gastronomy

Review

The Role of Sensory Cues in Promoting Healthy Eating: A Narrative Synthesis and Gastronomic Implications

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Abstract: Many consumers today pursue health goals to adopt healthier behaviors, and interest in promoting healthy eating habits in gastronomy is growing. Empirical evidence demonstrates that sensory cues (e.g., food color, food shapes, and background music) influence healthy eating behavior. However, the theoretical understanding of how sensory cues shape healthy food choices remains unclear. Specifically, this study develops the sensory–healthy eating model, a theoretical framework that explains how and when sensory cues influence healthy eating behavior (e.g., food choices and intake). By integrating related theories and empirical findings across interdisciplinary fields, we identify which sensory cues shape healthy eating and the psychological processes through which they operate. The theoretical model proposes that (1) sensory cues evoke cognitive (higher evaluation, lower potency, lower activity) and/or affective responses (positive valence, lower arousal), (2) these responses shape the perceived healthiness of foods based on their characteristics and quantity, and (3) the influence of perceived food healthiness on healthy eating behavior is stronger for consumers with health goals or motives. Our model provides a valuable framework for researchers and practitioners in marketing, food science, and gastronomy to promote healthy eating behavior.

Keywords: sensory marketing; healthy food; healthy eating; healthy perception; affect; connotative meanings; goals

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1. Introduction

Healthy eating has gained significant attention, as unhealthy diets majorly contribute to the global disease burden [1]. Excess intake of unhealthy nutrients (e.g., sodium) and high consumption of red and processed meats increase the risk of mortality, cardiovascular diseases, and obesity [1,2]. To mitigate these risks, policymakers implement healthy food policies, such as front-of-pack nutrition labels (e.g., Nutri-score in Europe), to guide healthier choices [3–6].

Interest in healthy eating is increasing among consumers and food marketers. Health-related factors (e.g., high vitamin and mineral content) influence food purchases [7]. A survey of 1600 consumers found that over 90% feel the need to eat healthy foods occasionally, while more than 60% actively try to make the effort [8]. In response, food manufacturers and retailers are adapting to this demand. Industry stakeholders recognize the importance of promoting healthier food environments [9], driving the growth of functional foods [10].

Despite the growing interest in promoting healthier food choices among stakeholders, the theoretical understanding of how food choice models explain healthier eating behavior remains unclear. Most food choice models were developed to account for general food choices rather than specifically addressing healthy ones, making them less applicable to research focusing on health-related behavior (e.g., [11–15]). For example, Chen and Antonelli reviewed 59 publications on conceptual models of food choice and provided an integrated model. The model indicates that food internal and external factors influence food choices via personal and cognitive factors [11]. Food's internal factors refer to the intrinsic characteristics of the food itself (e.g., taste, aroma, texture, and nutritional content), while food's external factors refer to external characteristics beyond the food itself, such as packaging, branding, advertising, and ambiance. However, existing food choice models do not sufficiently explain the psychological mechanisms underlying how these factors specifically influence healthier eating behavior. Furthermore, these models primarily focus on cognitive factors, overlooking the role of sensory cues in shaping food perceptions and choices. To address this gap, our study develops a conceptual framework from a sensory marketing perspective. We clarify how sensory cues shape healthy food perceptions and choices and outline the potential psychological processes that drive healthy eating behavior.

Sensory marketing is defined as "*marketing that engages the consumers' senses and affects their perception, judgment and behavior.*" [16] (p. 332). Sensory factors involve five senses (vision, audition, smell, touch, and taste) and include food's extrinsic and intrinsic factors in the context of food products [17,18]. Food's extrinsic factors encompass sensory properties of packaging, branding, labeling, and ambiance, such as serving plate ware, ambient temperature, and background music, to name a few [17,18]. Meanwhile, food's intrinsic factors include product color, aroma, texture, etc. [17]. Although the amount of research on sensory marketing is on the rise, from an ethical and public health standpoint, some researchers argue that sensory cues should capitalize on making consumers choose healthy foods [19–21].

A large body of evidence has demonstrated that sensory factors influence healthy food perceptions and healthy eating behavior (e.g., intention to eat, intake, choice) (Supplementary Table S1) [20–23]. Healthy foods are beneficial for one's health and are usually high in nutrients and low in calories, fat, and sugar [24,25]. A variety of sensory factors influence healthy perception and healthy food preferences. For example, lighter-colored (vs. darker-colored) packaging [26], higher-frequency (vs. lower-frequency) sounds in brand name stimuli [27], matte (vs. glossy) surfaced package [28], and lemon or cherry flavor (vs. control) [29] are more associated with food healthiness perception. Moreover, soft nature sounds (vs. noise) [30] and black-and-white (vs. color) ads [31], to name a few, increase healthy food preferences/choices.

Although each empirical research has revealed that sensory cues (e.g., color, background music) affect healthy food evaluations (Supplementary Table S1), no integrative models have been provided to our best knowledge. Sensory marketing research has assumed that sensory factors influence consumer evaluations through cognitive and affective routes [16,32]. Given this, we investigated the cognitive and affective responses underlying sensory factors that influence healthy food evaluations.

