



Extrinsic and intrinsic food product attributes in consumer and sensory research: literature review and quantification of the findings

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Abstract

As recent years have seen a growing interest in integrating consumer and sensory science, this paper aims at presenting a systematic literature review of empirical studies investigating the effects of intrinsic and extrinsic food product attributes on consumers' food decision making. Both an electronic search through a digital library database and a forward–backward search identified relevant international research. The final set of studies ($n = 602$) was coded in terms of research methods, intrinsic and/or extrinsic product attributes, consumer response measurement, study location, sample size, study origin, and food type. Although the importance of some product attributes such as taste, label, and price are very well recognized, other variables such as appearance, smell, sound, texture, and packaging have been neglected in research so far. Findings also show an imbalance of applied methods in consumer and sensory research. Surveys/questionnaires and acceptance tests are well-represented, whereas other methods or combinations thereof were rarely or never applied. Food liking was found to be the most frequent way to obtain consumer food evaluation data. Mirroring an increasing importance of product attributes in consumer food decisions, marketing managers and product developers today are well advised to take simultaneous effects of extrinsic and product attributes into account. This article calls for future studies with more holistic study designs to avoid the risk of misleading conclusions in both consumer and sensory research.

Keywords Food decision making · Systematic review · Intrinsic attributes · Extrinsic attributes · Consumer research · Sensory research

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1 Introduction

Today's food market seems to be saturated in almost all food groups, leading to an increased competition among food producers and, in turn, to the need to continuously develop new products (Combris et al. 2009). Strategic marketing, including the development of new businesses, plays an important role in promoting product innovations that are able to attract consumers' attention and to stimulate purchases. However, in the food market, between half and two-thirds of launched products end up failing (Dijksterhuis 2016). Due to market saturation and product variety, the main obstacle for food producers is finding success in the market. To do so, food marketers need to know which product attributes contribute to product success or failure. The aim of this review is to provide an overview of the existing knowledge of extrinsic and intrinsic food product attributes in consumer and sensory research that can be used by food marketers. Additionally, by filling the identified research gaps, the marketing and business practice might gain the potential to find new ways to influence consumer food decisions.

In stores, consumers make rapid choices among multiple products that differ in their extrinsic (e.g., brand, packaging, label, price) and their expected intrinsic attributes (e.g., taste). When purchasing a food for the first time, sensory information is missing and consumers are compelled to rely on *extrinsic food attributes*. Recent studies in marketing and business literature show that consumers form their judgments based on heuristic conclusions about the product's extrinsic attributes in the absence of intrinsic sensory properties (Irmak et al. 2011; Deng and Srinivasan 2013). In post-purchase situations, consumers are able to refer to sensory information without the need to deduce taste from heuristic cues (Mai et al. 2016). Prior research shows that taste judgments mainly build on actual sensory perception of *intrinsic properties*, rather than on expectations formed by extrinsic attributes (e.g., Arvola et al. 1999; Hoegg and Alba 2007). Despite a few studies showing that extrinsic cues may bias actual taste experiences (Wansink and Park 2002; Naylor et al. 2009; Irmak et al. 2011), most of the research focuses either on *intrinsic or extrinsic food attributes*. This raises research question 1:

Research question 1 Which extrinsic and intrinsic product attributes have been analyzed in food decision making research and to what extent?

Research on the impact of product attributes on food decision making originates from different academic disciplines, each using different scientific methods (Grunert 2015). *Business and consumer research* mainly use methods that analyze extrinsic food attributes. The extrinsic attributes are a part of the marketing mix with a focus on the visual sense of consumers only. In contrast, *sensory research* uses methods that analyze changes in the intrinsic properties of a food based on a variation of the nutritional composition or in the manufacturing process. These changes, in turn, influence all human senses (appearance, taste, smell, sound, texture), regardless of the purchase context (Grunert 2015). What has been neglected in research so far is an

overview about which methods are typical for both streams of research and to what extent they are used. Moreover, this article intends to provide an overview of method use over time. This leads to the second research question:

Research question 2 Which methods are typical for consumer and sensory research, to what extent were they used in food decision making research, and how has their use changed over time?

Although several articles have called to integrate consumer and sensory research more thoroughly (Garber et al. 2003; van Kleef et al. 2005; Jaeger 2006; Enneking et al. 2007; Raz et al. 2008; Combris et al. 2009; Simeone and Marotta 2010; Piqueras-Fiszman and Spence 2015), an overview of intrinsic and extrinsic food product attributes in consumer and sensory research is still missing. The third research question therefore aims to combine the findings of research questions 1 and 2:

Research question 3 Which extrinsic and intrinsic product attributes have been investigated? Which methods from consumer and sensory research were used and to what extent?

To answer the research questions, this paper employs a three-tier approach: (a) an extensive systematic literature review, based on methodological propositions of Tranfield et al. (2003), produces a comprehensive summary of existing scientific studies about intrinsic and/or extrinsic product attributes; (b) this review reveals research methods from consumer and sensory research that have widely been used to predict consumer food decisions; and (c) a subsequent quantitative content analysis synthesizes the findings across all included studies using a deductive approach (Konracki et al. 2002). Finally, a roadmap for further interdisciplinary research is outlined and implications for the business and marketing practice are discussed.

2 Theoretical background

2.1 Extrinsic and intrinsic product attributes

The sources from which consumers form expectations and perceptions of a food product are typically separated into extrinsic and intrinsic product cues. Both of them affect food decisions, but they differ in the point of time in which they occur. Extrinsic product attributes are related to the product but are not physically a part of what is tasted or consumed. Subsequently, consumers make their purchase decisions under uncertainty with regard to product quality (Akdeniz et al. 2013). Therefore, consumers base their decisions on product-related extrinsic attributes (e.g., brand, packaging, price, labels, claims) due to missing sensory perception (Akdeniz et al. 2013). Intrinsic cues comprise physical characterization and nutritional composition of a product, which in turn affect appearance, smell, taste, sound, and texture/mouthfeel of the food (Enneking et al. 2007). Sensory perception, based on such intrinsic cues, influences consumers' perception of and experience with the food. Extrinsic and intrinsic product cues evoke different responses in consumers, which then jointly shape purchase decisions. For instance, recent studies have revealed that both the ingredients (intrinsic attributes, e.g.,

fat, sugar) and the labeling (extrinsic attribute) drive the choice of yoghurt (Johansen et al. 2010; Hoppert et al. 2012).

2.2 Consumer responses in food product evaluations

Numerous terms have been developed in the business and sensory literature to describe how consumers react to food (Mela 2001; Jaeger et al. 2011; Symmank et al. 2017). Although terms like food choice, food preference, food liking, or food wanting are often used interchangeably, it is useful to make a distinction.

Purchase intention is often used in marketing research to determine whether the consumer would really buy a product or not. It is assumed that the intention is directly influenced by the attitude towards the product and influences a subsequent behavior (Ajzen and Fishbein 2000). Even though consumers intend to purchase a food, they do not always translate this intention into behavior. A meta-analysis of Sheeran (2002) shows that intentions explain only 28% of the variance in behavior. Recent research in food decision making dealt with the intention-behavior discrepancies, for instance in the context of organic or ethical food consumption (Carrington et al. 2010; Aschemann-Witzel and Niebuhr Aagaard 2014).

Food liking or *food pleasantness* describe the immediate experience from the orosensory stimulation of eating resulting in a degree of pleasure or displeasure from a certain food (Mela 2001). It refers to a qualitative and hedonic evaluation of food which is judged against an internal reference. Hedonic evaluations are affective responses, whereby affective generally means an emotional reaction to a stimulus, and hedonic specifically refers to the emotion of pleasure/enjoyment or displeasure/aversion.

Food wanting is the intrinsic motivation of humans to engage in eating a food (Mela 2006). Consumers want to eat pleasurable food. Based on the assumption that consumers' food decisions in food-rich environments are increasingly driven by pleasure rather than the physiological need to eat, food wanting reflects a motivational process that translates liking into action (Berridge 2009; Stroebe et al. 2008). While food liking remains relatively stable over time, food wanting can vary considerably over time and between situations (Mela 2001). Thus, food liking does not automatically cause food wanting. For instance, although an individual's general liking of fish is high and stable, the actual desire to eat fish is low at breakfast time. In recent food research, numerous attempts have been made to distinguish between liking and wanting (Finlayson et al. 2007, 2008). Even though liking and wanting can be manipulated and measured separately due to different neural substrates (Berridge 2009; Castro and Berridge 2014), they are not isolated systems, but rather interconnected (Havermans 2011).

