Consumer acceptance of technology-based food innovations: Towards an integrated framework of the consumer acceptance process and effective communication approaches

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Abstract

The food industry is facing major challenges against the background of current developments in the environment and society. Therefore, especially through scientific and entrepreneurial research and development, new concepts and innovative food products are driven to address these challenges. And although not only companies but also society can benefit from the advantages of innovations, especially technology-based innovations are rarely used in the food industry because their application is often met with initial skepticism and lack of acceptance in society. Effective communication approaches are therefore needed to reduce the barriers to a successful implementation of innovations in the food sector and to promote the acceptance of consumers. In this context, a comprehensive understanding of the factors involved in the initial perception of innovative food products, as well as the actions and decisions associated with acceptance, is essential.

This dissertation, therefore, focuses on two main research areas. In the first module, which consists of two research articles, relevant factors of the perception of innovative food are identified and a holistic model for capturing consumer acceptance is developed. Thereby, the understanding that acceptance is a dynamic construct that develops over several phases and passes through different stages of acceptance is taken as a basis. The second module, which also consists of two research papers, deals with the development of effective communication approaches, including the impact of information and information sources. In addition, neuroscientific methods are used to take into account the unconscious processes of information processing of the consumers.

The results of this dissertation enable the identification of drivers and barriers of consumer acceptance, which can be used together with the findings of the second module to develop effective communication approaches to promote the acceptance of technology-based food innovations. In addition, the findings of this dissertation provide different approaches for future research projects in the field of food acceptance research.

Keywords: Consumer acceptance, communication strategy, food innovations

Zusammenfassung

Vor dem Hintergrund aktueller Entwicklungen der Umwelt und der Gesellschaft, steht die Lebensmittelindustrie vor großen Herausforderungen. Daher werden insbesondere durch wissenschaftliche und unternehmerische Forschung und Entwicklung neue Konzepte und innovative Lebensmittel vorangetrieben, um diese Herausforderungen zu bewältigen. Und obwohl neben den Unternehmen auch die Gesellschaft von den Vorteilen der Innovationen profitieren können, werden gerade technologie-basierte Innovationen nur selten in der Lebensmittelindustrie verwendet, da ihre Anwendung in der Gesellschaft oft auf anfängliche Skepsis und mangelnde Akzeptanz stößt. Um die Barrieren einer erfolgreichen Implementierung von Innovationen im Lebensmittelbereich abbauen zu können und die Akzeptanz der Konsumierenden zu fördern, bedarf es daher wirkungsvoller Kommunikationsansätze. In diesem Zusammenhang ist ein umfassendes Verständnis der Faktoren der Wahrnehmung innovativer Lebensmittel sowie der mit der Akzeptanz verknüpften Handlungen und Entscheidungen von grundlegender Bedeutung.

Die vorliegende Dissertation konzentriert sich daher auf zwei Forschungsschwerpunkte. Im ersten Modul, welches aus zwei Forschungsartikeln besteht, werden relevante Faktoren der Wahrnehmung innovativer Lebensmittel identifiziert und ein ganzheitliches Modell zur Erfassung der Konsumentenakzeptanz entwickelt. Hierbei wird das Verständnis zugrunde gelegt, dass Akzeptanz ein dynamisches Konstrukt ist, dass sich über mehrere Phasen entwickelt und dabei unterschiedliche Stufen der Akzeptanz durchläuft. Das zweite Modul, welches ebenfalls aus zwei Forschungsbeiträgen besteht, setzt sich mit der Entwicklung wirkungsvoller Kommunikationsansätze auseinander, wobei die Wirkung von Informationen und Informationsquellen einbezogen wird. Zudem werden neuroökonomische Methoden eingesetzt, um auch die unbewussten Prozesse der Informationsverarbeitung der Konsumierenden berücksichtigen zu können.