The present research aims to propose a theory on sensory cues promoting healthy eating behavior. Specifically, our research develops a model that explains how and when sensory cues influence healthy eating behavior, including choices and intake (Figure 1). Given that our aim is to propose an original theory, we employ a conceptual or qualitative research method [33]. A systematic review was not conducted because the unique search term that encompasses all the constructs in our framework appears not to exist. Our procedure is similar to other conceptual papers that aim to construct an original theoretical

framework on consumer behavior and marketing (e.g., [34,35]). We primarily relied on the framework of meanings of concepts (evaluation, potency, and activity) for the cognitive responses [36,37] and the circumplex model of affect (Valence and Arousal) [38] for the affective responses. Moreover, to develop a nuanced and detailed conceptual model, we integrated the mediators and moderators identified in prior research into our conceptual model [39,40].

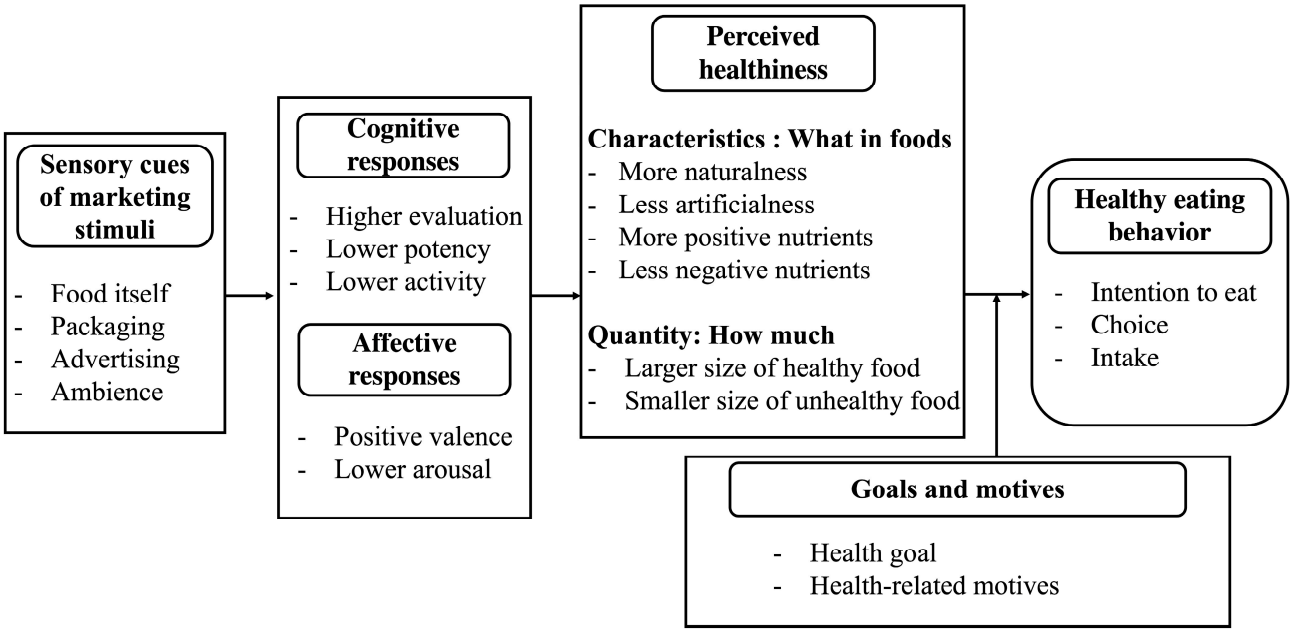


Figure 1. A conceptual model of how and what sensory cues influence healthy eating behavior.

2. Cognitive Responses to Sensory Factors Influencing Healthy Eating Behavior

2.1. The Framework of Meanings of Concepts

To investigate the sensory factors that influence healthy food evaluations, we rely on the framework of meanings of concepts [36,37]. The framework of meanings of concepts was proposed by Osgood and his colleagues, and it is currently known as the semantic differential technique [36,37]. The meaning of concepts was measured by a range of bipolar adjective scales (e.g., good–bad, warm–cold). The three factors (evaluation, potency, and activity) were often identified and considered as fundamental characteristics of the meaning of concepts [36]. The dimensions of evaluation, potency, and activity are measured by items such as good–bad, powerful–weak, and fast–slow, respectively.

The framework of meanings of concepts (or the semantic differential technique) has been widely applied to research on psychology, marketing, and sensory science. Specifically, the semantic differential technique has been studied by using sensory factors such as vision (e.g., color) [41], audition (e.g., sounds embedded in brand names) [42], smells [43,44], touch (e.g., materials such as metals) [45], and taste/flavor [46]. Therefore, it would be applicable for our research to examine the connotative meanings of sensory factors influencing healthy food evaluations by using the framework of meanings of concepts.

