller J, et al.

OPEN ACCESS**Keywords**

- Mindfulness
- Mindful eating
- Snacking
- Food behavior
- Attentive eating
- Taste satisfaction
- Hunger cues
- Satiety cues

Abstract

Over the last decades, eating episodes in addition to the three daily main meals have been observed worldwide; the prevalence of these “snacking” episodes raises health questions that mindful eating may contribute to answering. The goal of the symposium entitled “Mindful eating applied to snacking: a promising behavioral approach supported by research” was to introduce, for the first time in a scientific congress, the emerging science related to mindful eating and to evaluate its application to snacking occasions. It was held at the 21st International Congress of Nutrition (IUNS), which took place in Buenos Aires from October 15-20, 2017. Three primary topics were presented: 1) the definition of snacking and its role in dietary quality in adults; 2) the value of eating mindfully as an emerging concept, in relation to snacking occasions; 3) a detailed approach to mindful eating from theoretical principles to applications. Promoting mindful eating is a relatively new ‘third-wave’ cognitive-behavioral approach that enhances individuals’ awareness of, and attention to, physiological hunger and satiety, eating enjoyment, portion size and nutritional health when eating or when making food choices. Encouraging results have been obtained in obese individuals. Applied to snacking, mindful eating may help individuals’ better control food intake, and help orient their choices without compromising pleasure while eating. This symposium was organized by Mondelez International R&D.

INTRODUCTION

Over the last decades, extensive increase in food availability and convenience has led to significant changes in eating behaviors. Available snack foods are not only convenient, but also highly palatable and affordable. This contributes to the increase in the number of eating episodes in addition to the three daily main meals, known as “snacking” episodes [1,2]. Scientific research has investigated the reasons and consequences associated with this change in eating patterns and has focused on factors such as nutritional quality of snack foods and their hedonic characteristics [2-7]. Snacking episodes can be influenced by physiological needs, but also by sensory, affective, and social factors. While snacking is often associated with unhealthy eating and overeating, research on mindfulness has attempted to study

whether and how mindful eating can be applied to snacking, and to develop appropriate behavioral interventions [8].

The goal of the symposium entitled “Mindful eating applied to snacking: a promising behavioral approach supported by research” was to introduce the emerging science related to mindful eating and to evaluate it when applied to snacking occasions. Three experts in the fields of nutrition and eating behavior, food marketing, and psychology were invited to provide in-depth complementary approaches on these latest scientific advances. The session started by defining snacking and its role in diet quality. Then, in relation to snacking occasions, the value of eating mindfully was addressed as an emerging concept, including how some external cues may help consumers snack more mindfully. Finally, a detailed approach to mindful eating

was presented from theoretical principles to applications. The symposium, which was chaired by Dr. Jean Kristeller, ended with a general discussion involving representatives from both academia and industry. The symposium was held during the 21st International Congress of Nutrition (IUNS), which took place in Buenos Aires from October 15 to 20, 2017, and was organized by Mondelez International R&D.

PRESENTATION SUMMARIES

Snacking in different parts of the world: a marker of dietary anarchy or a useful contributor to diet quality and weight control?

Dr France Bellisle, Nutri Psy Consult, France

The intake of foods and beverages in humans, as well as in other animals, is a patterned activity. It occurs in several ingestive episodes distributed over the waking hours. A number of ingestive events of variable size occur daily, separated by intervals of variable duration [3]. Experimental science has established that the pattern of eating episodes, the distribution of a number of eating events over time, is one crucial aspect of the adaptation of energy intake to bodily energy needs, and therefore of the control of body weight. At the time of ingestion, sensory factors interact with internal signals of hunger and satiation to determine the size of the ingestive event. After the end of ingestion, a cascade of satiety factors delays the return of hunger and determines the duration of the interval between two successive events. [9].

In human consumers, however, the action of these basic biological mechanisms is complicated by the demands of social life. In developed societies, a plethora of convenient foods are available at all times. Societies have developed a number of rules determining the time and number of daily eating events, generally called meals, while allowing access to foods and beverages at other times, in eating responses that are often referred to as “snacks” [3]. In the context of the worldwide epidemic of obesity and nutrition-related diseases, the relative contribution of meals (culturally-defined main daily eating events) and snacks (other eating occasions outside of “meals”) to healthy nutrition or to overeating and poor food choices has been broadly discussed in the scientific literature.

One very influential expert on eating and nutrition, Professor David Booth, expressed the view that a “growing trend” for “grazing”, rather than the traditional pattern of “three proper meals a day”, is a major factor in the etiology of obesity” [10]. His view is not universally shared, however. Actually, the abundant scientific literature discussing snacking presents a highly complex picture. Some studies show how eating outside of main meals facilitates the adjustment of energy intake to energy needs and diversifies nutrient sources by including in the diet a variety of foods that are not part of the usual meal composition [11]. Other reports, however, highlight that the rising number of eating occasions between traditional meals increases the overall energy intake and the intake of foods and beverages of poor dietary quality, for example [12].

