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REVIEW

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A review of the cognitive and sensory cues impacting taste perceptions and consumption

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Abstract

Food has a daily impact on all consumers, requiring frequent evaluations and decisions pre-consumption, during, and post-consumption. Given the number of consumer interactions and the complexity of the food consumption process, researchers have increasingly studied food from both a sensory standpoint and cognitive standpoint. In this review, we create a framework for this existing research. Specifically, we discuss research addressing the key sensory drivers of taste perceptions and consumption, including all five senses: vision, olfaction, audition, haptic, and/or taste. We also identify key cognitive contextual drivers of taste perception and consumption within a marketing context, including social cues, atmospherics, branding, and advertising. Building from the extant literature, we generate and propose areas for future food-related research.

KEYWORDS

food and nutrition, hedonic and experiential consumption, marketing, sensory

1 | INTRODUCTION

While seemingly straightforward and somewhat mundane, frequently occurring events, food consumption experiences are incredibly complex processes. Beyond the taste of the food on one's tongue, there are myriad factors that influence the richness of the complete sensory taste that one experiences when consuming food. While we acknowledge that "taste" most accurately refers to the sensory and perceptual experience of the tongue, we will use the taste label to broadly refer to the combined impact of sensory and other cues on the evaluation of the food consumption experience. We will examine how certain cues impact overall enjoyment and also impact consumption. From a sensory perspective, cues intrinsic to the perceptual experience of consuming the food, or bottom-up cues, including all five senses—vision, olfaction, audition, haptic, and ultimately gustation (or taste) of the food—impact taste evaluations directly. These perceptual experiences are supported by more cognitive, extrinsic, top-down cues, such as what is stated in a food advertisements, menus, reviews, or product packaging, and also one's context when consuming the food—both social and environmental which can impact taste and consumption in a sensory or cognitive manner. We focus on both the sensory (bottom-up, intrinsic) and cognitive (top-down, extrinsic) cues that influence taste and consumption, as well as the interaction between these cues by examining the interplay between perception and cognition. Additionally, we explore relevant research on food, taste, and consumption and propose areas for future research.

The structure of this review is as follows: We will first provide details about the physiological and neural construction of taste, as well as the multisensory nature of taste perception. We will then examine relevant research on how sensory, bottom-up cues from food itself—the visual, olfactory, auditory, haptic, and/or textural cues from food influence taste and consumption. We then present research on how top-down cues from the context (cognitive or sensory) impact taste perception and consumption. These include marketer influences such as advertisements, branding, and product information, as well as environmental cues such as scents and lighting and social cues. Our overarching framework for this review is visually represented in

Aradhna Krishna and Ryan S. Elder contributed equally to the project.

Figure 1. We begin with the physiological and neural construction of taste and its multisensory nature.

We note that our review is not exhaustive. Food research is popular, and an exhaustive review is virtually impossible. For other reviews (related more to food consumption and healthy eating than to taste), see reviews by Cadario and Chandon (2019, 2020). Cadario and Chandon (2019, 2020) review research on healthy eating behaviors. The researchers review literature describing nudges to consume healthier foods (Cadario & Chandon, 2019), and also conduct a meta-analysis of field experiments looking at the efficacy of different types of healthy eating nudges (Cadario & Chandon, 2020). While these previous reviews have focused on consumption quantity and healthy eating, we focus primarily on reviewing the literature on taste perception and the consumption experience; however, we will also touch on consumption quantity.

2 | Sensory Experiences from Food and Taste

Taste as we perceive it is multisensory. The sensory experiences from the tongue, represented by the five basic tastes, are only a relatively small input to the overall taste experience. When simply relying on the tongue to define a food consumption experience, individuals have a hard time discriminating between foods with similar textures. When smell and sight are constrained, potatoes taste similar to apples, and red wine tastes similar to coffee (Herz, 2009). It is only with multisensory inputs that taste is formed. For example, while 75% cacao dark chocolate might elicit taste perceptions of sweet and bitter, but the complexity of the taste experience is greatly enhanced by the dark, rich color, the fruity smell of the chocolate, the crack of the chocolate when bit, and the texture of the chocolate as it melts in one's mouth.

The construct of taste primarily represents the combination of taste and smell, and is referred to as flavor. But, taste also includes the other three senses. Note, however, that because of the dominance of taste and smell in the taste experience, multisensory taste is often referred to as flavor (Spence, 2015). Thus, Breslin and Spector (2008, p. R153) state that "the convergence of sensory inputs in some cortical areas provides the anatomical infrastructure for integration that might subserve the perception of flavor." This convergence occurs from a neural perspective in parts of the orbitofrontal cortex, referred to as the secondary taste cortex (Rolls, 2005). The fact that flavor perception represents a combination of multiple sensory inputs means that what consumers commonly think of as the taste of the food is directly impacted by other bottom-up sensory cues. We will discuss relevant research showcasing the impact on taste of each sense individually before looking at how multiple sensory experiences impact taste simultaneously.

2.1 | How taste experiences are formed

Taste, or the perception of sensory experiences on the tongue, is a chemical process whereby receptor cells in the tongue are activated by different compounds (Breslin & Spector, 2008). Taste receptor cells on the tongue, called taste buds when roughly 50–100 are grouped together, transmit the incoming sensory information to the brain, and have a lifespan that ranges from 10 days to over 3 weeks (Hamamichi et al., 2006). Once taste leaves the tongue and travels to the brain, it travels to the primary taste cortex in the frontal operculum and insula (Rolls, 2002).