2.2. The Connotative Meanings of Sensory Factors Associated with Perceived Healthiness and/or Healthy Eating Behavior

2.2.1. Evaluation

Regarding the evaluation dimension, for example, green [47] or blue [48] colors, which are associated with higher evaluation, increase healthy food expectations compared with

other colors (e.g., red). Symmetrical (vs. asymmetrical) food shapes increase healthy food preference [49], and symmetry is generally evaluated more positively than asymmetry [50]. Brightness (vs. darkness) is perceived as having a higher evaluation and greater potency [51,52], and adjusting ambient lighting to be brighter (vs. darker) enhances healthy food choices [53,54].

2.2.2. Potency

As for the potency dimension, sensory attributes denoting lower potency increase healthy food perception and/or preference. For example, packages with lighter (vs. heavier) weight increase healthy food perception in terms of expecting fewer calorie counts [55]. The light versus heavy is one of the items used to measure potency dimension, with the light pole indicating lower potency [56]. Higher- (vs. lower-) frequency sounds in fictitious brand names increase expectations for healthy food [27] and are more associated with lower potency/higher evaluation [42]. Sonic logos and grating images that have a higher- (vs. lower-) frequency are also more matched with healthy foods [57]. Appearance of texture can engender a healthiness perception. It has been shown that consumers who see a snack food package with a glossy (vs. matte) surface infer lesser (vs. greater) healthfulness of its contents [28]. Another study also shows that food in matte (vs. glossy) packaging tends to be perceived as more natural [58]. Moreover, a soft texture, which is often regarded as having lower potency, led to an unhealthy perception (i.e., higher in calories) [59].

2.2.3. Activity

In terms of activity dimension, sensory attributes denoting lower activity increase healthy food perception and/or healthy food preference [47,48,60]. Colors (green, blue), which are associated with lower activity [61], increase expectations for healthy food compared to other colors (e.g., red) [47,48]. The cold–warm scale is one of the items used to measure activity dimension, with the cold pole indicating lower activity [36,62]. Yamim and colleagues have revealed that cold (vs. warm) food temperatures are rated as less filling and increase healthy food preference when the consumers have a health goal (aiming to reduce their calorie intake) [60]. Similarly, a warm (vs. cold) odor increases the perceived warm ambient temperature and, in turn, reduces the number of calories consumed [63].

In summary, higher evaluation, lower potency, and lower activity are likely to be connotative meanings of sensory factors that influence healthy eating behavior. We formally propose the following propositions.

P1.1. Sensory factors associated with higher evaluation lead to healthier food expectations and a greater tendency to approach healthy food.

P1.2. Sensory factors associated with lower potency lead to healthier food expectations and a greater tendency to approach healthy food.

P1.3. Sensory factors associated with lower activity lead to healthier food expectations and a greater tendency to approach healthy food.

3. Affective Responses to Sensory Factors Influencing Healthy Eating Behavior

3.1. The Circumplex Model of Affect

The circumplex model of affect indicates core affect [64] and represents a two-dimensional space of pleasure (or valence) and arousal [38]. The model was proposed by Russell and his colleagues and was expanded and refined from the pleasure–arousal–dominance model [65]. The valence dimension represents *happy/satisfied* on the positive pole and *unhappy/dissatisfied* on the negative pole [66]. The arousal dimension indicates *active/alert* on the activation pole and *passive/quiet* on the deactivation pole [66]. The relation-

ship between valence and arousal is typically V- or U-shaped [67], such that strong negative or positive affect often coincides with higher arousing states. This type of relationship is also identified in food-evoked emotions across cultures [68].

The core effect has been widely utilized in research on psychology, marketing, and sensory science [64,69]. In particular, the marketing literature has documented that valence and arousal influence consumer attitudes and behaviors [70,71]. The literature on store atmospherics shows that, in general, pleasure is associated with approach shopping behavior, higher consumer satisfaction, and more money spent [70,71]. Meanwhile, arousal is also related to higher satisfaction, more unplanned purchasing, and positive attitudes [71]. However, the effects of the arousal dimension are somewhat inconsistent and likely to be moderated by consumers' motivation [70] and/or the type of product or store [72,73].

3.2. The Affective Responses to Sensory Factors Influencing Healthy Food Evaluations

3.2.1. Valence

Visual features associated with positive valence and calm increase healthy food expectations and/or healthy food preferences. For example, green [47] or blue [48], which are associated with calmness [74], increase healthy food expectations compared to other colors (e.g., red). Symmetrical (vs. asymmetrical) food shapes increase healthy food preference [49], and symmetry is regarded as a positive effect [75]. Moreover, Peng-Li and colleagues also show that nature sounds, which are considered to induce positive calming emotions, increase explicit liking of healthy (vs. unhealthy) foods [30].

It has been suggested that higher anticipated pleasure (e.g., happiness) increases behavioral intention (e.g., purchasing) toward healthy food [76]. Specifically, Motoki and colleagues have revealed the mediating role of positive valence on the relations between background music genres and healthy food preferences [77]. Classical music, compared to other genres such as metal, induced a more positive valence, which led to a greater preference for healthy foods.