Food preferences become useful in discussing decision making processes of consumers. Preference means a selection of a food among two or more alternatives available in a given time and context (Mela 2006). Again, the liking of a food does not necessarily cause food preference. Product A may be preferred over product B, even though neither is liked (e.g., in the case of a forced choice task in marketing research, Dhar and Simonson 2003). Contrarily, a food may actually not be liked, but nevertheless preferred because of a price reduction or health concerns. In sensory analysis, preference tests are used to measure the liking of sensory attributes. In marketing,

preference often means choice. A third meaning refers to real sales data as an indicator for consumer preferences. However, in consumer and sensory research there is agreement that preference is more an outcome rather than an influencing factor (Peters et al. 2014; Chen and Lee 2015; Bianchi 2015; Byrnes and Hayes 2015). Contrarily, in nutritional science or medicine, food preference is seen as an influencing factor of dietary intake and eating behavior (e.g., Grimm and Steinle 2011; Takamura et al. 2014).

Keeping a wary eye on human behavior, food liking can be seen as an essential part of food wanting, and food wanting as a key contributor of food preference. However, liking of a food is only one of many factors in the formation of food preferences (Mela 2001). In the 1980s, a taxonomy of food acceptance and rejection was developed (Rozin and Fallon 1980; Rozin and Vollmecke 1986) which differentiates between three types of reasons for food preference or food aversion: First, *liking or disliking* of the intrinsic attributes (taste, smell, texture, or appearance); second, the *anticipated consequences* of food intake (e.g., health); and third, *food appropriateness*, i.e. the decision of whether food is deemed edible or not. In contrast to measuring food preference as an explicit decision in favor of a certain food (and implicit against a different food), there are several studies that explicitly measure *food rejection* (e.g., Giménez et al. 2015; Lima Filho et al. 2015). The rejection threshold method has been widely used to determine intensities of compounds or ingredients that become aversive at high levels, for instance bitter compounds in chocolate, or off flavors in wine (Prescott et al. 2005; Harwood et al. 2013).

Previous researchers have criticized these distinctions by stating that liking, preference, or purchase intention measure hypothetical constructs as consumers evaluate products which do not exist on the market yet or which they probably would never choose in real market situations (Van Loo et al. 2011). Recently, the measurement of *willingness-to-pay* has been established as a better approximation of true preferences and a better prediction of field behavior (Lusk and Shogren 2007; Chang et al. 2009). For instance, in experimental auctions, consumers receive money and reveal the value of a real product. Even though auctions are mainly conducted as central location tests, they are considered a possibility to reduce excessive hypothetical bias.

2.3 Classification of research methods

2.3.1 Consumer research methods

In this article, the classification of consumer research methods follows the classification of Eid et al. (2015). According to them, consumer research methods can be roughly divided into self- and external assessment methods, on the one hand, and methods based on human behavior on the other (Table 1). Methods in commercial marketing and consumer research are commonly divided into qualitative and quantitative methods (Calder 1977). Self- and external assessment methods can be of qualitative and quantitative natures, whereas methods based on human behavior are mostly quantitatively driven. Qualitative research provides an in-depth but also subjective understanding of the consumer. Quantitative research often makes use of numerical measurement and

Table 1 Classification of consumer research methods based on the literature search of this article

Self- and external assessment methods	Methods based on human behavior
Observation	Computer-based techniques
Face-to-face interview	Implicit associative test (IAT)
Focus group discussion	Eye tracking
Word association/completion techniques	Functional magnetic resonance imaging (fMRI)
Surveys and questionnaires (direct, phone, paper, online)	Adaptive conjoint analysis (ACA)
	Computer-supported/non computer-based techniques
	Choice task
	Choice-based conjoint analysis (CBC)
	Auction
→ Qualitative and quantitative techniques	→ Quantitative techniques

The categorization of methods is not completely free of overlaps, but provides a rough overview based on the present literature review

statistical analyses that do not require further subjective interpretation of the researcher (van Kleef et al. 2005).

In marketing research, direct *observation* either by the researcher or by videography and photography is used to record, for instance, the number of food items purchased or the path of consumers through the supermarket (Areni and Kim 1993; Basil 2011). *Face-to-face interviews* are based on personal interactions between researchers and participants. Depending on the research aim, the researcher uses structured (minimizing response options or preparing a question guide) or unstructured (next question depends on participant's answer) interview formats. In *focus group discussions*, a researcher provokes a discussion by forming a group of individuals to obtain insight into group interactions, individual motivations, and subliminal processes of human attitudes and beliefs (Threlfall 1999). Focus groups and interviews often serve as a preliminary stage of a research process, followed by further quantitative analyses. *Word associations* and *completion techniques* aim at identifying relevant determinants of consumers' decision making by asking them to freely think about a stimulus in order to extrapolate their behavior (Roininen et al. 2006). *Surveys or questionnaires* represent a way of gathering information about consumers' knowledge and awareness of products or brands, their attitudes and feelings towards them, and about demographics and lifestyles at a given point of time (Babin and Zikmund 2015).

Since product-induced inferences may be activated automatically and operate outside conscious awareness, the *implicit association test (IAT)*, a computer-based reaction-time measurement, is widely applied as a technique to measure underlying affects and attitudes (Greenwald et al. 1998). In food research, the IAT reveals, for instance, automatic linkages between light-colored food packages and healthiness (Mai et al. 2016). *Eye tracking* is an established method to allocate an individual's attention based on visual information (Velichkovsky et al. 1996). For instance, recent research explores how specific messages draw attention to visually suboptimal foods

(Helmert et al. 2016). *Functional magnetic resonance imaging (fMRI)* provides a real-time analysis of brain activations and a detailed understanding of psychological processes underlying the evaluation and expectancy formation during food purchase decisions (Enax et al. 2015). In *choice tasks* participants have to choose one product from at least two alternatives (similar to preference tests in sensory research). Consumers tend to demand the “perfect product” (i.e., all preferred attributes at the lowest price level). To overcome this inflation of expectations, researchers use decomposition techniques [e.g., *choice-based conjoint analysis (CBC)*, *adaptive conjoint analysis (ACA)*] that shed light on how an individual’s preference is constructed (Bettman et al. 1998). In many of the above mentioned research methods, participants are asked to make hypothetical choices or state hypothetical preferences instead of making real market choices. Participants believe their responses are inconsequential and they neither perceive gain nor loss from their decision (Lusk and Shogren 2007). In contrast, *experimental auctions* put participants in an active market environment including real economic consequences when stated preferences do not match their actual choice. Participants think about what they are actually willing to pay for a product.

2.3.2 Sensory research methods

The present article uses the classification of Lawless and Heymann (2010) to classify research methods in sensory research. Accordingly, the methods can be divided into three broad categories: difference testing, descriptive testing, and affective testing. Table 2 summarizes the sensory methods, their objectives, and their potential to be applied in marketing and business practice. For a comprehensive overview, see Lawless and Heymann (2010, p. 81).

Difference tests aim at determining whether there are detectable differences between products or product attributes (Naes et al. 2011). The results of difference tests do not indicate whether the difference is due to the taste, smell, or texture. If no difference was detected, this does not automatically allow the conclusion that the samples are completely similar, only that the participants were not able to detect a difference.

As it is not possible to deduce any qualitative assessments based on difference testing, *descriptive methods* are used to obtain detailed information concerning product appearance, taste, smell, or oral texture (Meilgaard et al. 2006). These methods allow for the description and quantification of inter-product sensory differences to provide relative sensory positioning of a set of products (Delarue and Sieffermann 2004; Varela and Ares 2014). Participants should be able to describe their perception by using sensory vocabulary without any hedonic evaluation.