Perceptions of sweet, sour, salty, bitter, and umami represent the chemical reactions and neural processing. Umami, which was discovered in 1908 (Ikeda, 2002), captures the savory nature of taste. Oleogustus, or the flavor of fat, has also been proposed to

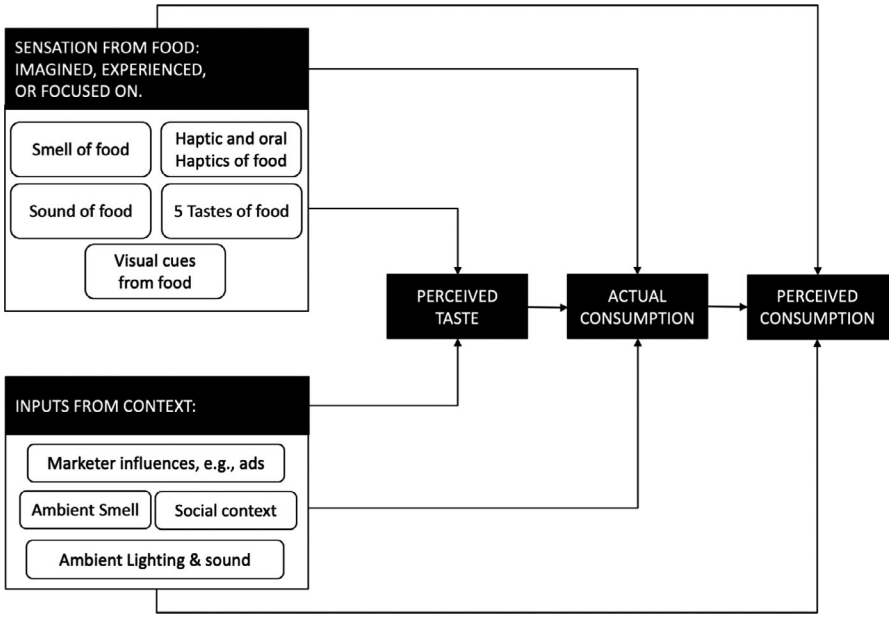

FIGURE 1 Review framework

be a basic taste sensation (Running et al., 2015). While commonly mapped to specific areas of the tongue, these specific taste perceptions are actually experienced throughout the mouth (Smith & Margolskee, 2001). Despite having five or potentially six basic taste sensations, as noted earlier, humans are poor at discriminating among different taste experiences (Herz, 2009). This leads to a reliance on other sensory cues in forming evaluations of consumption experiences.

2.2 | Taste and Smell

Taste and smell combine to form the perception of flavor (Small et al., 2005). One of the reasons that smell is so closely associated with taste is that smell impacts the evaluation of food twice during consumption. This occurs through orthonasal and retronasal olfaction (Rozin, 1982; Small et al., 2005). Orthonasal olfaction refers to the process of smelling stimuli that are outside of one's mouth. Retronasal olfaction refers to the process of smelling stimuli once they are inside the mouth. Thus, there are two direct inputs from smell on the flavor experience.

2.2.1 | Real smell, salivation, and desire to eat

Despite the critical connection between smell and taste on flavor, surprisingly little research in consumer behavior has examined the impact of smell on "taste evaluations" or on consumption. Most of the previous research relating smell to food looks at the effect of smell on salivation—which is considered to be a largely nonconscious physiological process which is stimulated while eating to help in digestion (Spence, 2011), and is even elicited through learned or conditioned reflexes by smelling appetizing foods (Pangborn et al., 1979). In addition to salivation, Wisniewski et al. (1992) showed that a palatable food stimulus can also lead to a desire to eat. Real smells from food (e.g., from a lemon; see Pangborn, 1968) are used in most of these studies.

Food companies seem to know the powerful connection between food smells, salivation, and longing for food. Thus, cookie, pizza, and Cinnabon stores in malls blow artificial smells (purportedly) of their foods into the mall to tempt shoppers. And, Hershey's store in Times Square blows artificial scents of chocolate into their store to entice patrons to purchase their chocolate (Cuda, 2019).

2.2.2 | Imagined smell, salivation, desire to eat, and consumption

While these are real smells, Krishna et al. (2014) propose the notion of "smellizing" (imagining smells) and explore the impact of olfactory imagery on food consumption experiences. The authors focused on the impact of orthonasal olfaction, such as scents coming from advertisements and imagined scents, physiological responses, and consumption. They show that both real and imagined scents can impact salivation, desire to eat, and consumption; but, that imagined scents require a visual representation of the stimulus to impact these measures (see Figure 2). Actual scents, such as those coming from the food stimulus itself, do not require a visual input to be operative. Their research also provides additional evidence for the existence of olfactory imagery (or smellizing)—a topic of some controversy.

Given the importance of the interaction between taste and smell in impacting food evaluations, more consumer psychology research is needed in this area. We next explore the impact of vision on taste perceptions. Visual cues in food consumption, also critically important in food evaluations, have received increased attention.

2.3 | Taste and Vision

The old adage, we eat with our eyes, has received considerable empirical support. Vision directly impacts taste perceptions and consumption through product color, through a cognitive, external cue such as product packaging, or from visual representations of the food item.

2.3.1 | Color and Taste

In a research context, Dubose et al. (1980) show that determining the flavor of a colored beverage is a very challenging task for consumers when color is obscured or manipulated. Participants in their studies were only able to identify the flavor of the beverages 20%

FIGURE 2 Advertising stimulus used in Krishna et al. (2014) [Colour figure can be viewed at wileyonlinelibrary.com]

Glossy Package Matte Package

FIGURE 3 Experimental stimuli used in Ye et al. (2020) [Colour figure can be viewed at wileyonlinelibrary.com]

of the time when they were unable to see the color, compared with 1,000% when the color was representative of the flavor. When the color was directly manipulated, the majority of participants inaccurately identified the flavor with the color versus the taste.