3.2.2. Arousal

Calming and/or relaxing states induced by sensory stimuli are likely to increase healthy food preferences. Using sounds as sensory stimuli, two studies suggest that relaxing states evoked by sounds increase healthy food preferences [30,78]. Peng-Li and colleagues demonstrated that soft nature (vs. noise) sounds increase the perceived relaxation and explicit liking of healthy (vs. unhealthy) foods [30]. In a related vein, Biswas and colleagues also demonstrated that lower-volume ambient music led to a greater preference for healthy foods, possibly due to increased relaxation [78]. Note that the effects of sounds on healthy food preferences were not observed when relaxation was directly induced before the main task (i.e., participants wrote an essay on relaxation time).

Together, positive valence and lower arousal are likely to be the affective basis of sensory factors influencing healthy eating behavior. We formally propose the following propositions.

P2.1. Sensory factors associated with positive valence lead to healthier food expectations and a greater tendency to approach healthy food.

P2.2. Sensory factors associated with lower arousal lead to healthier food expectations and a greater tendency to approach healthy food.

4. The Perceived Healthiness of Food

Foods are generally perceived as healthy or unhealthy. The perceived healthiness of foods is closely associated with eating behaviors such as liking food, food choice [79], and

food intake [80,81]. This suggests that the perceived healthiness of foods appears to be a driver of healthy eating behavior.

4.1. Food Characteristics: What Is in Foods

We introduce four components (Naturalness, Artificialness, Positive nutrients, and Negative nutrients) as a food type that influences the perceived healthiness of food [39,40]. The four components are theoretically chosen based on the presence–absence/nature–science framework [39] and the framework of paths to healthier eating [40]. Both frameworks assume that four components (Naturalness, Artificialness, Positive nutrients, and Negative nutrients) are key factors of the perceived healthiness of food.

4.1.1. Naturalness

Naturalness can be defined as the absence of human intervention and consists of terms such as "organic", "pure", "fresh", and "unprocessed" [39]. Consumers have a strong preference for natural foods [82], and naturalness is among the most important factors influencing their choice of healthy food [83]. The perceived healthiness of food is mainly explained by the concept of naturalness (e.g., "organic" and "harvest") [84]. Food with an organic label indicating naturalness is perceived as healthier than food without the label [85]. Several studies have found that perceived naturalness [24,49,86] and freshness [87,88] mediate the relationship between sensory factors and healthy eating behavior.

For example, Hagen tested the mediating role of perceived naturalness on the relation between pretty (vs. ugly) food and healthy perception [24]. Specifically, the results show that pretty (vs. ugly) food increases perceived naturalness, which in turn enhances perceived healthiness, ultimately leading to a greater preference for the food [24]. Moreover, the manipulation decreases the perceived naturalness (excessive prettiness, artificial modification) and attenuates the effects of prettiness on healthy perception. Moreover, Kuntz and colleagues have shown that freshness mediates relations between color saturation and healthiness expectations [87]. Participants evaluated the healthiness, tastiness, and freshness of food products with higher or lower color saturation. The results showed that the perceived freshness mediated the effects of the saturation on healthiness (and tastiness). That is, more (vs. less) saturated products increased the perceived freshness, which led to an enhanced perception of healthiness.

4.1.2. Less Artificialness

Foods with limited artificial ingredients are perceived as healthier [40]. Healthy claims in this dimension can be expressed by the absence of focus, such as "no additives", "no artificial flavor", "no preservatives", and "no chemicals" [39]. One study has shown that the effects of pretty food on perceived healthiness were mitigated when participants were informed that the food had been artificially modified [24]. This suggests that the presence or the perception of artificial information decreases the perceived healthiness of food.

4.1.3. Positive Nutrients

Foods with positive nutrients are perceived as healthier when they are added to the food [39]. Positive nutrients include fiber, protein, minerals, and omega-3 fatty acids, among others [39]. Healthy food is more likely to be described by words than by its positive nutritional content (e.g., nutritious, macronutrients) [89]. The perceived healthiness is correlated with the presence of positive nutrients [79]. Fiber content is positively associated with the perceived healthiness of food [79]. Certain colors are also associated with positive nutrients [90]. For example, green color is predominantly matched with fiber, though the color associations vary among types of positive nutrients [90].

4.1.4. Less Negative Nutrients

Negative nutrients are nutrients that negatively influence the perception of healthiness. Harmful nutrients include "saturated fat", "sugar", "calories", and "cholesterol", to name a few [39]. The nutrients are considered "negative" in the sense that excessive intake of these nutrients has detrimental effects on consumers' health. Food with more negative nutrients is evaluated as less healthy [39]. In other words, food with less negative nutrients is evaluated as healthier. Sugar and fat content is negatively correlated with the perceived healthiness of food [79]. Some research has suggested that expectations of negative nutrients (e.g., calories) mediate the relationship between sensory factors and perceived healthiness and/or healthy food perception [55,60,91]. For example, Li and colleagues show that foods described as lighter (vs. heavier) in weight were perceived as having fewer calories, which led to a healthier evaluation. It should be noted that the perceived weight of foods might be an antecedent of the calorie expectation [91]. In a related vein, Yamim and colleagues suggest that cold (vs. warm) foods are perceived as less filling [60]. Although Yamim et al. did not formally test the mediating role of filling perception in the relationship between food temperature and perceived healthiness, the mediation effect appears likely. Oral haptics of foods have been identified as the factors influencing calorie estimation. For instance, it has been demonstrated that foods with soft (vs. hard) and smooth (vs. rough) textures tend to be perceived as being higher in calories [59].