Die Ergebnisse dieser Dissertation ermöglichen die Identifikation von Treibern und Barrieren der Akzeptanz der Konsumierenden, welche gemeinsam mit den Erkenntnissen des zweiten Moduls genutzt werden können, um wirkungsvolle Kommunikationsansätze zur Förderung der Akzeptanz technologie-basierter Lebensmittelinnovationen zu entwickeln. Zudem liefern die Erkenntnisse dieser Dissertation unterschiedliche Ansätze für zukünftige Forschungsvorhaben im Bereich der Lebensmittelakzeptanzforschung.

Schlagwörter: Verbraucherakzeptanz, Kommunikationsstrategie, Lebensmittelinnovationen

Preface

"Nothing in life is to be feared, it is only to be understood.
Now is the time to understand more, so that we may fear less."

Marie Curie, Polish physicist and chemist, 1867 - 1934

1 Motivation and research objectives

The modern food sector as a whole is facing major challenges. These include changes regarding the economic and non-economic environment of the sector, changing lifestyles and changing attitudes of the society towards the consequences of the food system's activities, and the global increase in food consumption. To meet these and other challenges, innovation has been discussed not only as an opportunity but also as a prerequisite for success (Schiefer & Deiters, 2016). Because innovation is not only an important driver of productivity and economic growth by helping to achieve economic goals at lower cost and leading to new business opportunities and markets, but it can also be used to achieve environmentally friendly goals that also bring major benefits to the society (OECD, 2017).

Against this background, many new technologies and products have been introduced in the food industry in recent years (Bäckström et al., 2004; Verbeke, 2005). However, the failure rates of these product innovations are very high, with consumers rejecting various new technologies for different reasons (Miles & Frewer, 2001; Van Trijp & Steenkamp, 2005). In general, consumers do not ask about technology-based food innovations, so the public is often concerned about the application of new technologies (Bruhn, 2008; Miles & Frewer, 2001). Based on the high failure rates of novel food products and the associated losses for the companies as well as for society, it is important for all stakeholders in the food industry to identify ways to encourage consumers to adopt product innovations. As a result, academic interest in food products made with innovative technologies has increased, and special attention has been paid to factors that might explain consumer acceptance or skepticism of these new technologies (Verneau et al., 2014). Thus, in recent years, different studies were able to identify several extrinsic factors that influence the perception and acceptance of innovative foods (e.g., Amin et al., 2011; Connor & Siegrist, 2010; Verbeke, 2005). In order to understand the underlying determinants of consumer acceptance of innovative food products to its full extent, it is necessary to consider the

perception of the innovative product with all its extrinsic determinants, as consumer decision-making with regard to food innovations is also based on these determinants (Grunert et al., 2011). Nevertheless, most previous studies have only considered certain factors that influence the perception and acceptance of innovative foods. However, a holistic understanding of which factors determine consumer acceptance would be of great benefit to various industries and the scientific community.

In addition to the influencing factors, however, a holistic understanding of the acceptance of consumers themselves is necessary to encourage consumers to adopt product innovations. However, many of the previous studies on the acceptance of innovations have focused less on understanding acceptance itself and more on the factors influencing acceptance. Therefore, consumer acceptance is often represented and measured using a single construct such as willingness to buy or pay, positive attitudes, intention to use or general acceptance of the innovative (food) product (see Bearth & Siegrist, 2016 for an overview). However, in contrast to these constructs, which are related to one point in time, consumer acceptance should be viewed as a dynamic multidimensional construct that goes through several phases over time and includes multidimensional levels of interpretation (Kollmann, 2004). Hence, it is crucial to gain a deeper understanding of consumer acceptance of technology-based food innovations in all its phases in order to be able to derive targeted approaches for marketing management to improve consumer acceptance.

In relation to the above findings, on the one hand, it is particularly important to identify extrinsic determinants of consumer perceptions of innovative food products and to examine their impact in order to understand the basis on which customers make their decisions in the acceptance process. On the other hand, in order to understand what actions and decisions take place during the acceptance process and how they are influenced by innovation-related perceptions, it is necessary to develop a multidimensional model based on the idea of consumer acceptance as a multistage process. For this reason, the first part of this dissertation takes up this issue and deals with the development and validation of an integrated framework of the consumer acceptance process.