It has been observed that snacking, defined as eating at other times than traditional “main” meals, is very common in

individuals of all ages and different cultures. Snacking occurs at different times of day (and night) in different areas of the world, and there are also cultural differences in size, daily number and food composition of snacks. In the USA, the NHANES surveys have assessed the eating patterns of children and adults. A follow-up survey of snacking behavior between 1971 and 2010 established that, while the intake of three meals a day has become less frequent over time, snacking behavior has increased up to 2.3 snacks a day or more, representing about 23% of daily energy intake [2]. According to the authors, “the study demonstrated that adults in the US eat around the clock”. In European countries snacking also occurs but with important differences. In France, the recent INCA 3 [13] nationally representative survey confirmed that a large majority of adults and children do consume three meals a day. The daily number of ingestive events suggests that between 3 and 4 snacks are also ingested, representing 9% of the daily energy in adults and 16% in children. In Scandinavian countries [14], the daily pattern of intake shows that while traditional meals remain, snacking occurs at all times of day. In some individuals it can represent over 50% of the daily energy intake. In Latin America, snacking activity has also been investigated. In Mexico and Brazil, over 73% of the population report snacking on average 1.6 times a day, contributing over 20% of the total daily energy intake [15,16]. The China Health and Nutrition Survey of over 45,000 respondents showed that snacking increased between 1991 and 2009, taking place mainly in the evening, and now represents 12.3% of the daily energy intake [1].

The contribution of snacking to daily energy intake is likely to critically affect body weight control. The scientific literature, however, is inconsistent. From the 1960’s reports have appeared showing a lower body adiposity associated with frequent ingestive episodes [17]. These early works were questioned on the basis of a suspected bias due to under-declaration of intake among heavier respondents. In subsequent years, however, their conclusions were confirmed both in adults and in children. In American adults, for example, the SEASONS study, a large prospective study of variation in food intake across various time periods, showed a lower risk of obesity in participants having four or more eating episodes per day versus three or fewer [18].

By contrast, NHANES cross-sectional surveys carried out between 2003-2012 show the frequency of eating to be positively associated with overall overweight/obesity (BMI > 25 kg/m²) and with central obesity (waist circumference > 102 cm) [12]. Both sides of this apparent contradiction are reported in British adults in a study by [19] showing snacking frequency to be associated with lower adiposity in normal weight individuals but with higher adiposity in obese persons. This last study also suggests that the direction of the association could be critically dependent on the types of snack food options.

The contribution of snacking to the quality of the diet is also of substantial scientific controversy. Snacking has been repeatedly shown to increase daily intakes of fruits, whole grains, and fiber [20-23], and of several micro-nutrients, such as iron, calcium, vitamin C, riboflavin [20,24]. These observations contrast with numerous others describing the poor food choices ingested at snack times [13,23,25]. In France, Switzerland, and the USA, frequent snack options are high-sugar, high-fat, high-salt foods, plus the potential intake of alcohol in adults.

How can these widely opposing observations be reconciled? A few hypotheses have been proposed to differentiate between healthy, beneficial snacking versus unhealthy snacking. As observed in several of the studies cited above, the choice of foods and drinks ingested as snacks is of major importance. The regularity of the daily eating events, and of snacks, can be another critical dimension. Regular, predictable eating events, whether one calls them meals or snacks, are preceded by a small decline of glycemia that acts as a hunger signal [26], while unpredictable, irregular ones are more likely to be triggered by external stimuli in the absence of the metabolic conditions associated with need. Experimental studies have shown that eating in the absence of physiological hunger (in a state of post-ingestive hyperglycemia) induces poor compensation for the energy ingested and therefore leads to overeating [27]. When snacks are regular and predictable, they are integrated in the daily pattern of physiological/behavioral events; they are triggered by a metabolic hunger signal and exert positive effects on satiety mechanisms, post-intake insulin profiles and thermogenesis [28]. For snacks as well as meals, the total energy intake and satiety are affected by cognitive factors, such as the attention paid to the act of eating [29]. For example, watching television at the time of eating often increases the amount eaten, whereas memory of previous eating occasions decreases it [30].

These various influences have been recently integrated into the recommendations proposed by the American Heart Association in 2017. They issued a statement acknowledging that irregular eating patterns appear less favorable for the maintenance of body weight and optimal cardio-metabolic health, and that a more intentional approach to eating that focuses on the timing and frequency of meals and snacks could be the basis for a healthier lifestyle. In addition, it is acknowledged that adding eating episodes in the daily diet can be used to introduce a wider variety of healthful food options [31].

In conclusion, the scientific literature reveals that snacking is widely prevalent in all parts of the world. It can be viewed as both healthy and unhealthy depending of a number of factors that are progressively being identified. Healthy snacking seems to be characterized by regularity, predictability, good quality food options, and attention brought to the act of eating.