P3.1. Perceived naturalness of food (e.g., naturalness, freshness) mediates the relationship between sensory factors and healthy eating behavior.

P3.2. Perceived artificialness of food (e.g., additives, artificial flavors) mediates the relationship between sensory factors and healthy eating behavior.

P3.3. Perceived positive nutrients (e.g., fiber) mediate the relationship between sensory factors and healthy eating behavior.

P3.4. Perceived negative nutrients (e.g., fat) mediate the relationship between sensory factors and healthy eating behavior.

4.2. Food Quantity: How Much

4.2.1. The Roles of Sensory Factors in Consumers' Perception of Food Quantity

In addition to the food types, we introduce food quantity as a determinant of healthiness perception. A prior study shows that food quantity influences the perception of healthiness, although its effect is not as strong as that of a food type's impact [92].

The substantial literature on marketing and food science has documented the role of sensory factors, particularly visual cues in food packaging, in consumers' judgment of food quantity. For example, food or drink in a container with a more elongated shape (i.e., a package high in the height–to–width ratio) tends to be perceived as more [93], which is known as the elongation bias. Additionally, the elongated shape of packages is associated with concepts related to healthiness [94]. Similarly, the perception of food volume can be affected by visual cues, such as the saturation of package colors [95] and the number of product units depicted in packaging imagery [96]. In addition, visual cues on food packaging influence the perceived heaviness of the product, which can be considered as a dimension of food volume perceptions. For example, the perceived heaviness of the product is enhanced by a product image placed on the bottom (vs. top) of the package facade [97] and shadows drawn in a product picture [98].

Some studies demonstrate that consumers' size perception can be affected by the acoustic properties of a spokesperson's voice or background music. For instance, a lower (vs. higher) pitch in voice or music is associated with a larger product size [99] and leads to larger serving sizes in a self-serve retail setting [100]. Moreover, the effect of acoustic pitch

on the perceived size of the product is significant only when the product's color is in high saturation (vs. low saturation) [101].

4.2.2. Effects of Quantity on Healthy Eating Behavior

Impressions or inferences about food quantity can serve as a determinant of healthy eating behavior, particularly in terms of the volume of food consumed. The prior literature has examined the effects of portion size on the amount of food intake (see [102] for review). A meta-analysis study shows that portion size positively impacts food intake, but this relationship is nonlinear; as portions become increasingly larger, the effect diminishes [103]. Another meta-analysis revealed that larger plate sizes increased the size of the portion and the amount of consumption when the portion was self-served or participants were unaware that they were participating in a food study [104]. The elongation bias also influences the volume of food/drink purchased and consumed. A study analyzing scanner data showed that the more elongated a container, the lower its purchase quantity [105].

Besides the portion size, the visual presentation of food influences the volume of food intake. Research has demonstrated that visual aspects of food assortment moderate the effect of assortment variety on the quantity consumed [106]. For example, consumers who were given 24 (vs. 6) colors of jellybeans ate more when the jellybeans were organized by color (vs. randomly mixed together). A prior study also showed the effect of visual presentation on consumer choice. Specifically, horizontal (vs. vertical) display allows consumers to browse information more efficiently, which increases perceived assortment variety and leads to a greater variety being chosen [107].

Given these findings, we propose that visual cues of marketing stimuli (e.g., food packaging, assortment) influence consumers' eating behavior (e.g., food choice, food intake) via quantity perception (e.g., portion size, perceived heaviness, perceived variety).

P4: Perceived quantity of food mediates the relationship between sensory factors and healthy eating behavior.

5. Health-Related Motivation/Goals

5.1. Health Goals and/or Motives

Health goals serve as a moderator between sensory cues and healthy eating behavior [26,108,109]. The goal manipulation was implemented to induce a healthy or control (e.g., tasty) goal as a hypothetical scenario [26,108,109]. Prior research has shown that when participants are pursuing a healthy goal, sensory cues associated with healthiness are preferred [26,108,109]. For example, in one study, participants were primed with having a goal of tastiness (i.e., the friend attached great importance to tastiness) or healthiness (i.e., buying bread for a friend who took healthiness seriously) [108]. Then, they were asked to evaluate purchase intention for the angular or round type of bread. Participants with a healthy goal tended to report higher ratings of purchase intention for angular (vs. round) bread.