The sensory dominance of vision when determining taste has also been shown in consumer behavior research. Hoegg and Alba (2007) explored the role of different cues on taste preference and taste discrimination. Participants in one of their studies were presented with four samples of orange juice that varied in sweetness. One sample was low sweet, two were medium sweet, and one was high sweet. In a condition where color was manipulated, the two medium-sweet samples were of different colors. Participants then rated the perceived differences between the low- and medium-sweet conditions, the differences between medium and medium-sweet conditions with different colors, and the difference between medium-sweet and high-sweet orange juices. The authors found that difference ratings were significantly higher for juices with the same sweetness (taste) but with different colors than for juices with the same color but different sweetness. Thus, visual cues dominated the interpretation of taste.

2.3.2 | Visual cues on packaging and taste

Visual cues within product packaging can also directly impact perceived tastiness of food. One such cue is the glossiness of the packaging. Ye et al. (2020) propose that consumers have learned to associate glossy packaging with unhealthy foods, and matte packaging to be associated with healthy foods. Given the common perception that unhealthy foods are tastier than healthy foods (Raghunathan et al., 2006), glossy packaging aligns with goals to consume tasty foods. The researchers designed a field experiment wherein snack foods were sold in glossy or matte packaging on food trucks that served either hamburgers or salads (see Figure 3 for experimental stimuli used; Ye et al., 2020). The authors proposed that those choosing to eat at the salad food truck would be motivated by the health of the items and would be more likely to choose snack foods presented in matte packaging. Those choosing to eat hamburgers were proposed to be motivated by taste and consequently more likely to choose snack foods presented in glossy packaging. Indeed, this is what the authors found. Over a 25-day test period, the salad food truck sold more snack foods in matte packaging, whereas the hamburger food truck sold more snack foods in glossy packaging.

While Ye et al. (2020) research focuses on congruence between matte and healthy, and between glossy and unhealthy, Marckhgott and Kamleitner (2019) focus on what matte packaging and glossy packaging convey directly at the point of sale. They demonstrate that food in matte packaging can be perceived as more natural and expected to be tastier. While these two articles show that consumers expect food contained in matte packaging to be more natural and healthier, Ye et al. (2020) show that glossy packaging leads to tastier expectations, whereas Marckhgott and Kamleitner (2019) show that matte packaging leads to tastier expectations. These latter findings are contradictory with one another. One possible explanation proposed by Ye et al. (2020) is that the order of measurement in Marckhgott and Kamleitner's (2019) studies had perceptions of naturalness asked before tastiness questions, potentially leading to response biases. However, this remains an open question that future research should work to resolve.

The research above on the impact of visual cues on expectations has backing from neuroscience research as well. Visual representations of food have been shown to activate regions of the brain associated with taste (Simmons et al., 2005). Simmons et al. (2005) conducted event-related fMRI, while participants viewed images of food and locations. The food images, which were pretested to be appetizing (e.g., chocolate chip cookies and cheeseburgers), led to

TABLE 1 Importance of sensory cues (Elder & Mohr, 2016)

	Sensory experience				
Question	Sound	Vision	Taste	Smell	Texture
Importance to start eating	3.26[a] (0.101)	5.57[b] (0.077)	6.49[c] (0.057)	5.66[b] (0.074)	5.13[d] (0.096)
Importance to stop eating	3.14[a] (0.104)	5.28[b] (0.101)	5.82[c] (0.089)	4.79[d] (0.109)	4.82[d] (0.111)
How quickly bored of sensory experience	4.50[a] (0.124)	3.70[b] (0.112)	2.28[c] (0.099)	3.32[b] (0.103)	3.47[b] (0.109)
Importance to meal enjoyment	3.17[a] (0.110)	5.34[b] (0.094)	6.77[c] (0.039)	5.73[d] (0.071)	5.21[b] (0.095)

Note:: Numbers in parentheses represent the standard error of the means. Means that have no superscript in common are significantly different from each other (Bonferroni-corrected; $p < .05$).

significantly more brain activation in areas of the brain associated with taste, such as the gustatory cortex (right insula/operculum) than images of locations. Simply viewing pictures of appetizing food activated brain regions responsible for processing taste. The impact of visual cues on the taste experience has also been shown to have sensory-specific satiety implications. The behavioral implications of this are explored next.

2.3.3 | Seeing food cues and liking for food

Larson et al. (2014) examined how repeated visual exposure to food cues (i.e., pictures) might facilitate mental simulations of taste experiences. The researchers had participants view either 20 or 60 pictures of either salty or sweet foods. After viewing the pictures, participants were given three peanuts (a salty food) to consume and were asked how much they enjoyed eating the peanuts. As predicted, for participants who were shown sweet images, there was no difference in the liking of the peanuts based on how many pictures of sweet foods they saw. However, for participants who were shown salty images, those who saw 60 images enjoyed eating the peanuts significantly less than those who saw 20 images. Thus, visual cues of stimuli that were similar to specific sensory experiences impacted the taste experience of a food.

Vision has an impact on taste from both a bottom-up, intrinsic sensory property of the food, and top-down, extrinsic cues. Given the dominance of vision in driving sensory experiences, there are still myriad avenues to explore the role of vision on taste.

2.4 | Taste and sound

2.4.1 | The sound of crunchiness and taste

Of the sensory experiences, sound has a unique impact on taste perceptions. The intrinsic properties of sound in food consumption are only evident once the food is being consumed. Crunchiness or crispiness is important auditory characteristics of the consumption experience impacting taste and have been shown to impact perception of freshness (Zampini & Spence, 2004). In a clever experimental design, Zampini and Spence (2004) had participants seated in a soundproof booth bite potato chips in front of a microphone. Each participant was wearing a set of headphones. The sound of the bite of the potato chips was modulated by the amplitude and frequency of the sound. The perceptions of crispness and freshness were impacted directly by these manipulations. Similar findings have been found with other food stimuli (Dematte et al., 2014).