Affective testing is the third broad category of sensory research methods. Unlike the first two categories, panels of untrained participants are required here. It is therefore one of the most important tools in determining food decisions of consumers. Affective tests either measure the order of liking for different products or a sensory attribute, or they measure the degree of liking using hedonic scales. Hedonic scales have emerged as an effective tool in market research to estimate product success or failure and, thus, have gained great attention in research (e.g., Hein et al. 2008; Jaeger and Cardello 2009; Lawless et al. 2010; Lim 2011). The most common scale is the nine-point hedonic scale (Peryam and Pilgrim 1957; Jones and Thurstone 1955). Just-about-right (JAR)

Table 2 Classification of sensory methods (based on Lawless and Heymann 2010) and possible applications in marketing and business practice (list is not exhaustive)

Type of test	Category	Overarching question of interest	Participant characteristics	Field of application in marketing and business practice	Examples for tests	Objective and description
Analytic	Difference testing	Are products perceptibly different in any way?	Semi-trained, trained	Product development	Triangle test	Three samples are presented simultaneously to the participants and they either report which sample is the odd sample or which two samples are equal
				Change of ingredients Changes in manufacturing processes Quality assurance Observation of storage stability Influence of packaging material Developing me-too products within a different company		
					Paired comparison test	Participants have to determine which of two samples differs in a sensory attribute (one-tailed or two-tailed)
					Ranking	Participants receive samples with different intensities of a specific sensory attribute in random order and are asked to sort the samples based on this attribute either in ascending or descending order

Table 2 continued

Type of test	Category	Overarching question of interest	Participant characteristics	Field of application in marketing and business practice	Examples for tests	Objective and description
Analytic	Descriptive testing	How do products differ in specific sensory attributes?	Untrained, semi-trained, trained	Product development Change of ingredients Product comparison within or between companies Attribute selection before consumer testing	Conventional profiling	A first phase reveals terms which describe the sensory profile of the sample (need for seeking a common language); within a second phase, the intensity of each attribute is evaluated on an intensity line scale
					Free-choice profiling	Participants use their own vocabulary to describe the product (no need for seeking a common language) and rate each product according to its attribute intensity; product samples are served in a monadic way, so that participants judge attribute by attribute of one sample before receiving the next sample
					Flash profiling	Combines individual panelist vocabulary development (as used in free-choice profiling) with a simultaneous ranking of the whole product set

Table 2 continued

Type of test	Category	Overarching question of interest	Participant characteristics	Field of application in marketing and business practice	Examples for tests	Objective and description
Hedonic	Affective testing	How well are products liked or which products are preferred?	Untrained	Market research (product success or failure) Product optimization	Preference test	Participants are asked which of two samples is liked best Participants are asked to rank several samples either in ascending or descending order based on their liking
					Paired preference	
					Ranking	
					Acceptance test	Participants' acceptance can be displayed on a continuum from like to dislike (intervals between the nine categories are perceived as approximately equal)
				Nine-point hedonic scale		
					JAR scale	Measures participants' liking and reaction to a specific attribute using three- to seven-point scales with the end anchors "too much" and "too little", and the center point "just about right"

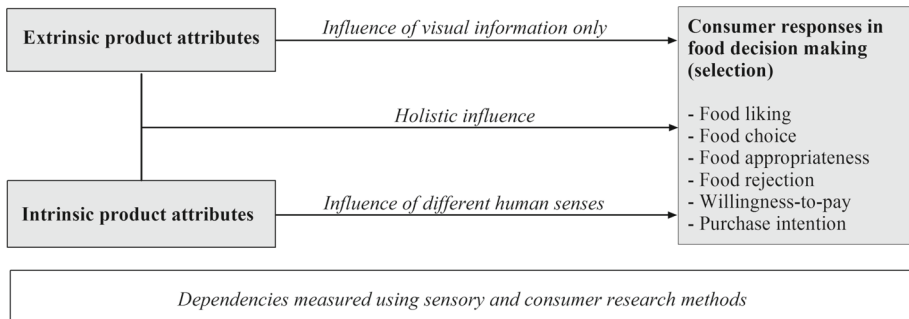


Fig. 1 Conceptual framework of the influence of extrinsic and intrinsic product attributes on product evaluation

scales combine hedonic evaluations with intensity ratings (Rothman and Parker 2009; Hoppert et al. 2013; Li et al. 2014a).

2.4 Conceptual framework of this review

Figure 1 shows the conceptual framework of this review. The core of this figure shows that either intrinsic or extrinsic product attributes, or their interaction, have an impact on consumers' responses to available foods. The dependencies between intrinsic and/or extrinsic product attributes and various kinds of consumer responses are measured using consumer and sensory research methods.

3 Identification and overview of relevant literature

3.1 Search process

Studies included in this review were initially obtained from the interdisciplinary electronic database *Web of Science*. The search was not limited to any publication date. The search string covered four main aspects: (1) dependent variables like *food choice*, *food preference*, *food acceptance*, *food liking*, or *food wanting* (or related terms that describe consumer responses to food); (2) influencing product attributes like *extrinsic*, *price*, *brand*, *packaging*, *label*, *information*, *intrinsic*, *sensory*, *taste*, *smell*, *flavor*, *sound*, *texture*, *appearance*, *fat*, *sugar*, *salt*, *fiber*, *protein*, *carbohydrates*; (3) content- and methodological-related exclusion criteria like *children*, *infants*, *animal*, *review*, or *overview*; and (4) the *consumer* as main actor. The search identified 331 articles. These articles were screened using a priori defined inclusion and exclusion criteria. Any study that empirically examines food decision making processes based on intrinsic and/or extrinsic product attributes fell within the scope of the inclusion criteria. In line with the research objective of this review to synthesize research methods and food product attributes examined in primary studies, overviews or reviews were excluded. All studies on animals, children, and infants were excluded (although the keyword combination contained these exclusion criteria, a number of corresponding hits had to

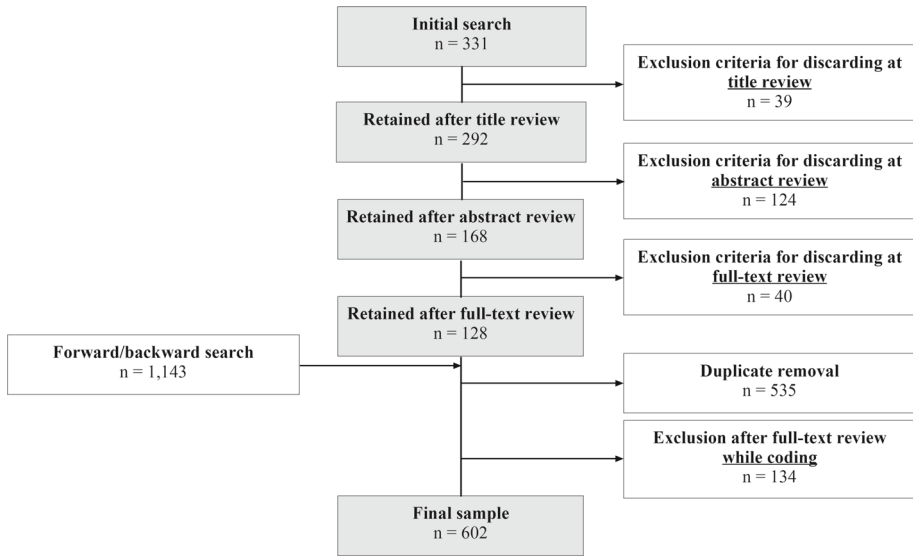


Fig. 2 Flowchart of the literature search

be dropped), because this review focuses on the behavior of adult human consumers. Furthermore, excluded studies typically dealt with attention, perception, understanding, or awareness as dependent variables, examined sales or scanner data to measure consumer behavior, examined only isolated sensory attributes (e.g., freshness, sweetness), or examined attitudes towards a food type (e.g., organic or functional food) without manipulating intrinsic or extrinsic product attributes. The search was limited to journal articles that were published in English because all necessary information needs to be understood for content analysis. However, an article did not have to be published in peer-reviewed journals. After applying inclusion and exclusion criteria during title-, abstract-, and full-text assessment, 128 articles remained. Subsequently, an extensive forward and backward search within citations and references provided 1143 matches. The retrieved articles underwent the same selection process as the initial studies. The final sample contained 602 articles,¹ published from 1964 to 2015 in academic journals. Figure 2 displays the search process.

3.2 Overview of included studies

Both consumer and sensory research are relatively young disciplines as originally there was little interest in consumer research in food (Grunert 2015). Recently, the research on extrinsic and intrinsic food product attributes has gained acceptance in consumer research, which is evidenced by a series of food-related studies in the top marketing journals (Chandon and Wansink 2007; Burton et al. 2009; Deng and Srinivasan 2013). Since the early 1990s, the number of published papers on extrinsic and intrinsic product cues has taken a great leap forward (Fig. 3), with 53 publications on average in

¹ The complete list of included articles is available on request.