How mindfulness can benefit snacking

Dr Yann Cornil, University of British Columbia, Canada

As presented in the previous section, there has been a growing trend for snacking among children and adults over the past forty years. One of the reasons why a habit of snacking represents a challenge for energy balance and body weight control is the mode of consumption of snacks, which tends to differ from that of other foods. Indeed, consumers often snack while watching TV or performing attention-grabbing activities; thus people are often mindless (that is, inattentive or distracted) while snacking. A large body of research shows that distraction increases both immediate and later food intake due to a lack of awareness of the sensory signals that lead to satiety [32]. Conversely, eating mindfully, that is, eating while cultivating the awareness of and the attention to sensory signals [33,34], has been identified as a promising solution to better control of food intake. Behavioral

research has pointed at simple solutions and brief interventions designed to promote mindful snacking. We consider two broad categories of such solutions: those that aim to increase attention to, and perception of, food portion sizes, and those designed to cultivate awareness of sensory enjoyment.

Substantial research has focused on solutions designed to make consumers more mindful about portion sizes. Indeed, portion sizes have increased dramatically over the past forty years, in parallel with the habit of snacking, and consumers often fail to realize how large portions are [35,36]. The size labels used for snacks (such as “small”, “regular” or “large”) may impact choices because of their normative influence [37], but in practice these labels mask large discrepancies in that a “large” size from one brand may be called “regular” or “small” from another brand. This problem is compounded by the portion size effect: on average, doubling the portion size of a food increases consumption by 35% without increasing feelings of satiety [38]. This is because satiety is only marginally influenced by the actual quantity of energy being ingested, and is largely driven by a vast array of cognitive factors, including consumption norms, monitoring of eating, and visual perception of food quantity [39]. In sum, people satiate (end an eating episode) based on their perceived consumption, rather than based on their actual consumption. Hence, “mindful” snacking relies on improving awareness and evaluation of food quantities, in order to align perceived and actual consumption. In line with this idea, studies have shown that visual cues indicating what has already been eaten, such as when the shells of eaten pistachio nuts or the wrappers of eaten candies remain visible, lead to faster satiation and to improved control of food intake [40,41]. Making portion sizes more salient also help consumers better monitor their consumption. In an experiment by Geier and colleagues [42], participants ate from tubes of potato chips while watching a video; one group of participants received identical chips, while another group received chips that had a red chip inserted at regular intervals. The latter group ate approximately 50% less, because the red chips served as segmentation cues, which helped participants’ better estimate how much they had eaten. Chandon and Ordabayeva [43], proposed another method: for “supersized” portions of snacks, rather than increasing the three dimensions of the food packaging (i.e., height, width, and depth), it is preferable to increase only one dimension (e.g., only height). This simple guideline largely improves the visual estimation of portion sizes, and makes consumers choose more reasonable portions.

Research suggests that mindful snacking also relies on increased attention to the sensory enjoyment of eating. A focus on sensory enjoyment is associated with a lower occurrence of impulse-based and mindless snacking episodes, ultimately leading to reducing calorie intake [44]. This is in large part because a higher sensory focus increases awareness of and responsiveness to physiological satiation cues, in particular to sensory-specific satiety, which predicts that the first few bites of a food are the most pleasurable, with pleasure declining with each subsequent bite [45]. Hence, several cross-cultural studies have found that portion sizes and obesity rates tend to be lower in food cultures with a strong emphasis on sensory pleasures, like France or Japan [46]. One possible explanation is that individuals who value the sensory and aesthetic dimensions of foods tend

to pay less attention to external signals of satiation (e.g., when the plate is empty, when the television program is over), and more attention to internal signals of decreased enjoyment and fullness [47,48]. Similarly, several experiments have shown that inviting consumers to focus on the sensory qualities of their snack promotes satiation during the eating episode, but also leads to reduced food intake later on because a sensory focus also improves the formation of eating memories [49,50]. Finally, a sensory focus can also help consumers better plan their snacking consumption ahead. In an experiment, Cornil and Chandon [51], asked a group of participants to vividly imagine the sensory enjoyment of a snack food (taste, smell, texture) prior to choosing a portion size of chocolate cake. Compared to a control group, these participants tended to choose smaller portion sizes. As shown on Figure 1, this choice was driven by the fact that the sensory imagery intervention led participants to anticipate more pleasure from the smaller portions (but not from the larger portions) of cake, compared to the control group. In other words, sensory imagery helped them better anticipate the effects of sensory-specific satiety.

It should be noted that the solutions and interventions described above have only been tested for short-term food consumption. The next section demonstrates that mindfulness can be trained and can have long-term benefits.