2.4.2 | How the sound of eating impacts the act of eating

Sound is also reported to be the "forgotten" flavor sense (Spence, 2015). Elder and Mohr (2016) asked participants in a survey to rate the importance of each of the sensory experiences when evaluating food experiences, including when to start eating, when to stop eating, how quickly individuals got bored with each sensory experience, and how important each sensory experience was for meal enjoyment. Specifically, they asked: "When determining what you are going to eat, how important are the following food-related sensory cues?" (1 = not at all important; 7 = extremely important); "When determining when to stop eating, how important are the following food-related sensory cues?" (1 = not at all important; 7 = extremely important); "In a typical meal, how quickly do you get bored of the following sensory experiences when eating?" (1 = not at all quickly; 7 = extremely quickly); and "How important is each food-related sensory experience in determining how much you enjoy your meal?" (1 = not all important; 7 = extremely important). They found that sound was rated as the least important sensory input to decide when to start eating and when to stop eating. Sound was also the sensory experience that participants got bored of most quickly and was rated as the least important sensory experience for overall meal enjoyment (see Table 1 for full data). Elder and Mohr (2016) used this information to highlight that sound might serve as a unique consumption monitoring cue. They show that when the sound the food makes during chewing is made more salient, consumption decreases. In one study, they manipulated food sound salience by altering the volume of white noise played in participants' headphones while they ate. Louder white noise reduced the salience of the food sound and led to less consumption than when the white noise was quieter.

2.4.3 | Sound of a brand name and taste

The sound that a brand name makes is another extrinsic cue that impacts taste expectations (Yorkston & Menon, 2004). The sound symbolism communicated via vowel sounds impacts perceptions. For example, brand names for ice cream that contain an *ä* sound (e.g., Frosh) led to significantly richer, creamier, and smoother perceptions of the ice cream than brand names that contained an *i* sound (e.g., Frish). Interestingly, the authors found that the effects of brand name on perceptions were moderated by diagnosticity, such that the effects only obtained when the brand name was presented as the true brand name rather than a test name.

More recent work has explored brand name sounds on the individual taste experiences (i.e., sweet, sour, salty, bitter, and umami; Motoki et al., 2020). The authors build off of prior research to propose that certain vowels and consonants will be associated more with size perceptions, pleasantness perceptions, and even specific tastes (e.g., sweet or sour), with the consequence that using such sounds in brand names will alter taste perceptions. Participants were presented with brand names that varied in the vowel sound (e.g., front vowels such as "I" or "e," or back vowel sounds such as "a," "o," or "u"), whether the consonants were fricatives (i.e., softer sounds such as "f" or "s") or stops (i.e., harder sounds such as "p" or "t"), and whether the consonants were voiced (i.e., consonants that vibrate the vocal cords) or voiceless (i.e., consonants that do not vibrate the vocal cords). This systematic approach in brand name construction led to interesting findings. For example, brand names with fricative consonants that were voiceless and used a front vowel (e.g., "Sefi") led to the highest perceptions of sweetness and the greatest preference scores, while stop consonants that were voiced and used a front vowel (e.g., "Gebi") had the lowest perceptions of sweetness and lowest preference scores.

Although sound may not be the most critical intrinsic cue to input taste perceptions, the variety and number of extrinsic auditory cues make studying the impact of audition on taste and consumption an important future research direction.

2.5 | Taste and Haptics

As with the other sensory experiences, haptics can impact taste and flavor perception from both intrinsic cues such as oral haptics and product texture (Biswas et al., 2014; Bult et al., 2007), and temperature (Cruz & Green, 2000), and extrinsic haptic cues such as the manual haptic feel of the cup a beverage is delivered in (Krishna & Morrin, 2008).

2.5.1 | Oral haptics, calorie perception, and consumption

The oral haptics or mouthfeel of food consumption, such as rough versus smooth, or hard versus soft, impact perceptions of how much one has to chew on the food, which impacts fatty perceptions, calorie estimations, food choice, and even consumption volume (Biswas et al., 2014). In one study, using visually identical chocolates that varied in hardness (hard versus soft), Biswas et al. (2014) show that a softer chocolate, which led to less mastication (chewing) and fattier orosensory perception, ultimately led to higher calorie estimates. The impact of oral haptic texture perceptions also impacts flavor perceptions directly, with greater flavor intensity from liquids with lower viscosity (Bult et al., 2007). Temperature of food, which also serves as an oral haptic input, can additionally impact taste perceptions. Most directly, simply warming the tongue can lead to sweet and bitter tastes, while cooling the tongue can lead to sour and salty tastes (Cruz & Green, 2000).

2.5.2 | Nondiagnostic haptic cues and taste

Krishna and Morrin (2008) show that even nondiagnostic manual haptic cues, unrelated to the food product itself, can impact taste and quality perceptions. Specifically, they show that the quality of a glass (either firm or flimsy) impacts ratings of quality for the water in the glass, with firm glass leading to more positive perceptions of water quality than flimsy glass. The impact of the haptic quality of the glass on quality ratings of the water was greater for those low in autotelic need for touch (Peck & Childers, 2003) than for those high in autotelic need for touch. This occurs as those high in the autotelic dimension of need for touch could discount the nondiagnostic nature of the manual haptics of the glass on perceptions of the water.

As with the other sensory experiences, touch impacts taste in both intrinsic, sensory ways, and through extrinsic, more cognitive pathways. Oral haptics and manual haptics each can impact taste perceptions.