Research objective 1: Development and validation of an integrated framework of the consumer acceptance process

In addition to the perceived characteristics of an (innovative) product, consumers are also influenced by information related to the product that they receive from different sources and through different communication channels (Bruhn, 2008). In fact, information about a product or the manufacturing process can influence consumer perceptions in such a way that consumers change their preconceived notions about a product to a positive one and thus view it with a higher level of acceptance (Pereira et al., 2019). However, in addition to the information itself, the source of the information is also a crucial element of the communication strategy, since the communication process begins with the source and thus it influences how the message is perceived by the target audience (Belch & Belch, 2009). In order for marketing management to develop effective communication strategies that increase the acceptance of innovative food products, it is necessary to investigate how consumers react to these two elements.

In addition to considering the information itself, particular attention must be paid to the fact that the decision-making behavior of consumers is always affected by the interplay of two types of information processing. Type 1 processes comprise general processes of implicit learning and conditioning and are characterized by intuitive, automatic, and spontaneous processes. Type 2 processes, on the other hand, are characterized more by explicit processes that are rational, controlled, and deliberate (Evans & Stanovich, 2013; Kahneman, 2012). In order to capture the impact of different communication approaches holistically, both processes need to be considered in market research. To enable the assessment of both processes, methods of consumer neuroscience, such as implicit association tests, must be integrated into research.

Therefore, the second part of this dissertation focuses on the effect of different communication approaches in order to identify which measures can be applied to encourage consumer acceptance of technology-based food innovations. On the one hand, the effect of information, as well as the source of information, is considered. On the other hand, the effect on both the explicit and implicit processes of information processing is tested.

Research objective 2: Providing new insights on the explicit and implicit effects of different communication approaches on acceptance-related indicators

In order to address the two research objectives outlined above, this dissertation is structured in two modules. The two articles in module 1 are dedicated to the first research objective, while the two articles in module 2 focus on the second research objective. The two modules and the associated articles are described in more detail in the following chapter.

2 Description of the research articles

2.1 Module 1: Development and validation of an integrated framework of the consumer acceptance process

The first module aims to develop a deeper understanding of consumer acceptance towards innovative food products. Therefore, a holistic framework for consumer acceptance based on a process of acceptance is developed in order to gain an understanding of the underlying causal relationships between the different stages of this process. Furthermore, antecedents of innovation-related perception are identified. While in research article 1 the antecedents are conceptualized as formative indicators of innovation-related perception, the antecedents and their influence are considered as independent dimensions in research article 2.

Research article 1 "The impact of innovation-related perception on consumer acceptance of food innovations - development of an integrated framework of the consumer acceptance process" provides a comprehensive conceptual framework, including the innovation-related perception and the consumer acceptance process, to gain a deeper understanding of the reactions of consumers towards technology-based food innovations. Specifically, the study identifies 14 characteristics that can be understood as antecedent factors of consumer innovation-related perception. The developed acceptance process involves five phases that represent different sequential levels of acceptance: assessment acceptance, attitude acceptance, action acceptance, use acceptance, and performance acceptance. Structural equation modeling confirms the predictive power of the developed multidimensional model of consumer acceptance. Moreover, the results show that relative advantage, naturalness, novelty, and discomfort are the most important driving factors for the innovation-related perception of food products. Other important findings show that innovation-related perception and the dimensions of the assessment acceptance (i.e., customer-perceived value and customer-perceived risk) are important variables for the acceptance of an innovative food product. The food industry can benefit from the findings of this study to communicate and market their products according to the results to reduce mistrust and increase consumer acceptance of food innovations.