Eating mindfully as a sustainable healthy behavior: Theory and evidence

Dr. Jean Kristeller, Indiana State University, USA

Mindful eating is a unique way of relating to the many food choices we face every day. Our minds and our bodies can provide us much wisdom, not only in regard to eating in a more healthy and flexible way, without dieting, but also to enjoy our food more – not less. Although snacking is often identified as an undesirable aspect of food intake, the evidence, as reviewed above by Bellisle, suggests that regular meals can be supplemented by snacks within healthy parameters, particularly in regard to quantity, but also related to quality of foods chosen. One of the challenges of highly restrictive diet programs, which generally curtail virtually all higher caloric snacks, is that little or no awareness is developed regarding how to eat such foods in a more limited, balanced and

sustainable way. Learning to eat mindfully can help people better self-regulate their intake, retraining a flexible, more satisfying relationship to eating and food.

As the research summarized above by Cornil has shown, mindless snacking can be reduced by bringing individuals' attention to two qualities related to food: making serving sizes more salient, and heightening awareness of taste experience. Even in experimental contexts, people can become more 'mindful' of their choices, thereby reducing the quantity eaten. Such approaches are also clinically applicable, and have been integrated into mindfulness-based treatment programs for weight management, for individuals with type II diabetes, and for addressing the habitual compulsive overeating patterns present in individuals with binge eating disorder, the most common eating disorder [52-55].

First, what do we mean by 'mindfulness'? Jon Kabat-Zinn, who developed the widely taught Mindfulness-Based Stress Reduction (MBSR) program [56,57], defines mindfulness as "...moment to moment non-judgmental awareness cultivated by paying attention." Why is mindfulness so powerful? Non-judgment means suspending, for a moment, years of conditioning, by engaging awareness, rather than just reacting mindlessly and habitually. Research has shown that people make between 200-300 decisions per day about what they eat [58]. Most of these, whether clearing your plate at a meal or grabbing a snack, are highly conditioned, occurring with little reflective consideration or awareness. As the research reviewed above by Dr. Cornil shows, even a few minutes of mindfulness training can lead an individual to be less reactive to common eating triggers, thereby eating healthier amounts.

Mindfulness-Based Eating Awareness Training (MB-EAT), a 12-week group program, teaches people with significant compulsive eating and weight problems how to use mindfulness to guide their eating experiences in wiser and healthier ways [53,54]. MB-EAT was developed over the years to link the rich experimental literature on eating behavior [59-63] with the principles and practices put forth by Kabat-Zinn in the MBSR program. MB-EAT also draws on cognitive-behavioral therapy, and can be considered an example of 'third-wave' CBT interventions [64]. MB-EAT helps people engage two types of 'wiser' eating. 'Inner wisdom' entails being more mindful of experiences such as physical hunger, taste, and fullness; thoughts and feelings about food; habitual responses to social pressures to eat; and to other common external triggers, such as the presence of food. 'Outer wisdom' entails mindfully using nutritional information, such as caloric and nutritional value of food options, to meet health and weight management needs. While attending to these aspects of food choice may seem obvious, many individuals with weight and/or compulsive eating issues acknowledge feeling so anxious or overwhelmed by such information that they ignore it entirely. The term 'wisdom' captures the focus of MB-EAT on flexibility and self-empowerment, while disengaging from long-standing habits; this is in contrast to rigidly imposed diets, which separate people even further from becoming more aware of their own experience. Heightening awareness of taste satisfaction and taste satiety (*sensory-specific satiety*) is a core element of "inner" wisdom [65,66]. Eating awareness exercises occur throughout the MB-EAT program, including snack foods such as chocolate, corn chips,

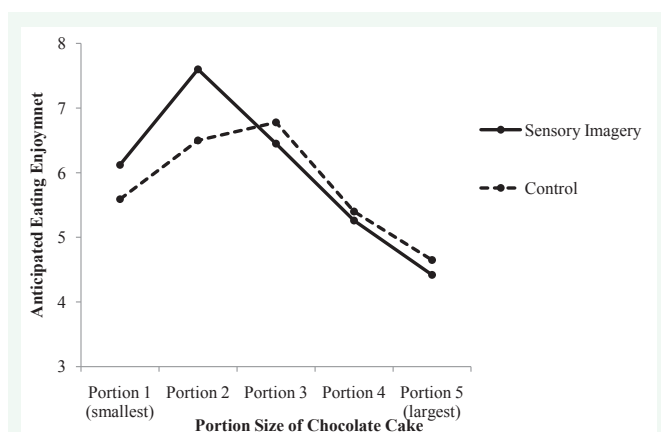


Figure 1 Effects of sensory imagery on expected enjoyment of chocolate cake. Adapted from Cornil & Chandon (2016).

cookies, and participants' preferred snack foods. Rather than forbidding such foods, which often results in rebound overeating, the intention is to help people learn to obtain maximal pleasure from smaller, rather than larger, quantities. Healthier foods are also presented as important alternatives, but again, in a balanced rather than exclusive way.