We have highlighted how sensory cues play a critical role in impacting taste perceptions. We next turn our attention to reviewing the literature on the impacts of cognitive cues on taste and consumption, including marketing cues, and contextual and social factors.

3 | Cognitive cues, taste, and consumption

We break up our discussion here into marketing influencers of taste, which include food advertisements, menus, reviews, or product packaging, and also contextual cues when consuming the food—both social and environmental. We begin with the first. Note that in our discussion of cognitive cues, we discuss their influence not only on taste, but also on consumption, since much of this work is highly related.

An important distinction to note is that between actual consumption and perceived consumption. The former refers to what one actually eats, whereas the latter to what one thinks one has eaten. Perceived consumption when systematically inconsistent with actual consumption shows that the stomach can be fooled and has incredible ramifications for obesity. To the best of our knowledge,

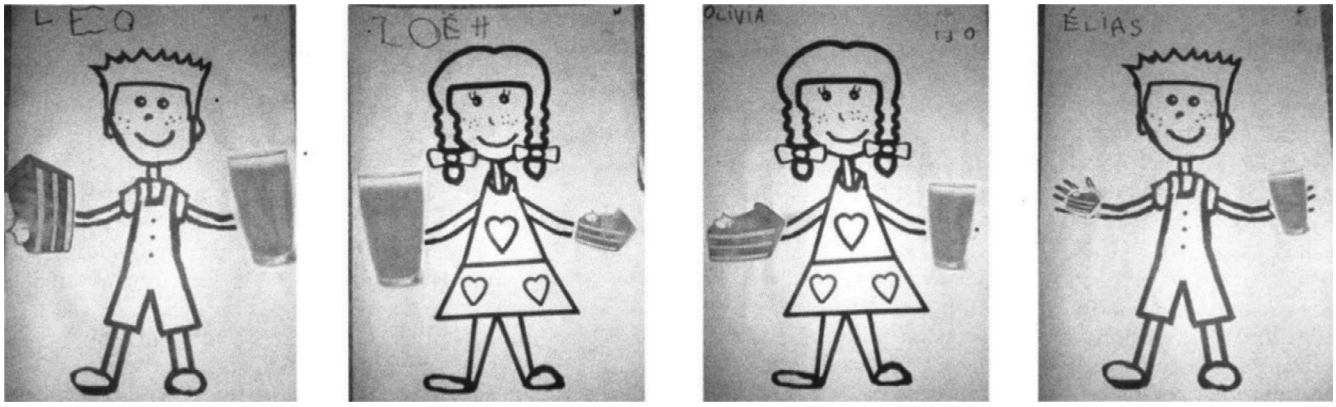

FIGURE 4 Stimuli used in Cornil and Chandon (2016; Study 1 stimuli taken from Figure 1)

this concept was first introduced by Raghubir and Krishna (1999, discussed later).

3.1 | Marketing influences on taste and consumption

Given the malleability of taste perceptions and the reliance on other information to define and perceive food and beverage consumption experiences, marketers spend considerable amounts of money with the intent to shape these experiences. Indeed, many of the extrinsic cues impacting taste discussed earlier are forms of marketing communications or branding information.

3.1.1 | Multisensory food ads versus taste ads—effect on taste

We begin with a multisensory exploration. Elder and Krishna (2010) explored the impact of verbal advertising copy that highlighted the multisensory nature of taste, thereby making salient the intrinsic elements of taste perception by calling them out in an extrinsic form of advertising. The researchers created advertisements that either focused on taste aspects of the advertised product or focused on multiple different sensory experiences. An example advertisement stimulus from one of their studies appears below used to describe popcorn in the single-sense (versus multiple-sense) condition:

> Emerald Aisle popcorn delivers the taste (smell) of a movie theater in your own home. You'll taste (see) the perfect amount of butter and salt in every handful. With its delicious, buttery flavor (texture) and a taste that dances on your tongue (crunch that's music to your ears), Emerald Aisle popcorn is the perfect choice for all your snacking.

The authors find that the multiple-sense (versus single-sense) advertisement leads to significantly more positive sensory thoughts and more positive taste perceptions. In other words, the ad directs attention to all the senses, so that the taste experience itself becomes richer.

3.1.2 | Multisensory appeals—effect on consumption

The same idea of making the taste appeal richer by bringing attention to all senses is used by Cornil and Chandon (2016)—not in ads, but in direct appeals, and to look at consumption. Cornil and Chandon (2016) show that multisensory imagery (versus control, or simulated satiation) leads to greater expectations of consumption enjoyment and impacts actual enjoyment. In addition, such multisensory appeals included in menu descriptions directly impact consumers' portion size selections. The authors propose that when given the choice of food size portions, consumers ask whether it will satisfy their hunger, whether it will affect their health and weight, and how much pleasure they will receive from its consumption. Since pleasure from food peaks after only a few bites due to sensory-specific satiety, smaller (versus larger) portions of food should lead to greater pleasure overall. Given the increased expectations of enjoyment from vivid multisensory imagery, sensory pleasure should be more heavily weighted when choosing among portion sizes as consumers focus on maximizing their pleasure, which would lead to smaller portion sizes chosen. Indeed, this is what the authors show.

In one study, the authors explored the impact of multisensory imagery on portion size choice among preschool students in France (Cornil & Chandon, 2016). The students were asked to cover their eyes and either imagine multisensory experiences with three different foods (e.g., the smell of a chocolate waffle) or imagine multisensory experiences with three nonfood experiences (e.g., the warmth of the sun on their skin). They were then asked to select stickers of various sizes of cake and soft drinks and place them on a picture representing themselves (see Figure 4). The students then chose their actual food portions. The authors found that the multisensory imagery (versus nonfood imagery control) condition led to significantly smaller stickers used and smaller actual portions selected for both cake and soft drinks. Overall, across their studies, they show similar effects, with multisensory imagery leading to heightened expectations for consumption enjoyment and smaller portions chosen.