Individual differences in health-related motives, knowledge, interests (e.g., the importance of healthy eating, subjective nutrition knowledge), and/or restrained eaters act as moderators [47,109–112]. One study revealed individual differences in the importance of healthy eating as a moderator [47]. Green- (vs. white-) colored labels increased the perceived healthfulness among participants, which was of higher importance in healthy eating [47]. Additionally, Mead and Richerson examined the moderating role of subjective nutrition knowledge (e.g., "I am more knowledgeable than others about nutrition information") and restrained eating (e.g., I am on a diet) [109]. Participants viewed saturated or muted food packages and indicated healthiness expectations of the products. Interestingly, the significant effects of muted (vs. saturated) packages on healthy evaluations were ob-

served for participants with lower levels of subjective nutrition knowledge or with stronger restrained eating behavior.

P5.1. The influence of perceived food healthiness on healthy eating behavior is stronger for consumers with health goals and/or motives compared to those without these goals or motives.

5.2. Healthy-Tasty Beliefs

Healthy-tasty beliefs appear to moderate the relationship between the perceived healthiness of food and healthy eating behavior [113]. Raghunathan and colleagues revealed the existence of the unhealthy-tasty intuition in American participants. One of their studies shows that the strength of the unhealthy-tasty belief is positively correlated with differences in taste ratings between unhealthy and healthy foods [113]. That is, American participants with stronger unhealthy-tasty beliefs tend to rate unhealthy foods ad tastier than healthy foods [113] (see also [110]). Given that taste expectation is a primary driver of food choices [114], the findings of Raghunathan et al. suggest that consumers with stronger unhealthy-tasty beliefs are less likely to engage in healthy eating behavior after perceiving a food as healthy. It is worth noting that the opposite intuition is observed in France [115] and other European countries [110]. French participants are more likely to consider healthier (vs. less healthy) foods as tastier [115]. Austrian and German participants tend to associate healthiness with tastiness, although individual differences in the "healthy = tasty intuition" moderate this association [110].

Healthy-tasty beliefs are also related to socioeconomic status and food habits. Individuals with higher socioeconomic status tend to emphasize health over taste information more than those with lower socioeconomic status [116]. Moreover, individuals with a stronger healthy-tasty belief are more likely to consume vegetables, which, in turn, are associated with lower BMI [117]. Similarly, highly restrained eaters are less likely to hold the healthy-tasty belief [115]. In sum, participants with stronger healthy-tasty beliefs are more likely to eat healthily after perceiving the food's healthiness.

P5.2. The influence of perceived food healthiness on healthy eating behavior is stronger for consumers with healthy-tasty beliefs (vs. those without the goal or motives).

6. General Discussion

Our paper presents a novel and practical model, referred to as the "sensory–healthy eating model" (Figure 2). To the best of our knowledge, no research has developed a healthy food choice model that theoretically explains how and why food's internal and external factors influence healthier eating behaviors. By capitalizing on the theories of interdisciplinary fields (e.g., the circumplex model of affect, the framework of meanings of concepts, and the presence–absence/nature–science framework), we established a novel and socially responsible model. Our theoretical models assume that sensory cues denoting specific cognitive responses (higher evaluation, lower potency, lower activity) and/or affective responses (positive valence, calming feeling) induce the perceived healthiness of food (more naturalness, less artificialness, more positive nutrients, less negative nutrients). Then, consumers with health goals, motives, and/or healthy-tasty beliefs are likely to eat healthily after perceiving the food's healthiness. In sum, from a sensory marketing perspective, our research provides an integrated conceptual framework of healthy food eating to guide researchers and practitioners in promoting consumers' well-being. Further studies should empirically test our model.