Initial pilot research enrolling women (BMI \geq 30) with Binge Eating Disorder (BED) showed marked decreases in binge eating frequency, correlated with amount of mindfulness practice [67]. Based on these results, the first randomized clinical trial (RCT) funded by NIH compared MB-EAT to a Psycho-Educational-CBT-based program (PECB) and to a wait-list control, again among obese individuals with binge eating disorder. At 4-month follow-up, 95% in the MB-EAT group no longer met criteria for BED vs. 76% of the PECB group, and remaining binges in the MB-EAT group were significantly smaller. Improvement in bingeing again correlated with amount of mindfulness practice. Although average weight loss was minimal, those who lost more weight also reported more mindfulness practice ($r = -.33$) [8,55]. A subsequent NIH-funded RCT augmented the 'outer wisdom' components, with a focus on sustainable caloric reduction, enrolling individuals both with and without BED, but at higher weight (BMI \geq 35). Improvement in eating patterns occurred that was highly comparable to that found in the previous studies, regardless of BED status, along with more consistent weight loss (Kristeller, unpublished work). Another NIH-funded RCT, enrolling individuals with BMI \geq 30, without BED, found significantly greater weight loss at 1-year follow-up for the MB-EAT-based intervention compared to an active control group, along with significantly improved eating patterns, emotional regulation and fasting glucose [52].

The results to date suggests that individuals can bring compulsive overeating under control, improve emotional regulation related to eating, and decrease weight, and that improvement across a range of variables is associated directly with amount of mindfulness practice. Mindful eating can, therefore, help individuals create a more balanced, sustainable, yet flexible relationship to eating and food.

DISCUSSION

The forum session addressed the value of mindful eating applied to snacking in adults. The two topics of mindful eating and snacking were discussed conjointly for the first time in a scientific congress. Eating outside of the three main meals of the day has been observed in all parts of the world, and may have increased in the last few decades. This development has dramatically increased the number of daily food choices each individual makes [58]. In this context, the brain plays a key role in the control of energy intake. Recent research in neuroscience brings a new view of the homeostatic and hedonic (non-homeostatic) neural circuitries that control appetite and regulate body weight [68]. Functional neuroimaging research in humans combined with animal research has demonstrated that both hedonic and homeostatic systems have strong functional and anatomical interactions unifying homeostasis with reward systems, cognition and emotion [7]. In this context, decisions related to food choices during snacking are influenced by interrelated factors including external and internal cues. The

results of these interactions may influence the quality of daily food intake and long term weight management. Indeed, satiation process and satiety feelings are clearly influenced by perceived experiences involving external parameters (labeling, portion size, sensorial properties, distraction...). Two widely spread habits are eating while distracted (for example, while watching TV or other screens), and eating in the absence of physiological hunger sensations. Both have been clearly associated with mindless eating behavior and may lead to overconsumption, short term energy imbalance, and sustained weight gain [69,70]. Thus, defining new behavioral approaches to help people develop healthier eating habits, including snacking, presents emerging challenges.

Mindfulness may help people better control food intake through several processes. When individuals are invited to focus on the sensory experience of the food they are eating, then they are more likely to detect satiety signals, leading to reduced food intake in the current eating episode. Sensory focus also reduces food intake in the subsequent eating episode because it helps people better remember what they have already eaten [71,72]. These opportunities to develop awareness of food intake have been integrated into comprehensive programs for developing mindful eating. This is a relatively new third-wave cognitive-behavioral approach that has provided encouraging results in obese subjects, and that aims to raise individuals' awareness of, and attention to, physiological hunger, eating enjoyment, portion size and food healthiness when eating or when making food choices.

Several studies have already documented that mindful eating programs can reduce eating disorders and improve emotional regulation related to eating [73]. Mindfulness practices have also been linked to weight loss in overweight and obese individuals [74]. These encouraging results need further confirmation. Applied to snacking, mindful eating may provide a valuable approach to helping individuals control food intake, and regulate their emotions without compromising pleasure when making food choices. These effects need to be further explored and confirmed by additional research.

KEY MESSAGES

--Snacking, defined as eating between the three main meals, is a widespread eating habit worldwide.

--As the number of daily eating occasions is increasing worldwide, some novel behavioral approaches may be applied to help people to better determine the quality and the quantity of their food choices.

--By enhancing the consumer's focus on interoceptive and cognitive cues, mindful eating principles demonstrated their effectiveness in improving emotional regulation related to eating and decrease compulsive overeating

--Mindfulness principles can be applied to each snacking occasion to promote deliberate and conscious food choices that are likely to better meet individuals' needs.

AUTHORS' CONTRIBUTIONS

FB, YC, and JK each wrote one of the three main parts of the manuscript; SV wrote the first version of the abstract,

introduction and discussion parts which were revised by all authors. All authors read and approved the final manuscript.

ACKNOWLEDGEMENTS

We are grateful to Camille Birault and Elisabeth Riou (Mondelez Int R&D) and Christine Bouley (Orchidali) for the organization of the symposium during the IUNS congress.

CONFLICT OF INTEREST AND FUNDING

SV is employed by Mondelez International. JK, YC and FB have no conflict of interest. Mondelez International R&D organized this symposium at the IUNS congress, Buenos, 2017.