Research article 2 "Turning Waste into Smoky Taste: Identifying Consumer Acceptance Drivers of an Innovative Food Flavoring" aims to further develop the model presented in research article 1, to gain a deeper understanding of possible drivers of consumer acceptance of technology-based food innovations. Particular focus is given to identifying drivers of customer-perceived value and customer-perceived risk as critical factors for consumer acceptance. In

addition, the effects on the attitude components (i.e., affective, cognitive, and conative attitude) are analyzed as further dimensions of the consumer acceptance process. The structural equation modeling results confirm the high predictive power of the multidimensional model of consumer acceptance once again. Furthermore, using the importance-performance map analysis, the compatibility dimension for value perception and the health expectancy dimension for risk perception are identified as particularly promising for improving consumer acceptance. Knowledge of the importance and performance of factors influencing value and risk perceptions enables the development of targeted communication strategies and marketing approaches to reduce consumer uncertainty and skepticism and increase their acceptance of innovative food technologies and product innovations.

2.2 Module 2: Investigation of explicit and implicit effects of different communication approaches on acceptance-related dimensions

While research module 1 focuses on the development of an integrated framework and the identification of antecedents of consumer acceptance, research module 2 examines the effect of different communication approaches on acceptance-related dimensions. Research article 3 investigates the effect of different amounts of information and the role of information sources. Research article 4 concentrates on the explicit and implicit information processing related to consumer acceptance of innovative food products.

Research article 3 "How product information and source credibility affect consumer attitudes and intentions towards innovative food products" examines two research questions. First, it investigates the effect of different amounts of information about an innovative food product on the consumer evaluation (i.e., consumer attitudes and behavioral intention). Second, it explores the role of information sources and their credibility as part of the communication approach with regard to consumers' product evaluation. To investigate these research questions, the research paper presents two online experiments that used a ham product, which is processed with an innovative smoke flavoring, as the product stimulus. In study 1, participants were given different amounts of information (low, medium, high) about the innovative smoke flavoring to analyze the impact of the amount of information. In study 2, the information was provided by different information sources to examine the effect of the information source. Analyses of variance are performed in both studies to compare the different groups. The results for study 1 show no significant differences, but nevertheless it is evident that more information does not always lead to better product evaluations. Furthermore, the results of study 2 show that independent or scientific sources of information are perceived as more credible and tend to lead

to higher product evaluations. In addition, higher credibility, measured in terms of attractiveness, trustworthiness, and expertise, leads to significantly higher product evaluations. These results provide valuable insights for marketing managers in developing effective communication strategies that create higher consumer acceptance for food innovations.

Research article 4 "When More Information Means Less Consumer Acceptance of Innovative Food Technologies" investigates the role that information about innovative food products plays in consumer decision-making. In contrast to research paper 3, a conceptual model is derived to gain an understanding about the explicit and implicit information processing related to consumer acceptance of and behavioral intentions towards innovative food products. Furthermore, this article investigates the effect of different levels of information about an innovative food product on the explicit and implicit consumer acceptance. In order to asses both, the explicit and implicit effects, explicit self-report measures were combined with a response latency measure used as a qualified implicit measure for consumer assessments. Against the background of the conceptual model and to increase the insights obtained from data analysis, a universal structure modeling approach with Bayesian neural networks were used. The results indicate that perceived risk, in contrast to perceived benefit, is a less critical factor for consumer acceptance and behavioral intention. In addition, the results reveal that, with the exception of explicit risk, all variables in the model have at least an indirect effect on the indicator of behavioral intention (i.e., product choice). In line with the results of research article 3, the results also suggest that less information may lead to better product evaluations and higher consumer acceptance, depending on the information context. This knowledge enables policy makers to develop communication strategies to increase consumer acceptance of food innovations. Furthermore, given the predictive power and the practicality of the combined implicit-explicit method, marketing managers can use the presented approach to assess consumer acceptance of food, in general, and of technology-based food innovations, in particular.