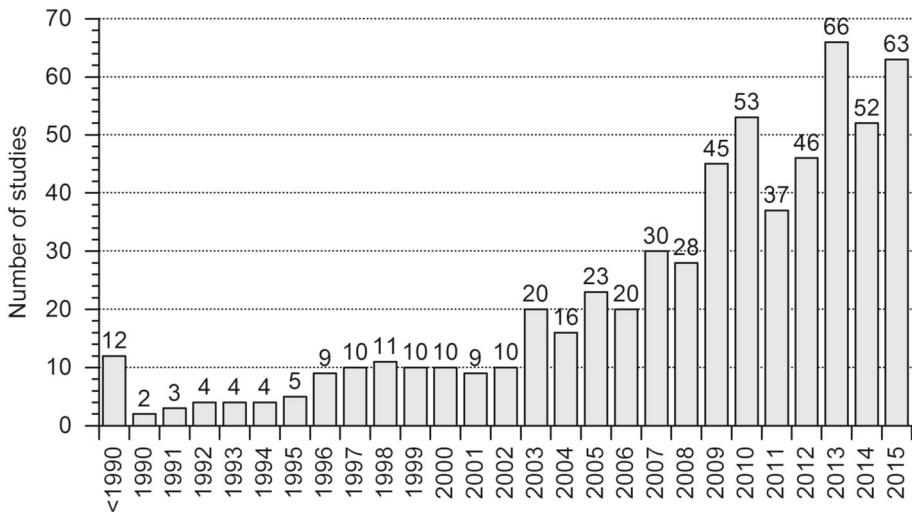


Fig. 3 Number of publications per year ($n = 602$)

the last 5 years. The 602 publications were published in 138 different journals from marketing and consumer research (e.g., *Journal of Marketing Research*, Shah et al. 2014), nutritional science (e.g., *Journal of Nutrition Education and Behavior*, Vermeer et al. 2010), agribusiness (e.g., *Agribusiness*, Moro et al. 2015), business research (e.g., *Journal of Business Research*, Louviere and Islam 2008), sensory science (e.g., *Journal of Sensory Studies*, Kobayashi and de Benassi 2015), and from various other fields related to consumer behavior, thereby underlining the interdisciplinary nature of food research.

Sample sizes in the present studies ranged from 10 to 11,322 participants per article with a median of 163 participants. In sensory research (e.g., profiling, triangle test) as well as in qualitative consumer research (e.g., face-to-face interview, focus group discussion), sample sizes are quite small as these methods often serve as pretests or to gain additional information about consumer attitudes and thoughts.

Considering the studies' geographic foci, research on food decision making is dominated by European- and North American-centric research. This might be due to the fact that compared to other countries, the United States and European countries hold a longer tradition in competitive marketplaces, and the progressively consumer-driven food sector fosters research in sensory and consumer food science (Linnemann et al. 2006). This disposition potentially explains the dominance of 311 studies with European samples and 166 studies in North America (151 in the USA). In Europe, most of the studies were conducted in Spain (43), the Netherlands (31), UK (31), Italy (29), Finland (26), and Germany (20). Contrastingly, Australia's agriculture and food industry has undergone a period of rapid change over the last few years (Delforce et al. 2005), and a total of 40 studies explicitly analyze Australian samples (e.g., Mueller et al. 2010; Morley et al. 2013; Van Doorn et al. 2015). Since 2004, scholars have been examining developing countries in Asia, such as China (e.g., De Steur et al. 2012), Thailand (e.g., Silayoi and Speece 2007), and Lebanon (Haddad et al. 2007). Research on food decision making in South America started to appear in 2005. African countries

are almost completely neglected in consumers' food decision making research so far, since other topics, such as unstable and unpredictable food prices, or affordability of staple foods, have been shown to be more relevant (Chapoto and Jayne 2009). From the 38 studies that adopt a cross-country perspective (i.e., the study was conducted with at least two samples from different countries), only 13 adopt a cross-continental perspective with at least two samples from countries of different continents (e.g., Asia and Europe: Tu et al. 2010; North America and Asia: Chung et al. 2012).

4 Discussion of the state of the art

4.1 Content-based assessment

4.1.1 Extrinsic product attributes

The extrinsic product attributes were classified into brand, claims, product information, labels, packaging, and price (Fig. 7). *Labels* are studied the most often (353 studies), with the strongest increase among the extrinsic attributes since 2007. Different front-of-pack labeling systems have been developed by industry and organizations to promote health and dietary quality (Hodgkins et al. 2015). They aim at signaling key nutrients, for instance reduced fat (Norton et al. 2013), sugar (Miklavec et al. 2015), or salt content (Burton et al. 2009), reduced calories (Burton et al. 2009), or daily nutrient intake [guideline daily amounts: Hamlin et al. (2015), nutrition facts panel: Howlett et al. (2008)]. Research revealed that consumers struggle to use common labels and that these labels do not achieve government policy goals of facilitating healthy choices and lowering health risks (Maubach et al. 2014). Therefore, recent studies enhanced research on new types of labels and their influence on consumer choice behavior or product perception compared to common labels. For instance, the “multiple traffic light label” is designed in red (green) to signal unfavorable (favorable) nutrient levels with the aim of helping consumers to select more healthy food options (Koenigstorfer et al. 2014). Other labels provide a holistic rating for the entire product rather than for a single nutrient. In 2006, the “healthy choice logo” was launched in the Netherlands as a result of the effort of government and industry to guide consumers towards healthier food choices (Liem et al. 2012). The “Nordic Keyhole” is a label certified for healthy food alternatives (e.g., moderate amounts of sugar, salt, and fat, while being high in fiber) by the Swedish National Food Administration (Thunstrom and Nordstrom 2015). The development of the “Health Star Rating system” was funded by the Australian government in collaboration with industry, public health, and consumer organizations in 2014 (Maubach et al. 2014). It aims at providing an easy way for consumers to choose foods that contain more positive nutrients and less risky nutrients. Other labels were designed to inform consumers that the company conforms to certain standards (e.g., organic label: van Doorn and Verhoef 2011; fair trade: Poelman et al. 2008; corporate social responsibility: De Magistris et al. 2015; animal welfare: de Jonge et al. 2015). Consumers also make inferences about the quality of a product, e.g., by using an origin label as a risk-reduction strategy (Chamorro et al. 2015).

183 studies of the dataset analyzed the influence of *price* on food decision making [Fig. 7; e.g., Grunert et al. (2009), Hellyer et al. (2012)]. Price appears as a relevant cue when consumers do not have adequate information about intrinsic quality cues (Acebrón and Dopico 2000).

183 studies paid attention to *product information* that is either provided verbally to consumers, or is part of the food packaging (but not necessarily included in a label) (Fig. 7). For instance, 82 studies examined how information about organic versus conventional production methods of food affect consumers' food acceptability (e.g., Laureati et al. 2013; Barbieri et al. 2015). Kaye-Blake et al. (2005), for instance, discussed consumers' reactions to information about genetically modified food. 77 studies delivered insights about how food evaluation or willingness-to-pay is affected by the knowledge of food ingredients, for instance fiber or antioxidants, that are often discussed as functional food ingredients (e.g., Ares et al. 2009; Ginon et al. 2009). Further studies examined which information on portion size is most promising in helping consumers to select appropriate food amounts (Vermeer et al. 2010; Just and Wansink 2014). Claret et al. (2012) investigated how information about storage conditions influences the decision making process around sea fish. Hersleth et al. (2011) evaluated effects of information about reduced salt content, prolonged aging time, and origin on the acceptance of dry-cured ham within a Norwegian consumer sample.

132 studies explored the impact of *claims* on consumer food choices (Fig. 7). Among these studies, common claims are health claims (e.g., Kozup et al. 2003; Wagner et al. 2015), nutrition claims (e.g., Gracia et al. 2009; Czarnacka-Szymani and Jezewska-Zychowicz 2015), and risk reduction claims (e.g., Hoefkens and Verbeke 2013; Coleman et al. 2014). The nutrition and health claims regulation was implemented to harmonize the rules of making nutrition and health claims across Europe (European Commission 2006; Gilsenan 2011). Nutrition claims highlight beneficial nutritional properties regarding energy or nutrients. Health claims are used for foods that improve the state of health and well-being. Risk reduction claims promise a significant reduction of a risk factor in the development of human diseases, provided that substantial scientific evidence is available (European Commission 2006).

The effect of *product brand* was analyzed in 68 studies (Fig. 7). Previous research has indicated that brand names guarantee homogeneity, identity, and quality in the decision making process (Acebrón and Dopico 2000). For instance, Di Monaco et al. (2004) evaluated consumer expectations and overall liking of pasta generated by the brand name. In an experiment of Mueller and Szolnoki (2010), participants rated hedonic liking and purchase intention of different brands of white wine.

54 studies focused on *packaging* attributes (shape, symbols, colors, messages), which have emerged as an important communication tool at the point of sale, similar to other marketing communication elements (Nancarrow et al. 1998; Rettie and Brewer 2000) (Fig. 7). Silayoi and Speece (2007), for instance, varied five attributes of the packaging of a convenience food. More recent research assessed consumer liking and purchase intention of olive oils based on bottle type, cap type, and notes on the label (Delgado et al. 2013). Kobayashi and de Benassi (2015) analyzed the impact of packaging characteristics on purchase intention of instant coffee in refill packs and glass jars.