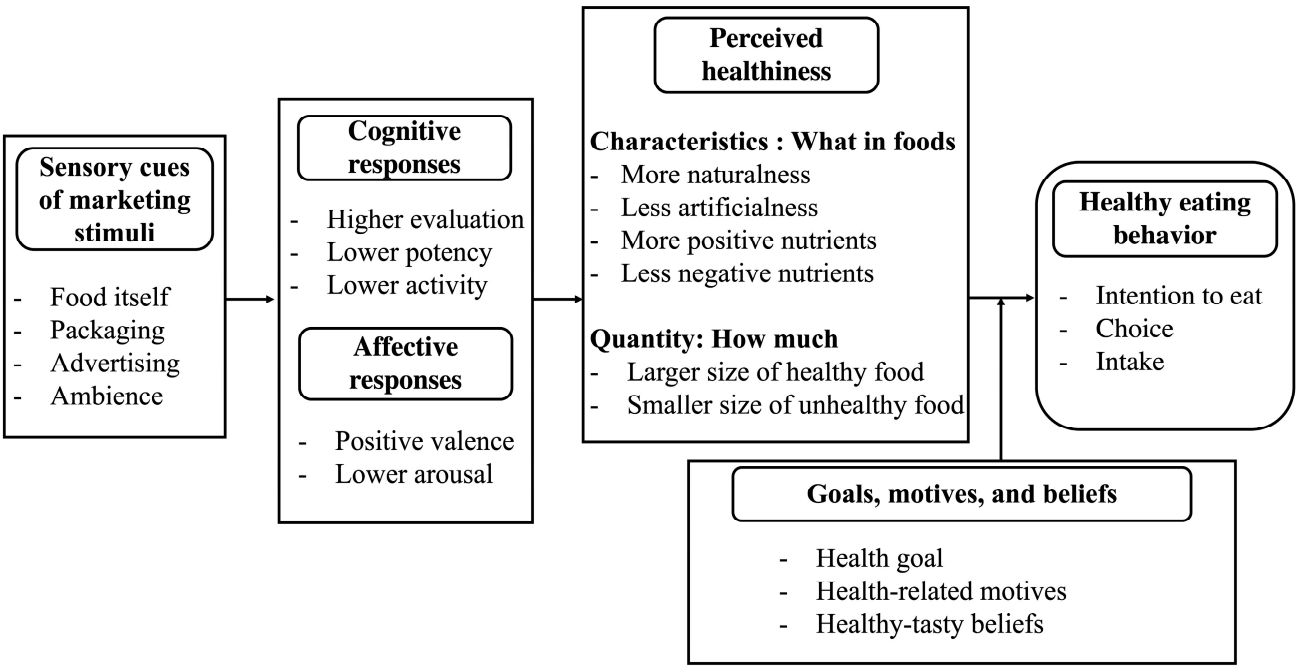


Figure 2. A theoretical model (sensory–healthy eating model) proposed in the current article. This model assumes that sensory cues evoke cognitive and/or affective responses, which influence the perceived healthiness of foods (What is foods, how much). The influence of perceived food healthiness on healthy eating behavior is stronger for consumers with health goals/motives and healthy-tasty beliefs (vs. those without the goal/motives and beliefs).

6.1. Theoretical Contribution to Sensory Marketing

Our research makes a theoretical contribution to the literature on sensory marketing. The topic of healthy eating behavior has recently garnered considerable attention in the sensory marketing literature [20,21,116]. A growing number of research has shown that sensory cues, including visual attributes (e.g., color, shape), auditory attributes (e.g., noise, background music), olfactory cues (e.g., healthy food odors), touch cues (e.g., temperature, weight, texture) evolve cognitive and affective responses and influence healthy eating behavior [21]. However, to our knowledge, no systematic framework has been provided to capture the existent findings of sensory marketing on healthy eating behavior. Our research presents a plausible theoretical model that can guide future sensory marketing research in generating valuable hypotheses for testing.

6.2. Psychological Explanations of Our Model: Congruity Theory, Spreading Activation Theory

Our model appears to be partly explained by congruity theory and spreading activation theory. The congruity theory suggests that sensory and semantic cues are interrelated into product's intrinsic and/or extrinsic cues [117]. As for sensory factors and healthy food, connotative and affective meanings seem to be interrelated. A growing body of evidence has shown that healthy foods are associated with specific connotative and affective meanings [77]. For example, healthy foods are rated as less arousing (e.g., less exciting) than indulgent foods [77]. Healthy foods are also described as less exciting than unhealthy foods in media posts (e.g., social media posts and food reviews) [118]. Moreover, healthy food tends to be linked with higher evaluation (i.e., healthy eating is regarded as "good") [119] and metaphorically expressed using less potent words (e.g., light foods) [55]. Interestingly, this paper and our framework have identified that sensory cues influencing healthy food evaluations tend to convey connotative and affective meanings similar to those of healthy foods.

Our theoretical framework and the congruency of meanings of sensory cues with healthy foods can be explained by the spreading activation theory of semantic concepts [120]. The theory suggests that semantic concepts are represented as nodes in memory [120]. The semantic concepts are interrelated or connected with other concepts via nodes [120]. Once the external stimuli (e.g., higher-frequency sounds in brand names) activate the nodes in the memory, semantic concepts within the nodes (e.g., lower potency, higher evaluation), and then the associated nodes and their linking concepts (e.g., naturalness, freshness) are activated. Moreover, it has been considered that spreading activation of semantically related concepts is pleasurable [121]. In line with this, congruent stimuli in terms of connotative and/or affective meanings have been found to result in the positive evaluation of products and/or stores [122–124]. For example, congruent scent and music in arousing states lead to greater approach behavior and higher satisfaction than an incongruent pair of scent and music [123]. These findings may partially explain why the congruency of sensory stimuli and healthy foods in terms of cognitive and/or affective responses increases healthy food preferences.

6.3. Practical Implications

Our theoretical framework offers valuable insights for policymakers seeking to promote healthy food choices. Based on our theoretical framework, they can encourage the food industry to choose sensory stimuli that are likely to increase healthy food perception and preferences. From a managerial standpoint, our framework provides practical guidelines to marketers offering healthy foods and/or beverages. For effective marketing communication, they can utilize sensory stimuli that are expected to induce specific cognitive (i.e., higher evaluation, lower potency, and lower activity) and affective (i.e., positive calming) responses. For example, sensory stimuli can be applied to a broad range of marketing contexts including packaging design, advertising, in-store music, and ambient odors, to name a few.

Moreover, our theoretical framework suggests segments or targets for sensory marketing that promote healthy food. Specifically, health goals, health motives, and/or nutrition knowledge are considered modulators that influence the effects of sensory cues on healthy perceptions and preferences. Those who have health goals, stronger health motives, and/or greater nutrition knowledge should be the target consumers. Advertisements that activate health goals may be effective [125] when paired with sensory stimuli and healthy foods.