REFERENCES

- Wang Z, Zhai F, Zhang B, Popkin BM. Trends in Chinese snacking behaviors and patterns and the social-demographic role between 1991 and 2009. *Asia Pac J Clin Nutr.* 2012; 21: 253-262.
- Kant AK, Graubard BI. 40-year trends in meal and snack eating behaviors of American adults. *J Acad Nutr Diet.* 2015; 115: 50-63.
- Bellisle F. Meals and snacking, diet quality and energy balance. *Physiol Behav.* 2014; 134: 38-43.
- Bortz WM, Wroldsen A, Issekutz B, Rodahl K. Weight loss and frequency of feeding. *N Engl J Med.* 1966; 274: 376-379.
- Mattes RD. Snacking: A cause for concern. *Physiol Behav.* 2018; 193: 279-283.
- Cornil Y, Chandon P. Pleasure as an ally of healthy eating? Contrasting visceral and Epicurean eating pleasure and their association with portion size preferences and wellbeing. *Appetite.* 2016; 104: 52-59.
- Berthoud H, Münzberg H, Morrison CD. Blaming the Brain for Obesity: Integration of Hedonic and Homeostatic Mechanisms. *Gastroenterology.* 2017; 152: 1728-1738.
- Kristeller JL, Wolever RQ. Mindfulness-based eating awareness training for treating binge eating disorder: the conceptual foundation. *Eat Disord.* 2011; 19: 49-61.
- Bellisle F, Blundell JE. Satiety, satiety: concepts and organisation of behaviour. In: *Satiety, satiety and the control of food intake.* Oxford: Woodhead Publishing; 2013; 3-11.
- Booth DA. Mechanisms from models--actual effects from real life: the zero-calorie drink-break option. *Appetite.* 1988; 11: 94-102.
- Hess JM, Jonnalagadda SS, Slavin JL. What Is a Snack, Why Do We Snack, and How Can We Choose Better Snacks? A Review of the Definitions of Snacking, Motivations to Snack, Contributions to Dietary Intake, and Recommendations for Improvement. *Adv Nutr.* 2016; 7: 466-475.
- Murakami K, Livingstone MBE. Eating Frequency Is Positively Associated with Overweight and Central Obesity in U.S. Adults. *J Nutr.* 2015; 145: 2715-2724.
- ANSES (Agence Nationale de Sécurité Alimentaire, de l'Alimentation, de l'Environnement et du travail). *Etude individuelle nationale des consommations alimentaires 3 (INCA 3).* 2017.
- Lund TB, Gronow J. Deconstruction or continuity? The daily rhythm of eating in Denmark, Finland, Norway and Sweden in 1997 and 2012. *Appetite.* 2014; 82: 143-153.
- Duffey KJ, Pereira RA, Popkin BM. Prevalence and energy intake from snacking in Brazil: analysis of the first nationwide individual survey. *Eur J Clin Nutr.* 2013; 67: 868-874.
- Duffey KJ, Rivera JA, Popkin BM. Snacking is prevalent in Mexico. *J Nutr.* 2014; 144: 1843-1849.
- Fabry P, Hejl Z, Fodor J, Braun T, Zvolankova K. The frequency of meals. Its relation to overweight, hypercholesterolaemia, and decreased glucose-tolerance. *Lancet.* 1964; 2: 614-615.
- Ma Y, Bertone ER, Stanek EJ, Reed GW, Hebert JR, Cohen NL, et al. Association between Eating Patterns and Obesity in a Free-living US Adult Population. *Am J Epidemiol.* 2003; 158: 85-92.
- O'Connor L, Brage S, Griffin SJ, Wareham NJ, Forouhi NG. The cross-sectional association between snacking behaviour and measures of adiposity: the Fenland Study, UK. *Br J Nutr.* 2015; 114: 1286-1293.
- Hampel JS, Heaton CLB, Taylor CA. Snacking patterns influence energy and nutrient intakes but not body mass index. *J Hum Nutr Diet.* 2003; 16: 3-11.
- Kerr MA, Rennie KL, McCaffrey TA, Wallace JMW, Hannon-Fletcher MP, Livingstone MBE. Snacking patterns among adolescents: a comparison of type, frequency and portion size between Britain in 1997 and Northern Ireland in 2005. *Br J Nutr.* 2009; 101: 122-131.
- Sebastian RS, Cleveland LE, Goldman JD. Effect of snacking frequency on adolescents' dietary intakes and meeting national recommendations. *J Adolesc Health.* 2008; 42: 503-511.
- Hartmann C, Siegrist M, van der Horst K. Snack frequency: associations with healthy and unhealthy food choices. *Public Health Nutr.* 2013; 16: 1487-1496.
- Gatenby SJ. Eating frequency: methodological and dietary aspects. *Br J Nutr.* 1997; 77 Suppl 1: 7.
- Piernas C, Popkin BM. Trends in snacking among U.S. children. *Health Aff (Millwood).* 2010; 29: 398-404.
- Chapelot D, Marmonier C, Aubert R, Gausseres N, Louis-Sylvestre J. A role for glucose and insulin preprandial profiles to differentiate meals and snacks. *Physiol Behav.* 2004; 80: 721-731.
- Marmonier C, Chapelot D, Fantino M, Louis-Sylvestre J. Snacks consumed in a nonhungry state have poor satiating efficiency: influence of snack composition on substrate utilization and hunger. *Am J Clin Nutr.* 2002; 76: 518-528.
- Bertéus Forslund H, Klingström S, Hagberg H, Löndahl M, Torgerson JS, Lindroos AK. Should snacks be recommended in obesity treatment? A 1-year randomized clinical trial. *Eur J Clin Nutr.* 2008; 62: 1308-1317.
- Higgs S. Cognitive influences on food intake: the effects of manipulating memory for recent eating. *Physiol Behav.* 2008; 94: 734-739.
- Higgs S, Woodward M. Television watching during lunch increases afternoon snack intake of young women. *Appetite.* 2009; 52: 39-43.
- Kris-Etherton P, Varady K, St-Onge M, Chiuve SE, Baskin ML, Johnson HM, et al. Meal Timing and Frequency: Implications for Cardiovascular Disease Prevention: A Scientific Statement From the American Heart Association. *Circulation.* 2017; 135: e121.
- Robinson E, Aveyard P, Daley A, Jolly K, Lewis A, Lycett D, et al. Eating attentively: a systematic review and meta-analysis of the effect of food intake memory and awareness on eating. *Am J Clin Nutr.* 2013; 97: 728-742.
- Kabat-Zinn J. Eating meditation, in *Mindfulness for Beginners [CD]*. Louisville, CO; 2006.
- Kristeller JL, Wolever RQ. Mindfulness-Based Eating Awareness Training for Treating Binge Eating Disorder: The Conceptual Foundation. *Eat Disord.* 2010; 19: 49-61.
- Chandon P, Wansink B. Does food marketing need to make us fat? A review and solutions. *Nutr Rev.* 2012; 70: 571-593.
- Young LR, Nestle M. The contribution of expanding portion sizes to the