3.1.3 | Brand name—effect on taste

Brand name is another cue that influences taste perception. As discussed, the sound a brand name makes can impact perceptions of creaminess or richness of a product (Yorkston & Menon, 2004). Brand names can also serve as a diagnostic cue impacting taste perceptions. In early research, Allison and Uhl (1964) showed that brand name can dominate taste perception, with loyal beer drinkers unable to discern their favorite beer when given a blind taste test. Hoegg and Alba (2007) additionally show that those inexperienced with discriminating between tastes of orange juice rely on brand name rather than taste. Neuroscience evidence also supports the fact that brand logos can impact taste perceptions. When Coca-Cola and Pepsi were delivered to participants blindly in an fMRI study, participants showed neural activity that aligned with their preferences (McClure et al., 2004). However, when brand identifying information was present, brain responses differed significantly, with Coca-Cola leading to more activation in the hippocampus, DLPFC, and midbrain.

3.1.4 | Nutrition and ingredient labels and taste

Another marketing variable that influences taste perception are the labeled ingredients in a food or beverage. When labeled as healthy, food items become less tasty (Raghunathan et al., 2006). These types of labels alter the actual perceptual experience rather than simply adjusting the cognitions surrounding the experience (Lee et al., 2006; Litt & Shiv, 2012). Lee, Frederick, and Ariely had participants assigned to one of three conditions (blind, before, and after). They created a beer that had a unique ingredient in it—balsamic vinegar—that enhances the flavor of beer but is unique enough to cause some aversion prior to consumption. In the blind condition, participants sampled beers and indicated preferences without any additional information. In the before condition, participants were given ingredient information about the beer prior to consumption and indication of preferences. In the after condition, participants were given ingredient information after consumption but before indication of preference. They found that the after condition and the blind condition led to similar preferences of the beer. However, knowing the ingredient information before consumption altered the consumption experience and changed preferences.

3.1.5 | Price and taste

Work exploring the impact of price on taste builds off of research showcasing the impact of price on expectations (Gneezy & Gneezy, 2011; Plassmann et al., 2008; Shiv et al., 2005). Plassmann et al. (2008) explored the specific impact that price would have on experienced pleasantness via neural processes. The authors had participants scanned using an fMRI while consuming three different wines, with price information preceding consumption and experienced pleasantness ratings. The results showed a significant impact of price on rated experienced pleasantness, supporting prior behavioral work examining the impact of price on expectations (Gneezy & Gneezy, 2011; Shiv et al., 2005). More importantly, the results additionally showed that price information on its own increased brain activity in the orbitofrontal cortex, an area associated with pleasantness and reward.

3.1.6 | Food package design and consumption

Information from product packaging and containers can significantly impact food consumption behavior for both actual consumption and perceived consumption. Raghubir and Krishna (1999) show that container shape can differentially impact perceptions of volume before and after consumption. Specifically, they show that consumers expect taller containers to contain more volume, whereas perceived consumption is reported as greater from shorter containers. Consumers additionally make errors in food volume estimates when more than one dimension (e.g., length, width, or height) of a container changes (Chandon & Ordabayeva, 2009). For example, when participants were asked to triple the amount of cocktail mixture in a container, participants poured significantly more into a conical container where three dimensions change versus a cylindrical container where only one dimension changes. When pouring content out of rather than into the initial container, these effects reversed, with greater content poured out of the conical container than the cylindrical container.

Package size serves as a consumption signal to consumers, such as whether or not a product is to be completely consumed in one setting (Coelho do Vale et al., 2008; Ilyuk & Block, 2016). Single-serve packaging, like a sealed package of five sport jellybeans, feels more complete and adequate to consumers than one serving from packaging containing multiple servings, such as a resealable package of fifteen sport jellybeans, or three servings (Ilyuk & Block, 2016). This adequacy mediated the impact of serving size format on performance, with the single-serve packaging leading to increased performance. The size of the packaging also impacts quantity consumed. Coelho do Vale Pieters and Zeelenberg (2008) show that when hedonic food products are packaged in small versus large formats, participants expect the packaging to help control consumption. However, the authors show that when self-regulatory concerns were activated by making physical health salient, participants were able to resist temptations from large format packaging (e.g., potato chips) more than from small format packages. Put differently, small format packages led to increased likelihood of consumption for participants who had self-regulatory concerns active.

The above findings compellingly show that the size of the container the food or beverage is served in, or the product packaging that contains the food itself, directly impacts consumption decisions. The information contained on such packaging in the form of labels additionally impacts consumption.

3.1.7 | Food labels and consumption

Aydinoğlu and Krishna (2011) examine the power of "food size labels." As we know, labels are simply descriptors, but they can change the way you think. They test what happens when a moderate amount of food is labeled as a small size or a medium size. They find that when it was labeled small, people eat more of the same portion that is given to them, than when it is labeled medium; more interestingly, they think that they have eaten less—that is, the label even fools their stomach. The same effect does not happen in reverse—that is, when a small(ish) size of food is labeled medium or small, there is little difference in consumption. It is as if people need a reason to eat more without guilt, and just the label of the food can help them do this.

Labels containing caloric information can similarly impact consumption quantity. Tangari et al. (2019) show that when calories-per-serving information is present on packaging it leads to more consumption of unhealthy items than when calories are listed as a double serving. The authors propose and show that this effect occurs due to the calories-per-serving being lower than expectations, allowing for increased consumption.