3 Conclusion and implications

3.1 Main contributions

This dissertation provides several contributions to a more comprehensive understanding of consumer acceptance of technology-based food innovations. Based on the two defined research objectives, the main contributions of the thesis are twofold.

First, it introduces an integrated framework of the consumer acceptance of technology-based food innovations based on a process of acceptance and including determinants of innovation-related perception. The acceptance process consists of five successive phases of acceptance (assessment acceptance, attitude acceptance, action acceptance, use acceptance, and performance acceptance), which in turn have been depicted with the help of marketing-relevant indicators to better understand which actions and decisions take place during this process. In addition, extrinsic determinants of the innovation-related perception of innovative food products could be identified, which are antecedent to the acceptance process. It has been shown that determinants such as naturalness, familiarity, compatibility, and trust in regulations, among others, are important factors with regard to the perception of innovative food products and can have a positive influence on consumer acceptance. Overall, the developed model was confirmed to have high predictive power, providing a first frame of reference to also investigate the acceptance of innovative food products in other contexts in future research.

Second, this dissertation examined the impact of different communication approaches to promote consumer acceptance of technology-based food innovations. Specifically, the findings of this dissertation provide new insights into how different amounts of information, as well as different sources of information and their credibility, contribute to enhancing product evaluation and consumer acceptance of innovative food products. In this regard, the results showed that more information about a product and its production process, depending on the context, does not necessarily lead to better product evaluations. This applies to both explicit and implicit information processing. The results regarding the use of different sources of information show that these are perceived differently in terms of credibility depending on their professional background, which is reflected to some extent in the product evaluation. The latter effect is intensified when credible sources are contrasted with less credible sources.

3.2 Implications for management practice

The results of this work provide marketing managers with approaches to measure consumer acceptance of innovative food products in order to ensure an evidence-based management foundation. In this respect, marketing managers can draw on the reference framework of the acceptance process, including the holistic view of the influencing dimensions of innovation-related perception, on the one hand. On the other hand, they can use the approach that combines explicit and implicit information processing with regard to consumer acceptance. For example, innovative food products or approaches to communication strategies can be tested in terms of perception and acceptance in the course of their development and prior to market launch as part of a consumer survey. In this way, marketing managers can investigate the extent to which the innovation or the corresponding communication strategy creates or solves acceptance barriers among consumers. The insights gained in this way can be used to decide which aspects of the innovation should be improved further, if this is possible, or which potential for improvement exists with regard to the communication strategy. In order to understand consumer decision-making more holistically, and since explicit and implicit information processing may differ significantly, it is also important for companies to capture (dual) implicit-explicit processes to ensure that they perform well at both levels. Otherwise, acceptance barriers may be overlooked, leading to a lack of consumer acceptance and behavioral intention with regard to technology-based food innovations.

In addition, this dissertation provides valuable insights for the development of communication strategies for enhancing consumer acceptance of technology-based food innovations that tend to trigger rejection and skepticism among consumers. First, regarding the determinants of innovation-related perception, the results provide valuable insights for organizations and companies by identifying dimensions that can help increase the acceptance of beneficial food innovations, leading to an increased likelihood of successful market introduction. Depending on the product under investigation, communication strategies should, for example, emphasize aspects of the product's naturalness, such as the natural origin of the ingredients, in order to increase the perception of a technology-based food innovation. In addition, compatibility with an innovation could be highlighted and familiarity could be established by giving reference products as examples, which have already been successfully established on the market and that have been processed using the same or a similar technology. Furthermore, since the customer perceived value is more important than customer perceived risk in terms of acceptance, both at the explicit and implicit level, strategies should also aim to highlight the values and benefits of

consuming and using the innovative food product in order to achieve a stronger impact on consumers in the subsequent phases of the acceptance process.