Concerning the joint analysis of extrinsic attributes, the findings show that price together with label was most often examined (Table 3, e.g., Costanigro et al. 2014),

Table 3 Number of studies analyzing the combination of two extrinsic attributes

	Brand	Claims	Product information	Labels	Packaging	Price
Brand	–	23	28	47	10	30
Claims		–	43	59	8	53
Product information			–	105	12	98
Labels				–	9	139
Packaging					–	15
Price						–

The sum exceeds the number of 602 studies due to multiple coding (one study may have analyzed more than one extrinsic attribute)

Table 4 Number of studies analyzing the combination of two intrinsic attributes

	Appearance	Smell	Taste	Texture
Appearance	–	6	42	18
Smell		–	14	5
Taste			–	31
Texture				–

followed by product information and label (e.g., Ridley et al. 2015), and price and product information (e.g., Claret et al. 2012). Combinations of the other extrinsic attributes received comparatively less attention in food research (Table 3).

4.1.2 Intrinsic product attributes

The intrinsic product attributes were differentiated into appearance, smell, taste, and texture. As flavor can be regarded as a complex combination of olfactory and gustatory sensations perceived during tasting (ISO 2008), studies dealing with flavor were assigned to both smell and taste. 314 studies deal with *taste* and have received the greatest research interest among the intrinsic attributes. The proportion of studies dealing with food *appearance*, *texture*, and *smell* is relatively small (Fig. 7). No study was found that dealt with the *sound* of food to influence food decisions. Table 4 shows how often the combination of two intrinsic attributes was analyzed. Most studies investigated *appearance and taste* (e.g., Di Monaco et al. 2003; Hobbs et al. 2014), followed by studies that measured consumer acceptance based on *taste and texture* of the food (e.g., Isleten and Karagul-Yuceer 2006; Bakke and Vickers 2011). *Taste and smell*, *smell and appearance*, and *smell and texture* have been neglected in research so far.

4.1.3 Joint analysis of intrinsic and extrinsic product attributes

The analysis reveals that 192 studies investigated both intrinsic and extrinsic product attributes. The most frequently observed combination of intrinsic and extrinsic product

attributes is *taste and label* (96 studies). As a typical example for this group of articles, Hoppert et al. (2012) integrated intrinsic and extrinsic attributes of vanilla yoghurt in an adaptive conjoint analysis by simultaneously varying fat content, sugar content, and flavor intensity. Tarancon et al. (2014) analyzed how facts about fat source and fat content on biscuit labels affect perceived healthiness and overall liking of the tasted product. *Taste* was also often analyzed *together with product information* (63 studies). For instance, in the study of Vazquez et al. (2009) participants were provided with information about salt and fiber content of biscuits and had to evaluate overall liking after tasting. A relatively large number of studies examined *taste and price* (49 studies), *taste and claims* (36 studies), *taste and brand* (34 studies), and *taste and packaging* (23 studies). Surprisingly, only a few studies were found that investigate product *appearance together with extrinsic attributes* (price: 20; product information: 15; label: 10; claims: 4; packaging: 4; brand: 3). Similarly, few studies combined *texture with extrinsic attributes* (3–8 studies). Finally, the number of studies that simultaneously analyzed the impact of *smell and extrinsic attributes* was very small (0–2 studies).

4.1.4 Measurement of consumer responses

The distribution of the dependent variables shows that consumer responses are most often conceptualized in terms of food liking (39%), followed by food choice (30%), purchase intention (17%), and willingness-to-pay (13%). Food appropriateness and food rejection are rarely used for food product evaluations (each only 1%). 485 studies focused on a single dependent variable, and only 117 studies referred to several dependent variables.

4.1.5 Food categories

Regarding the type of food, the analysis reveals a wide range of foods that were grouped into nine food categories (Fig. 4). Furthermore, the categories “menu” and “different” were added in cases where a dish or different types of food were analyzed in one study. Bakery products were investigated in terms of bread (Rodbotten et al. 2015), biscuits (Tarancon et al. 2014), or cookies (Cavanagh et al. 2014). Almost one-fifth of the studies manipulated extrinsic or intrinsic attributes of alcoholic (e.g., Saenz-Navajas et al. 2013; Chaya et al. 2015) and non-alcoholic beverages (e.g., Li et al. 2014b; Kobayashi and de Benassi 2015). A few other studies analyzed cereals/grain products (e.g., Khouryieh and Aramouni 2013), and dairy (e.g., Cliff et al. 2013; Chrysochou and Grunert 2014). Since 2000, a growing interest can be observed in the investigation of menus, like soups (e.g., Bolhuis et al. 2012) or fast food (e.g., Harnack et al. 2008). Aschemann-Witzel and Hamm (2010) investigated different products (yoghurt, breakfast cereals, and pasta) within one study and showed that products with a nutrition or health claim are preferred over products without claims. Only a few studies analyzed the choice of meat, fruits and vegetables, fish, oils and fats, and snacks and sweets.

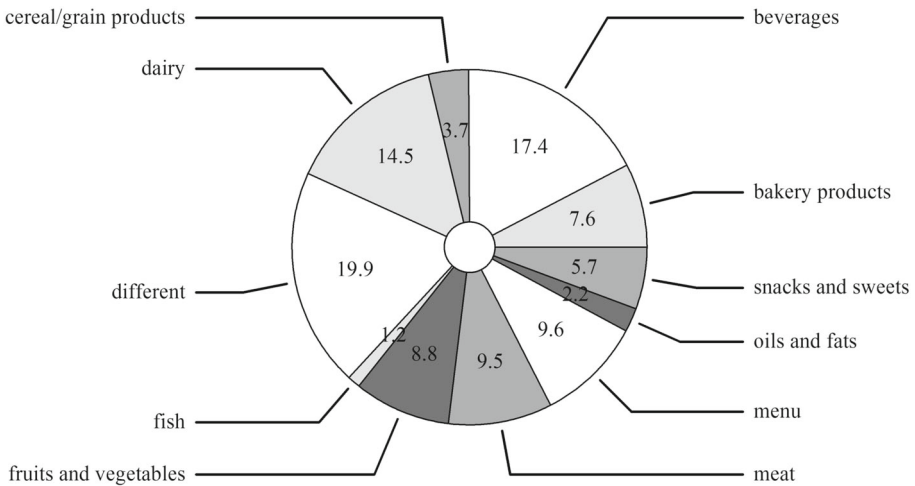


Fig. 4 Food categories analyzed in the present sample (n = 602)

4.2 Methodological assessment

4.2.1 Research methods and their interaction

The studies of the present dataset include all of the aforementioned research methods, except the IAT (Table 5). This might be explained by the fact that an IAT measures underlying affects and attitudes towards food, but not the final decision for or against a food (which is the focus of the present article). 286 studies used only methods of consumer research and 166 studies used only sensory methods. 150 studies applied both consumer and sensory research methods. Most studies assessed consumers' food choice or liking using acceptance tests, followed by surveys and questionnaires (Table 5). About one quarter of the studies applied a choice task and 13% conducted conjoint analysis or profiling, respectively. All other methods seem to be underrepresented in consumer and sensory research, at least concerning the present sample.

Multiple coding was possible when one study applied more than one research method. The most frequent combination *within the sensory research methods* is profiling and acceptance test (68 studies). For instance, Hernandez-Carrion et al. (2015) recently applied a flash profile first to generate a list of attributes that are appropriate for discriminating between milkshakes. Subsequently, consumers scored their degrees of overall liking and liking of sensory attributes. In all other cases, sensory methods were rarely (15 of 21 possible combinations with only 1–7 studies) or never (4 of the 21 possible combinations) applied within one study.

Within the consumer research methods, surveys/questionnaires were mostly combined with choice tasks (57 studies, e.g., Scott et al. 2008), followed by conjoint analyses (31 studies, e.g., Silayoi and Speece 2007) and auctions (12 studies, e.g., Thunstrom and Nordstrom 2015). Focus group discussions as qualitative method were

Table 5 Methods of data collection used in studies of consumers' food decision making (n = 602)

Method of data collection	Frequency of use n	% of total studies
Sensory research methods		
Triangle test/duo-trio test	5	1
Paired comparison test	6	1
Ranking	17	3
Profiling	81	13
Acceptance test	282	47
Preference test	15	2
Self- and external assessment methods		
Observation	7	1
Face-to-face interview	26	4
Focus group discussion	41	7
Word association/completion Techniques	13	2
Surveys and questionnaires	250	42
Methods based on human behavior		
Implicit associative test (IAT)	0	0
Eye tracking	14	2
Functional magnetic resonance imaging (fMRI)	6	1
Conjoint analysis	79	13
Choice task	143	24
Auction	34	6

The sum exceeds the number of 602 studies due to multiple coding (one study may apply more than one research method)

used in 18 studies before a survey was carried out (e.g., Coleman et al. 2014), and in 14 studies before a conjoint analysis was carried out (e.g., Chung et al. 2011). 11 studies combined eye tracking with choice tasks (e.g., Milosavljevic et al. 2012). 22 of the 45 possible combinations were only rarely combined (1–8 studies) and 17 of the 45 possible combinations have been neglected so far.