Other labels that impact consumption behavior include those reflecting the healthiness of the food (Finkelstein & Fishbach, 2010). When foods are labeled as being healthy, such as bread that is "nutritious, low-fat, and full of vitamins," consumers were hungrier following consumption than when the foods were labeled as being tasty, such as bread that is "tasty, with a thick crust and soft center."

The consequences of different cognitive cues impacting taste and consumption, such as advertising, branding, price, packaging, and labeling, have direct marketing and societal well-being implications. In addition to sensory and cognitive cues, social and environmental cues also impact food consumption. We next discuss relevant research in these areas.

4 | Social and environmental contextual cues and food consumption

4.1 | Environmental cues and food consumption

4.1.1 | Ambient smells and food purchase

Biswas and Szocs (2019) show that when scents of indulgent (versus non-indulgent) foods are presented in a store for a relatively long time (e.g., >2 min), choices of unhealthy foods are lower. These effects are obtained within both laboratory and field settings. In the field experiment, they dispersed ambient scents for indulgent (i.e., cookie) or non-indulgent (i.e., strawberry) foods via a nebulizer. The researchers then collected receipts from shoppers and examined the percentage of unhealthy versus healthy foods selected. They found that when there was an indulgent scent, shoppers purchased a higher percentage of healthy versus unhealthy foods. But, when the scent was not indulgent, shoppers purchased a higher proportion of unhealthy versus healthy foods. Thus, although not directly impacting taste perceptions, prior research shows that scent can have a significant impact on food purchase behavior. The authors suggest that prolonged exposure to an indulgent/rewarding food scent induces pleasure in the reward circuitry, which in turn diminishes the desire for actual consumption of indulgent foods. However, desire for indulgent foods increases if there is only a brief (<30 s) exposure to the scent.

4.1.2 | Ambient sound and taste

Extrinsic to the food stimulus, sounds such as music in the background can impact taste perception (Crisinel et al., 2012; Knöferle & Spence, 2012; see Spence, 2012 for a detailed review). Certain sounds correspond to different taste experiences, such as sweet tastes and high-pitched sounds as well as bitter tastes and low-pitched sounds (Crisinel & Spence, 2010). In one study (Crisinel et al., 2012), participants were given four identical samples of toffee to consume while wearing headphones. In the headphones, music was played that had been shown to be perceived as either bitter or sweet. Participants in the bitter music condition rated the toffee to be significantly less sweet than those in the sweet music condition, showing a direct impact of extrinsic auditory cues on taste perceptions. Ambient sounds, including music and background noise, can also influence the types of foods purchased, with low volume leading to more relaxation and healthier purchases, and high volume leading to more excitement and less healthy purchases (Biswas, Lund, et al., 2019).

4.1.3 | Ambient lighting and food consumption

Ambient lighting has also been shown to impact food choice and food consumption (Biswas et al., 2017; Bschaden et al., 2020). Across laboratory studies and field studies, Biswas et al. (2017) show that lighting directly impacts ambiance within consumption contexts. In one field study, lighting was manipulated in four separate restaurant locations for one evening. Two of the restaurants had bright lighting (i.e., 250 lux), while the remaining two had dim lighting (25 lux). The expectation was that bright lighting would lead to healthier food choices than dim lighting. Indeed, this is what the authors found. When the lighting was bright compared with dim, consumers chose significantly more healthy food options. However, when the lighting was dim compared with bright, consumers chose significantly more unhealthy food options. The operative mechanism in these studies was shown to be mental alertness, with brighter lighting leading to more mental alertness and healthier food choices than dim lighting.

Ambient lighting has additionally been shown to engage the hot emotional system, affecting choice (Xu & Labroo, 2014). The authors show that increasing the brightness of ambient lighting leads to participants feeling warmer, more positive affective reactions toward spicy food, and an increased desire for spicy foods. Participants in one of their studies chose significantly hotter sauces on chicken

wings when the lights were bright than when they were dim. Participants reported how much they liked spicy food, how thrilling they found the burning sensation from spicy food on their tongues, and more generally how thrilling they found spicy food to be. These affective reactions mediated the impact of lighting on choice of spiciness, with physical warmth from the lighting also serving as a mediator within this process.

Environmental cues play a prominent role in affecting food consumption experiences. As each environment is a combination of these cues, the interactions among each remain an open research question. Just as environmental cues surround food consumption decisions, so too do social cues, such as the individuals one is eating with.

4.2 | Social context and food consumption

Almost universally, food consumption occurs in the presence of others. Many cultural celebrations across the globe center around sharing food. Therefore, the impact of social cues on consumption represents a key topic in food consumption research (for an early review, see Herman et al., 2003).

McFerran et al. (2010a), McFerran et al. (2010b) have directly examined the role that the presence of others has on consumption decisions. They find that when participants follow another individual in selecting food, they choose significantly more food overall than when selecting the food without someone else preceding them (McFerran et al., 2010a). In a clever manipulation, the authors altered the size of the confederate who selected food before the study participants. Specifically, the confederate wore a body prosthesis that significantly changed her perceived size (see Figure 5). Participants in the study took significantly more food when following a thin versus obese confederate. In a related set of studies (McFerran et al., 2010b), the extent to which participants were chronic dieters moderated the effect of the presence of others on consumption. The confederate in these studies was a server rather than a purported study participant. The results showed that chronic dieters consumed more food when the server was obese than when she was thin. For non-dieters, the results were reversed, with increased consumption when the server was thin than when she was obese.