- US obesity epidemic. *Am J Public Health*. 2002; 92: 246-249.
37. Aydinoglu NZ, Krishna A. Guiltless Gluttony: The Asymmetric Effect of Size Labels on Size Perceptions and Consumption. *J Consumer Res*. 2011; 37: 1095-1112.
38. Zlatevska N, Dubelaar C, Holden SS. Sizing Up the Effect of Portion Size on Consumption: A Meta-Analytic Review. *J Marketing*. 2014; 78: 140-154.
39. Cornil Y. Mind over Stomach: A Review of the Cognitive Drivers of Food Satiation. *J Association for Consumer Res*. 2017; 2: 419-429.
40. Kennedy-Hagan K, Painter JE, Honselman C, Halvorson A, Rhodes K, Skwir K. The effect of pistachio shells as a visual cue in reducing caloric consumption. *Appetite*. 2011; 57: 418-420.
41. Polivy J, Herman CP, Hackett R, Kuleshnyk I. The effects of self-attention and public attention on eating in restrained and unrestrained subjects. *J Pers Soc Psychol*. 1986; 50: 1253-1260.
42. Geier A, Wansink B, Rozin P. Red potato chips: segmentation cues can substantially decrease food intake. *Health Psychol*. 2012; 31: 398-401.
43. Chandon P, Ordabayeva N. Supersize in One Dimension, Downsize in Three Dimensions: Effects of Spatial Dimensionality on Size Perceptions and Preferences. *J Marketing Res*. 2009; 46: 739-753.
44. Tapper K. Can mindfulness influence weight management related eating behaviors? If so, how? *Clin Psychol Rev*. 2017; 53: 122-134.
45. Rolls BJ, Rolls ET, Rowe EA, Sweeney K. Sensory specific satiety in man. *Physiol Behav*. 1981; 27: 137-142.
46. Rozin P. The meaning of food in our lives: a cross-cultural perspective on eating and well-being. *J Nutr Educ Behav*. 2005; 37: 107.
47. Cornil Y, Chandon P. Pleasure as an ally of healthy eating? Contrasting visceral and Epicurean eating pleasure and their association with portion size preferences and wellbeing. *Appetite*. 2016; 104: 52-59.
48. Wansink B, Payne CR, Chandon P. Internal and external cues of meal cessation: the French paradox redux? *Obesity (Silver Spring)*. 2007; 15: 2920-2924.
49. Higgs S, Donohoe JE. Focusing on food during lunch enhances lunch memory and decreases later snack intake. *Appetite*. 2011; 57: 202-206.
50. Poothullil JM. Role of oral sensory signals in determining meal size in lean women. *Nutrition*. 2002; 18: 479-483.
51. Cornil Y, Chandon P. Pleasure as a Substitute for Size: How Multisensory Imagery Can Make People Happier with Smaller Food Portions. *J Marketing Res*. 2015; 53: 847-864.
52. Daubenmier J, Moran PJ, Kristeller J, Acree M, Bacchetti P, Kemeny ME, et al. Effects of a mindfulness-based weight loss intervention in adults with obesity: A randomized clinical trial. *Obesity (Silver Spring)*. 2016; 24: 794-804.
53. Kristeller J. *The Joy of Half a Cookie. Using mindfulness to lose weight and end the struggle with food.* New York: Perigee/Penguin Books. 2016.
54. Kristeller J, Wolever R. *Mindfulness-Based Eating Awareness Training (MB-EAT): A Treatment Manual.* New York: Guilford Press.
55. Kristeller J, Wolever RQ, Sheets V. Mindfulness-Based Eating Awareness Training (MB-EAT) for binge eating: A randomized clinical trial. *Mindfulness*. 2014; 5: 282-297.
56. Kabat-Zinn J. *Full catastrophe living: using the wisdom of your body and mind to face stress, pain, and illness.* New York, N.Y.: Delacorte Press; 1990.