220 studies *jointly used consumer and sensory research methods* to examine consumers' food decision making. Figure 5 illustrates that the most frequent combination of consumer and sensory research methods was acceptance test and surveys/questionnaire (93 studies). 18 studies jointly used profiling techniques and surveys/questionnaires. The dominance of the use of surveys/questionnaires in combination with other methods might be explained by the fact that surveys/questionnaires help to gather additional information about attitudes of the consumer and socio-demographic data (e.g., Lawless et al. 2013). Acceptance tests were jointly applied with conjoint analysis in 18 studies, and in 13 studies with choice tasks. Acceptance tests measure liking, but in marketing practice liking is not enough to determine whether the consumers translate their liking into real choice behavior. Therefore, choice tasks

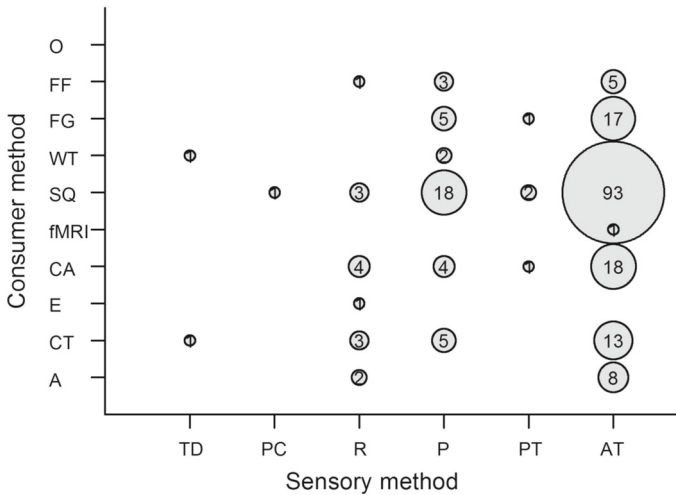


Fig. 5 Number of studies per sensory research method (x-axis) combined with consumer research methods (y-axis), $n=220$; *O* observation, *FF* face-to-face interview, *FG* focus groups, *WT* word association, completion techniques, *SQ* surveys/questionnaire, *CA* conjoint analysis, *E* eye tracking, *CT* choice task, *A* auction, *TD* triangle test/duo-trio test, *PC* paired comparison test, *R* ranking, *P* profiling, *PT* preference test, *AT* acceptance test

and conjoint analyses are used as additional tools to make empirical studies on food choice as realistic as possible (e.g., Roosen et al. 2007; Lusk and Parker 2009). In 17 studies, focus group discussions were used in preparation for a main study in which acceptance tests were finally conducted to measure food liking (e.g., Endrizzi et al. 2015).

4.2.2 Timeline of consumer and sensory research methods

Considering the development of research methods over time, Fig. 6 shows that the use of consumer methods and sensory methods, as well as their combination, was relatively low between the early 1990s and the turn of the millennium (which correlates with the findings of the development of studies in general, see Sect. 3.2). A steady increase of general method use since 2002 is noticeable. Since 2004, the number of studies on food decision making research has been dominated by the use of consumer research methods, with currently more than 30 studies per year. Figure 6 also demonstrates that research in food decision making still neglects to combine consumer and sensory methods, supporting the findings visualized in Fig. 5.

4.2.3 Study locations

The use of research methods is based on the assumption that the results have external validity and help in marketing. In contrast to this assumption, prior research showed that results of empirical studies are only valid for the investigated sample, for the particular product, and in a given context (Boutrolle et al. 2007). Thus, the results of food

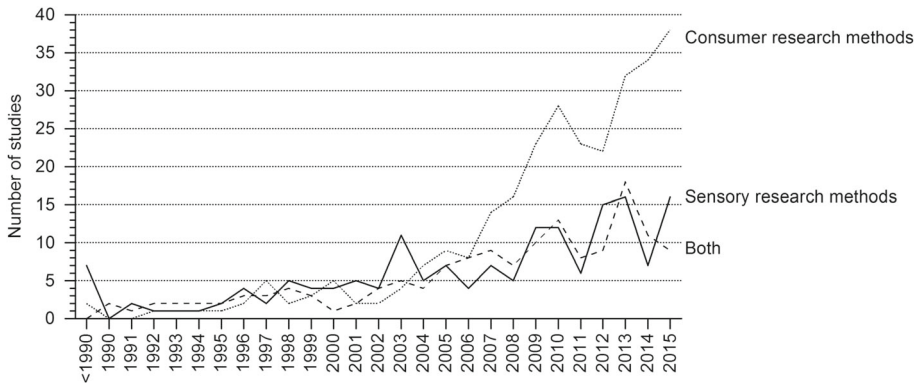


Fig. 6 Number of studies using methods of consumer research, sensory research, or both

evaluation studies depend on the testing conditions. The most popular method to test food is the *central location test*. It usually takes place in a standardized laboratory under controlled conditions (e.g., sensory laboratory, university, market research institute). In contrast to the artificial conditions of central location tests, in *home-use tests* consumers take the product home for common daily use (Lawless and Heymann 2010). It is assumed that home-use tests yield more realistic data, but may cause the problem of uncontrolled conditions (i.e., researcher do not know who really rated the product and under what circumstances). *Field experiments*, conducted in supermarkets, cafeterias, or shopping centers, are explored in a real setting to collect data about which groups of consumers are most responsive to targeted products, or how a product performs relative to competitive products (Lambrecht and Tucker 2015). With the increasing ubiquity of the internet, *web experiments* have emerged as a further approach to conduct behavioral experiments (Germine et al. 2012). In the present sample, 388 central location tests, 34 home-use tests, 141 field experiments, and 69 web experiments were identified. In 11 studies, both a central location test and a home-use test were conducted (e.g., van Doorn and Verhoef 2011); in 12 studies, a central location test and a field experiment (e.g., Shah et al. 2014); in 3 studies, a central location test and a web experiment (e.g., Coleman et al. 2014); in 3 studies, a home-use test and a field experiment (e.g., Kozup et al. 2003); and in 2 studies, a web experiment and a field experiment (e.g., Burton et al. 2009).

4.3 Integrative consideration of attributes and methods

Derived from a variety of intrinsic and extrinsic product attributes, the bubble charts in Fig. 7 disclose numerous combinations with research methods. In the following, some combinations are described for illustrative purposes.

In the majority of studies dealing with food *appearance*, acceptance tests were conducted. For instance, in the study of Leksrisompong et al. (2012), consumers had to rate their overall liking of sweet potatoes with varying flesh color (orange, purple, yellow). Only one study investigated the effect of food appearance on food decision