Food consumption decisions are impacted not only by the presence of a salient other, but also by broader crowding of others. The presence of many (versus few) others serves as a distraction from what one is consuming, leading to increased weighting of affective components (Hock & Bagchi, 2018). This increased affective processing leads to greater calorie consumption. These effects were shown in both laboratory studies, as well as by examining data from restaurants. When restaurants were busier, consumers order significantly more calories per order.

A different way in which another person can matter in the food context is in terms of "who" served the food. Hagen et al. (2017) show that people choose a larger portion size of unhealthy food when someone else served them (versus when they serve themselves).

FIGURE 5 Image of experiment confederate from McFerran et al. (2010b; Figure 1)

This does not happen for healthy foods. The authors show that this behavior occurs because having another person serve the food, and therefore being less physically involved in serving the food, allows one to reject responsibility for the unhealthy eating. This also results in consumers opting to have another person serve them unhealthy foods—in order to strategically reduce guilt about eating indulgent foods (Hagen et al., 2019).

5 | CONCLUSIONS

5.1 | Future research areas

We have focused our review on how sensations from food and sensations from the context impact taste and consumption. We have not focused on satiation. However, there is an immense amount of literature on satiation and we refer the reader to that (Cornil, 2017; Morewedge et al., 2010; Redden, 2008).

Do other sensations besides smell, taste, vision, haptics, and sound affect taste and consumption? Biswas, Szocs, et al. (2019) have shown that even vestibular sensations impact our consumption behaviors. They demonstrate that this "sixth sensory system"

affects taste perceptions. Specifically, the authors show that standing increases stress on the body when compared to sitting, reducing the intensity of sensory experiences. Thus, standing leads to less favorable evaluations and less consumption than sitting. This research suggests that other sensory experiences beyond the traditional sensory experiences impact food consumption. It is possible that proprioception or the knowledge of where one's limbs are and one's musculature may similarly impact taste perceptions.

The interaction among multiple senses, while explored within advertising (Elder & Krishna, 2010) and food descriptions (Cornil & Chandon, 2016) also warrants additional attention. Taste shares core characteristics with other sensory experiences, which may affect its role as a stimulator for other senses. For example, taste is a proximal sensory experience, meaning that stimuli have to be physically close to the perceiver to be perceived (Elder et al., 2017). Other sensory experiences also vary along this distance continuum, with smell serving as a more proximate sensory experience as well. Recent research shows that the proximal nature of smell increases the perceived physical proximity of advertised products when accompanied by scents in the advertisements (Ruzeviciute et al., 2020). This increased proximity leads to more favorable product evaluations. Just as smell facilitates proximity, so too might taste impact the perceived distance of a stimulus, even an unrelated one. How taste experiences affect other sensory experiences remains largely an open question.

So far, there has been little work on how sensory imagery impacts taste (an exception is the work on smellizing by Krishna et al., 2014 discussed earlier). Much more can be done. More work can also be done on mental simulation and its impact on food choice. For instance, Elder and Krishna (2012) show that people have a greater intent to purchase a food product if it is displayed with an eating utensil that can be held in dominant versus non-dominant hand (see Figure 6). They also show that mental simulation of picking up the eating utensil drives this result by blocking mental simulation by making participants hold clamps in their hands. This work has also been replicated by Shen and Sengupta (2012) and by Eelen et al. (2013). More research exploring how sensory imagery impacts taste and food consumption is needed.

Additional work on mental simulation shows that it can also drive choice of food. Shen et al. (2016) show that a touch device is more likely to result in a choice of indulgent (e.g., cake) versus more healthy food options compared with a non-touch device, because the action of touch choice is more consistent with the visceral mental simulation of reaching out and picking up the indulgent option (see Figure 7).

As the penchant for natural and organic food grows, there is still room for work on perceptions of naturalness of food. Recently, Hagen (2020) considers the effect of pretty food on taste perception. The interesting dimension of "pretty" that she considers is whether the food is classically pretty, meaning, is it pretty as found in nature—so that it is more symmetric and balanced—just like nautiluses, cacti, or flowers are. She proposes that classically pretty food will be perceived as being more natural and therefore healthier. This recent research adds to the research stream on the (negative) relationship between health and taste (e.g., Raghunathan et al., 2006) and the (positive) relationship between health and expense (Haws et al., 2017)—we do not go into details of that research here, but advise the reader to consult the original papers. Additional work can look at how to make people give up on less sustainable food like red meat.

Another avenue for future research is to focus on meal planning, that is, how do people decide what to eat in a day. Jia et al. (2020) look at how individual calorie budgets can be function of the budgeting approach—whether the calorie budget is set for the day or per meal. They find that the budget is lower if set by meal. They explain this through a motivated reasoning argument—they suggest that consumers are motivated to reduce calorie consumption, and a meal-wise approach provides more opportunities to cut calories. They call this the contraction effect of unpacking effect. They find the traditional (see, e.g., Tversky & Koehler, 1994) expansion effect of unpacking when consumers are motivated to increase consumption.

Related to meal planning is also research on how a portion served (versus the original portion that one served from) impacts perceived consumption. Krishna and Hagen (2019) show that larger amounts leftover reduce perceived consumption and result in additional eating (and less exercise) later on. In their studies, the authors hold the absolute amount of food consumption equal but vary the food leftover. As food portions continue to grow, this research has greater consequential relevance.

While food consumption research has received increased attention in recent years, we hope that the framework we used to

FIGURE 6 Advertising stimuli used in Elder and Krishna (2012) [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 7 Stimuli used in Shen et al. (2016) [Colour figure can be viewed at wileyonlinelibrary.com]

synthesize much of this research helps to identify areas for future research that is founded in the existing research we have reviewed. As one of the most frequent consumer choices and one of the most common consumer experiences, taste and food consumption research plays an integral role in consumer psychology research.

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