57. Kabat-Zinn J. *Mindfulness-Based Interventions in Context: Past, Present, and Future.* *Clinical Psychology: Science and Practice*. 2003; 10: 144-156.
58. Wansink B, Sobal J. Mindless Eating: The 200 Daily Food Decisions We Overlook. *ENVIRONMENT AND BEHAVIOR*. 2007; 39: 106-123.
59. McFarlane T, Polivy J, McCabe RE. Help, not harm: Psychological foundation for a non dieting approach toward health. *J Social Issues*. 1999; 55: 261-276.
60. Heatherton TF, Polivy J, Herman CP. Dietary restraint: Some current findings and speculations. *Psychology of Addictive Behaviors*. 1990; 4: 100-106.
61. Marcus MD, Wing RR, Hopkins J. Obese binge eaters: affect, cognitions, and response to behavioural weight control. *J Consult Clin Psychol*. 1988; 56: 433-439.
62. Ruderman AJ, Christensen H. Restraint theory and its applicability to overweight individuals. *J Abnorm Psychol*. 1983; 92: 210-215.
63. Spencer JA, Fremouw WJ. Binge eating as a function of restraint and weight classification. *J Abnorm Psychol*. 1979; 88: 262-267.
64. Hayes SC, Folette VM, Linehan MM. *Mindfulness and Acceptance: Expanding the Cognitive-Behavioral Tradition.* Guilford Press ed. New York; 2004.
65. Blundell JE, Bellisle F. *Satiation, Satiety and the Control of Food Intake: Theory and Practice.* Cambridge, GB: Woodhead Publishing. 2013.
66. Remick AK, Polivy J, Pliner P. Internal and external moderators of the effect of variety on food intake. *Psychol Bull*. 2009; 135: 434-451.
67. Kristeller JL, Hallett CB. An Exploratory Study of a Meditation-based Intervention for Binge Eating Disorder. *J Health Psychol*. 1999; 4: 357-363.
68. Münzberg H, Qualls-Creekmore E, Yu S, Morrison CD, Berthoud H. Hedonics act in unison with the homeostatic system to unconsciously control body weight. *Front Nutr*. 2016; 3: 6.
69. Hetherington MM. Cues to overeat: psychological factors influencing overconsumption. *Proc Nutr Soc*. 2007; 66: 113-123.
70. Feig EH, Piers AD, Kral TVE, Lowe MR. Eating in the absence of hunger is related to loss-of-control eating, hedonic hunger, and short-term weight gain in normal-weight women. *Appetite*. 2018; 123: 317-324.
71. Meier BP, Noll SW, Molokwu OJ. The sweet life: The effect of mindful chocolate consumption on mood. *Appetite*. 2017; 108: 21-27.
72. Arch JJ, Brown KW, Goodman RJ, Della Porta MD, Kiken LG, Tillman S. Enjoying food without caloric cost: The impact of brief mindfulness on laboratory eating outcomes. *Behav Res Ther*. 2016; 79: 23-34.
73. Warren JM, Smith N, Ashwell M. A structured literature review on the role of mindfulness, mindful eating and intuitive eating in changing eating behaviours: effectiveness and associated potential mechanisms. *Nutr Res Rev*. 2017; 30: 272-283.
74. Carrière K, Khoury B, Günak MM, Knäuper B. Mindfulness-based interventions for weight loss: a systematic review and meta-analysis. *Obes Rev*. 2018; 19: 164-177.

Cite this article

Kristeller J, Cornil Y, Bellisle F, Vinoy S (2020) *Mindful Eating Applied to Snacking: A Promising Behavioral Approach Supported by Research. Summary of the Symposium Held at the 21st International Congress of Nutrition (IUNS 2017).* *J Hum Nutr Food Sci* 8(1): 1131.