6.4. Future Research Directions

How can the combination of EPA dimensions be related to perceived healthiness? Our model suggests that, in general, the combination of higher evaluation, lower potency, and lower activity would lead to a greater perception of healthiness. However, it is plausible that other combinations of EPA dimensions can also lead to a higher perception of healthiness. For example, although Ku-Ding tea (Ku means bitter in Chinese) may be associated with a lower evaluation and high potency, its extremely bitter taste contributes to a greater perception of healthiness. One study shows that (post-tasting) positive information about Ku-Ding tea (e.g., health benefits) increases positive evaluation of the tea regardless of its unpleasant taste [126]. Thus, future research could examine how the combinations of EPA dimensions affect the perceived healthiness of foods in detail.

How do cognitive and affective factors interact to influence healthy eating behavior? Our model treats cognitive and affective factors separately. However, given that cognition and emotion appear to be intertwined at various stages of information processing, it seems possible that these factors influence each other (e.g., higher evaluation and positive feeling

strengthen each other). Future empirical research is needed to examine these interactive effects of cognitive and affective factors on healthy eating behavior.

The effects of cognitive and affective factors on healthy food preferences may depend on the dominant nutrient in food products. Regarding the activity dimension, our models indicate that sensory factors denoting lower activity (e.g., white color) would increase healthy food preferences. However, some nutrients (e.g., vitamin C) are associated with sensory factors denoting higher activity (i.e., yellow) [90]. It seems possible that sensory factors denoting higher activity (i.e., yellow) increase healthy food products (e.g., citrus fruits).

Our model does not incorporate the cognitive experiences. Some research has argued that cognitive experiences, such as attentional processes [53,127,128], self-related cognition (i.e., psychological ownership, moral self-perception, self-accountability) [54,128–130], and congruency [31], mediate the effects of sensory factors on healthy food evaluations. Regarding the attentional process, Peng-Li and colleagues have shown that a health-related (vs. unhealth-related) soundtrack increases visual attention to healthy foods, leading to healthier food choices [127]. In terms of self-related cognition, it has been demonstrated that moral self-perception (e.g., "I am moral") mediates the relationship between higher- (vs. lower-) pitched music and healthy food choices [129]. Higher- (vs. lower-) pitched music increased moral self-perception, leading to a healthier preference. Wan and colleagues also showed that congruency and feeling right mediate the between ad color and healthy food preferences [31]. Participants viewed black-and-white or color ads that focused on either taste or health. The results demonstrated that black-and-white (vs. color) ads increased positive attitudes when the ads focused on health, and the effects were driven by perceived congruence and a sense of "feeling right".

Similarly, our model focuses exclusively on sensory cues and does not account for other influencing factors. However, consumer decision-making involves multiple elements, such as prior experiences, price sensitivity, and convenience. Future studies should incorporate these factors and further explore their interaction with sensory cues in shaping consumer food choices.

Future studies should empirically test our model. For example, researchers could manipulate sensory cues in marketing stimuli as a between-participants factor (e.g., country music vs. heavy metal) and measure cognitive and affective responses (i.e., EPA dimensions and core affect) as the first mediators. Additionally, perceived healthfulness should be measured as the second mediator, while individual difference factors (e.g., health-related motives) should be assessed as moderators. Healthy food choices should be served as the outcome variable. Researchers can test these variables using PROCESS Model 87, which includes one predictor (X), two mediators (M1 and M2), one moderator (W), and one outcome (Y).

6.5. Implications for Gastronomy

Our theoretical framework offers valuable implications for gastronomy, aiming to promote healthier food choices. Our framework offers actionable guidance for chefs, culinary professionals, and food designers who promote healthy foods or beverages. In marketing communications, they can apply sensory cues that are expected to trigger specific cognitive responses, such as improved evaluation, reduced potency, and decreased activity, as well as affective responses, including positive and calming feelings. These sensory elements can be incorporated into various marketing strategies, including packaging design, advertising, in-store music, and ambient scents, among others.

However, it is important to acknowledge potential barriers to the effectiveness of these strategies. Consumer skepticism toward sensory-driven food marketing warrants further consideration. If consumers feel their sensory perceptions are being deliberately manipu-

lated, they may react negatively, leading to resistance rather than increased acceptance of healthy food choices. Additionally, there is a risk of unintended consequences, such as over-reliance on sensory cues at the expense of actual food quality. These concerns highlight the need for a balanced approach, ensuring that sensory strategies are used transparently and ethically. Furthermore, these strategies may not be universally effective across all consumer groups. Their effectiveness may depend on individual differences in health motives and health interests or on cultural groups in which these factors are particularly emphasized. In particular, sensory cues that convey perceived healthiness may be more effective among individuals with high health consciousness or within cultures where health awareness is deeply ingrained in food choices.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/gastronomy3020006/s1, Table S1: Representative research on sensory factors influencing the perception and preference for healthy food. References [131–141] are cited in the Supplementary Materials.

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