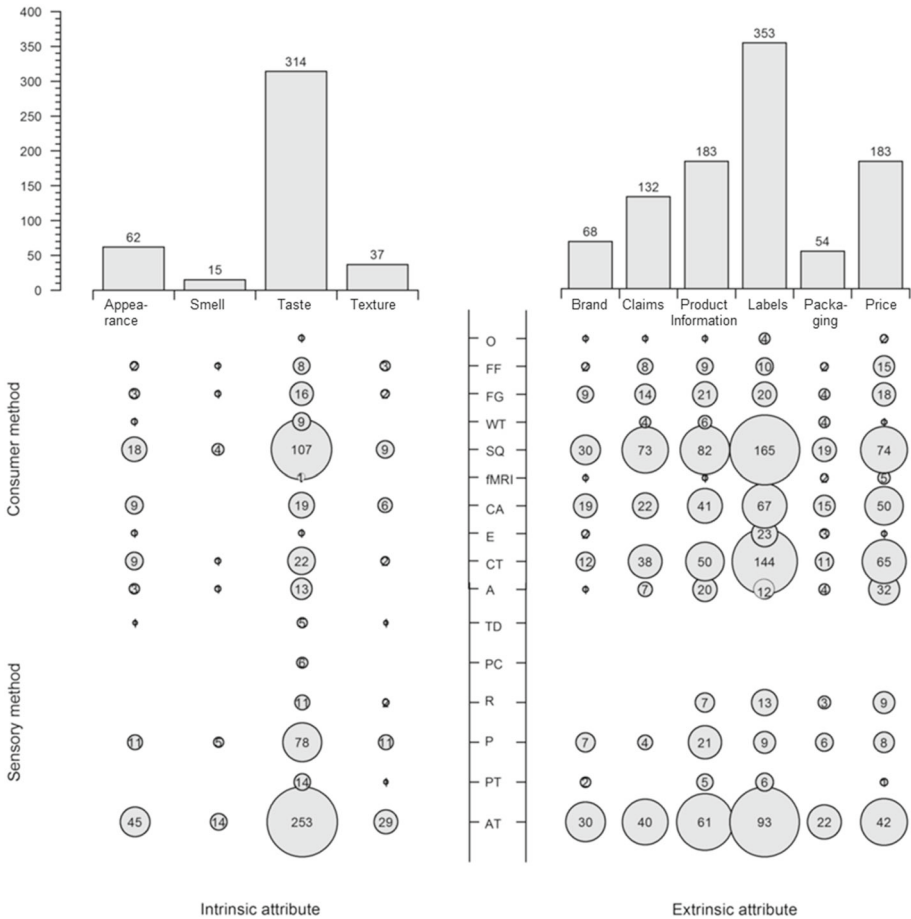


Fig. 7 Number of articles per intrinsic and extrinsic product attribute combined with research methods. The numbers in the bar charts and in the bubble charts may add up to more than $n = 602$ because one study may have analyzed more than one product attribute or applied more than one research method; *O* observation, *FF* face-to-face interview, *FG* focus groups, *WT* word association, completion techniques, *SQ* surveys/questionnaire, *CA* conjoint analysis, *E* eye tracking, *CT* choice task, *A* auction, *TD* triangle test/duo-trio test, *PC* paired comparison test, *R* ranking, *P* profiling, *PT* preference test, *AT* acceptance test

using eye tracking technology (Jantathai et al. 2014). *Smell* received far less attention in prior research with a maximum of 14 studies using acceptance tests (e.g., Koskinen et al. 2003; Bazala et al. 2015). *Taste* has been examined within a wide range of different consumer and sensory research methods with a strong focus on acceptance tests (e.g., Kähkönen et al. 1999; Altisent et al. 2013) and surveys/questionnaires (e.g., Becker et al. 2011; Rossi et al. 2015). Recently, Biguzzi et al. (2015) explored the effect of fat- or sugar-reduced biscuits on food liking. In the study of Baixauli et al. (2008), consumers completed a questionnaire related to food, nutrition, and purchase intention of fiber-enriched muffins. Somewhat surprising is the combination of the fMRI technology and taste in the study of Enax et al. (2015). They investigated neural

and behavioral processes underlying the influence of a fair trade label with a subsequent tasting of chocolates, presented either with or without a fair trade label. Even more common is taste evaluation using profiling techniques prior to a large consumer survey (e.g., Czarnacka-Szymani and Jezewska-Zychowicz 2015; Rodbotten et al. 2015). *Texture* was measured in terms of firmness as an indicator for the level of ripeness of fruits and vegetables using conjoint analysis (e.g., Gamble et al. 2010), thickness in dairy products and hardness in meat products using acceptance tests (e.g., Li et al. 2015; Cilla et al. 2005), or crunchiness in bakery products using free choice profiling (e.g., Taracón et al. 2013). Notably, taste is the only intrinsic product attribute that was analyzed across all sensory methods.

The majority of studies dealing with product *brand* were either conducted using acceptance tests (e.g., Varela et al. 2010; Kim et al. 2013) or surveys/questionnaires (e.g., Pohjanheimo and Sandell 2009; Mueller and Szolnoki 2010). The same can be observed for *claims* with an additional focus on choice tasks. For instance, Naylor et al. (2009) demonstrated how conflicting (versus complementary) information about the validity of a health claim influences the likelihood of choosing a functional over a nonfunctional food. There are several studies that investigated *product information* using acceptance tests (e.g., Kihlberg et al. 2005), choice tasks (e.g., Brooks and Lusk 2010), and conjoint analyses (e.g., Morales et al. 2013). In contrast, only a few studies used ranking and fMRI technology. For instance, Lusk et al. (2015) measured brain activation while consumers made choices between two milk options varying in price and technology. Research on food *labeling* is clearly dominated by the use of surveys/questionnaires and choice tasks. Moreover, food labeling is the product attribute for which the most eye tracking studies have been conducted. In the study of Mawad et al. (2015), participants were asked to select their preferred yoghurt label while their eye movement was recorded. Few studies analyzed food *packaging* using sensory research methods. Instead, food packaging is dominated by consumer research methods, particularly surveys/questionnaires (e.g., Scott et al. 2008; Becker et al. 2011) and conjoint analyses (e.g., Quester and Smart 1998; Silayoi and Speece 2007). *Price* levels of food play a major role in consumers' food decisions, which is reflected by the inclusion of price as a crucial attribute in many studies using different research methods. Prices were most frequently included in surveys/questionnaires, choice tasks, and conjoint analyses, in which consumers react to price levels that are preset by the researcher. In experimental auctions, participants disclose their willingness-to-pay according to the true value of their preferences (e.g., Thunstrom and Nordstrom 2015; Bruschi et al. 2015). Price and food labeling are the only two extrinsic product attributes that received attention across all consumer research methods. However, a few studies that focused on the sensory evaluation of a food also included the price into their research design.

5 Critical appraisal of the state of the art and identification of research gaps

Knowledge about product characteristics which have the potential to influence consumer purchase behavior is important when developing food products and designing

marketing strategies. Both sensory and non-sensory product attributes could have a major influence on consumers' choice or rejection. The next section highlights and discusses some research gaps and challenges of interdisciplinary research on food decision making.

5.1 Participants of the study

Consumer and sensory research traditionally employ different test panels, either (semi-)trained panels or untrained panels. The participants receive different tasks based on what is most efficient to solve a problem (Meiselman 2013). Previous research has already started to rethink this strict separation (Chollet et al. 2005; Worch et al. 2010), but clearly state that it always depends on the research aim. Future research should scrutinize their research aims and carefully select an appropriate test panel. Conducting research with a trained panel may be useful, for instance for the development of sensory attributes. However, using these attributes in consumer studies with untrained participants may cause confusion and uncertainty in food evaluation.

5.2 Product attributes

As can be seen in Fig. 7, the proportion of studies dealing with food appearance, texture, and smell as intrinsic product attributes is relatively small. No study was found that deals with the sound of a food and its effect on food choices. A recent review of Zampini and Spence (2010) showed that auditory stimuli (either food-related or nonrelated, such as background music) can have a dramatic effect on food perception. However, the important role of auditory cues in food decision making is thus far underrepresented in food research. Concerning extrinsic attributes, research on packaging, including the full range of possible features, has been neglected so far. As a consequence, combinations like packaging and label, or packaging and claim received comparatively less attention in prior research. Almost one-third of the studies (192 of 602) comprise intrinsic *and* extrinsic attributes. This finding is consistent with previous studies (e.g., Hoppert et al. 2012; Akdeniz et al. 2013; Mai et al. 2016) which observed that a large share of the research focused on isolated effects, whereas only a small proportion of studies used a holistic approach to examine intrinsic and extrinsic product attributes simultaneously. In addition, some combinations of product attributes and research methods show a concentration of studies, whereas other combinations have been neglected so far (Fig. 7). On the one hand, more emphasis should be laid on research that focuses on more integrative approaches to describe real food choices. On the other hand, not every combination of attribute and method seems worth investigating. This needs to be checked against the demands of the practice.

5.3 Measurement of consumer responses

The findings of the present article show that 485 studies focused on a single dependent variable. 39% of the studies asked participants for their liking, and only 17%

of the studies included purchase intention. As the liking or preference of a food is influenced by environmental factors (Scheibehenne et al. 2014; García-Segovia et al. 2015) and learning processes (Hermans et al. 2005; Morgan et al. 2014), one cannot conclude from food liking that consumers automatically translate their liking into purchase intention or behavior. With respect to this intention-behavior gap, future studies should be careful in drawing the right conclusions from research and transferring scientific results into practice. This could be achieved by measuring dependent variables at different stages of the decision making process (liking and purchase intention, preference and willingness-to-pay). In addition, it is largely difficult to harmonize dependent variables and their use across disciplines (same terms have different definitions, or different terms mean the same). For instance, various food liking and food wanting tests have been conducted, but it has proven to be very difficult to measure wanting separate from liking (Havermans 2011). Thus, the complexity of food research has led to isolated approaches in consumer and sensory science. This will require the development of common definitions across disciplines in future studies.

5.4 Food categories

The present article shows that only a few studies analyzed the choice of fish (1%), oils and fats (2%), or snacks and sweets (6%). Especially given the rising problems in public health, the analysis of specific food types (e.g., snacks and sweets), but also their correlation with physical activity (Lakerveld et al. 2014; Horodyska et al. 2015), should be intensified. 10% of the studies investigated menus. Testing a meal consisting of different ingredients is more complicated than testing consumer acceptance for single ingredients (Olsen et al. 2012). Because out-of-home and convenience-oriented food choices will continue to increase, more attention needs to be paid to these issues.

5.5 Consumer and sensory research methods

Findings of the present article show that there is an imbalance between well-represented and underrepresented methods in consumer and sensory research. While the application of acceptance tests and surveys/questionnaires are well documented, other methods as well as their combination were rarely or never applied. From Table 5 and Fig. 5, one might conclude that not enough attention has been paid to auctions in food decision making research so far, although this approach has several advantages over standard approaches (e.g., surveys and focus groups; Jaeger et al. 2004). Auctions are currently being used mostly in experimental economics to measure the real monetary value of goods. As many studies focus on consumers' food liking and purchase intentions, their real willingness-to-pay is often disregarded. Auctions put great emphasis on realism by using real goods, real money, and market discipline of consumers.

The complex origins of food decision making processes in humans necessitate either new or combined research methods, or the simulation of situations (e.g., eye tracking studies) rather than merely on questionnaires and self-reports (Köster and Mojet 2006). Beneficial findings may result, for instance, from the combination of

ranking tests with choice tasks or auctions. In hedonic ranking, participants rank several products based on their liking, but the researcher does not gain insights into whether the consumers would choose the product and what they are willing to pay for it. Moreover, the information obtained from preference tests does not say anything about the acceptance of the product because one product might be preferred over another even though both are disliked. For this reason, companies should not base their manufacturing and selling activities only on preference tests. Acceptance tests allow for the evaluation of only one product, whereas preference tests need at least one further product for comparison. However, preference tests could be combined, for instance, with conjoint analyses in which consumers have to decide in favor of one product based on both sensory impression and extrinsic cues. For instance, Hoppert et al. (2012) integrated sensory assessment of yoghurt (varying in fat content, sugar content, and flavor intensity) and product evaluation based on packaging information into an adaptive conjoint analysis. Finally, observations of actual choices in real purchase situations could replace methods based on just asking for liking, wanting, or purchase intention (Köster 2009).

In the present sample, only 83 studies used qualitative methods (face-to-face interview, focus group discussions, and word association/completion techniques) and combined them with quantitative ones. However, the challenge for researchers will remain finding appropriate methods in the complexity of qualitative and quantitative tools to analyze consumer behavior (e.g., laboratory experiment vs. field experiment, with vs. without tasting). In sum, this article proposes the combination of several behavioral (e.g., choice experiment), sensory (e.g., ranking), neural (e.g., fMRI), and/or psychological (e.g., IAT) methods to enlighten the conceptualization of human food choice behavior. Especially in concrete industrial product development situations, it is crucial to have methods available that can be used to investigate both intrinsic and extrinsic attributes simultaneously.

5.6 Origin of the studies

The analysis reveals that 564 of 602 studies were conducted with samples of a single country. This finding is consistent with observations of previous researchers who criticize the limited geographical distribution of studies (Meiselman 2013). However, there are signs of a slow reorientation towards more multinational and cross-cultural food research, for instance in Europe, where a number of EU-funded projects have been performed (e.g., <https://www.dedipac.eu/>, <https://cosus.nmbu.no/>). This trend needs to be continued at least in the context of developing and testing global products.

5.7 Study locations

It is obvious from the present dataset that central location tests are most commonly used in consumer and sensory research, whereas the other approaches received less attention. To address real world issues, future studies need to find a better balance between laboratory research under artificial conditions and uncontrolled research (home-use tests, field experiments). Researchers will also need to understand how to conduct

effective internet research using web experiments due to an increased online shopping behavior. Moreover, different approaches should not be applied comparatively to answer a research question, but instead to collect data at different stages of the study (e.g., pretest vs. main study).

6 Conclusions and limitations

The present article provides an overview of the extrinsic and intrinsic food product attributes in consumer and sensory research. 602 studies, published from 1964 to 2015 in 138 academic journals, were analyzed. Over the last two decades, an increase in the number of publications can be observed, with the majority of studies being conducted as central location tests in Europe and North America. The analysis revealed a wide range of tested foods that were grouped into nine food categories, of which beverages, dairy, and menus were investigated most often. Responses of consumers were usually conceptualized in terms of food liking, food choice, purchase intention, and willingness-to-pay. Most studies assessed consumers' food evaluation using acceptance tests and surveys/questionnaires. The most frequent combination within the sensory research methods was profiling and acceptance test. Within the consumer research methods, surveys/questionnaires were most often combined with choice tasks. Consequently, the most frequently used combination of consumer and sensory research methods was acceptance test and surveys/questionnaires.

Concerning the intrinsic product attributes, taste has received the greatest research interest so far and is often analyzed in combination with appearance. Taste has been examined with a strong focus on acceptance tests and surveys/questionnaires. Taste was the intrinsic product attribute that was analyzed using all sensory methods. Food labeling was the most often studied extrinsic product attribute, followed by price, with both being considered in combination with many other extrinsic attributes. Research on food labeling was clearly dominated by the use of surveys/questionnaires and choice tasks. Price and food labeling were the only two extrinsic product attributes that received attention across all consumer research methods. The most frequently observed combination of intrinsic and extrinsic product attributes was taste and label.

In sum, this review has presented detailed evidence of which product attributes influence consumers' food decision making and which methods have widely been used for analyzing human behavior in consumer and sensory research. In consumer research, researchers aim particularly at obtaining knowledge on which and how individuals use informational stimuli that are provided by packaging or advertising without physically modifying the product. In contrast to complex purchase decisions (e.g., buying a smart phone), food decision making is conducted repeatedly so that, once a particular food has been selected, sensory properties are usually borne in mind and remembered in subsequent purchases. Sensory scientists mainly focus on analyzing the impact of food ingredients or processing parameters on intrinsic sensory attributes which determine perceived quality (e.g., appearance, taste, smell, sound, texture). Although many studies have been found in both consumer and sensory literature, it was shown that many attributes, particularly the combination of extrinsic and intrinsic attributes, have not been researched sufficiently so far. With regard to *Research Question 1*, future

studies are well advised to expand research on product attributes to derive further useful practical implications.

The findings of this review pose further dilemmas for researchers because of the variety of methods that can be used to explain consumers' food decision making. With regard to *Research Question 2*, the research still suffers from a lack of interdisciplinarity and more attention needs to be paid to using methods from both disciplines in future studies. Sensory scientists, with their expertise in testing intrinsic attributes of food, are able to predict consumer preference and choice. However, to ensure the required external validity to achieve marketing objectives, sensory researchers will need to incorporate elements of the marketing context into their study designs. Thus, marketing and sensory approaches have to be linked to realize not only one-time, but repeated food purchases.

The pooling of scientists' knowledge about consumer attitudes towards both intrinsic and extrinsic product attributes and competencies on how to measure consumer behavior remains an obstacle for further research that has to be overcome. Neither consumer nor sensory science needs to be changed, since they are well established disciplines and have developed an important pool of methods. Instead, with regard to *Research Question 3*, this review calls for ways to timely strengthen the link between consumer and sensory science. From a purely scientific perspective, researchers have to consider both marketing and sensory aspects when studying consumers' food decision making. From the perspective of a practitioner, it is highly relevant that new product development be based on the cooperation between consumer and sensory science as products are potentially more likely to meet consumers' needs and lead to improved satisfaction. This allows the food industry to avoid many unnecessary product failures.

While the present article has provided useful insights into the state of the art of the research in consumers' food decision making, there are *limitations* that have to be mentioned. The selection process of the studies caused the exclusion of certain publication types. As stated in Sect. 3.1, this review aims to analyze research activities based on primary experimental studies. Therefore, literature was included selectively by focusing on journal articles. It is conceivable that research is also published in working papers or conference proceedings that were excluded. Considering the need to understand study content correctly for the coding procedure of this review, only studies that were published in English were included. However, studies did not have to be published in peer-reviewed journals, as it would narrow the scope of studies. An extensive forward–backward search was conducted and studies were screened using a priori defined inclusion and exclusion criteria. Therefore, it is assumed that the study sample is representative with respect to the research efforts in consumer and sensory science. This article does not claim completeness, but intends to provide an overview of existing knowledge and to deduce implications for further research in food decision making. However, since the article does not provide any information about the explanatory power of the results of the primary studies, it remains unclear whether the limited attention given some attributes, methods, or their combination is due to the fact that they are simply not as interesting. Research and corporate practice are invited to propose new methods of investigating consumer food choices, assuming it is practically relevant.

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