Second, further insights for policy makers and marketing managers can be obtained from the research regarding the amount of information and the sources of information in module two. Since the results of the studies showed that product evaluations decreased with increasing information content and tended to be moderate overall for the different information sources, it can be assumed that simply providing information about the technology-based food innovation to the public will not lead to acceptance of the innovation. To be able to ensure that the information provided actually addresses consumer uncertainties, information dissemination should be driven not only by science and technology but also by the needs of the public to increase consumer acceptance of new technologies and innovative foods. It is therefore important to understand and design the communications strategy as an iterative, two-way process to proactively engage the public to understand what information is actually relevant to the public. Finally, the information sources in this dissertation were perceived differently in terms of their credibility, and the credibility of the source in turn had a significant impact on consumers' product evaluations. Therefore, marketing managers must use credible sources when designing information campaigns to maximize the impact of the information source on product evaluations. Because scientific experts are perceived as particularly credible sources, they may play an important role in the increasingly complex global food system.

3.3 Implications for future research

The results of this dissertation provide new insights into the influences on and decisions of consumers during the acceptance process. These new insights offer interesting starting points for future research projects.

First, the studies presented in this dissertation should be carried out with further product examples in order to confirm the results with regard to model quality and to extend the findings with regard to consumer acceptance. Since consumers perceive different products, ingredients, or technologies differently, this perception influences the understanding and acceptance of consumers. A broader view in this respect would provide further insights into consumer acceptance of innovative food products. Furthermore, the approaches developed could also be transferred to other industries (e.g. health industry) in order to gain insights into the acceptance of innovative products in other industries. Second, the influence of other informational content, as well as other approaches to providing information about the products, could be investigated. Although the information chosen in the studies presented was intended to be as objective and neutral as possible, other information, for example, information that emphasizes the benefits of the innovation, will have a different impact on consumer acceptance. In this context, for example, the actual needs of the public concerning the innovation to be tested could be identified in advance, so that appropriate information can then be included in the communication strategy and tested for its effectiveness. Third, the studies in this dissertation are limited to German consumers. Therefore, future research should examine the discovered relationships and influences in other countries, in order to be able to identify cultural differences with regard to consumer acceptance of food innovations. These findings should be taken into account when developing communication strategies for innovations. In addition to the cultural context, further contextual effects could be investigated, for example, attention could be paid to which topics are currently attracting particular public attention and whether or to what extent these are linked to the innovation and therefore need to be taken into account. Fourth, while a variety of external determinants of innovation-related product perception have already been examined in the presented studies, additional variables are likely to have an impact on consumer acceptance of innovative food products. Therefore, additional variables related to consumers' food choices, such as sensory perception or price perception, could be included to provide a holistic understanding of the perception of food innovations. In addition to such product-related factors, personal factors (e.g., food neophobia or health interest) can also be investigated, for example, to identify underlying concerns that hinder the acceptance of certain innovations.

Based on these personal factors, it is also possible to identify consumer groups with different views regarding specific innovations, which in turn can be used as target groups for different communication approaches. Fifth, since the study of conscious and unconscious effects and the application of neural networks to measure nonlinear causal relationships undertaken in this dissertation has addressed only a part of the research questions of this dissertation, the application could be extended to further issues. For example, the influences of external determinants of innovation-related perception could also be measured and their effects analyzed at these two levels to develop a deeper understanding. In addition, the application of further neuroscientific methods (e.g., electroencephalography, facial recognition) may shed further light on the automatic processing of consumer acceptance related to technology-based food innovations.

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Research articles

Module 1: Development and validation of an integrated framework of the consumer acceptance process

A1. **Albertsen, L.**, Wiedmann, K.-P., & Schmidt, S. (2020). The impact of innovation-related perception on consumer acceptance of food innovations - development of an integrated framework of the consumer acceptance process. *Food Quality and Preference, 84*(2020), 103958.

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A2. **Walten, L.,** & Wiedmann, K.-P. (2021). Turning Waste into Smoky Taste: Identifying Consumer Acceptance Drivers of an Innovative Food Flavoring. *International Journal of Consumer Studies.* Submitted and under review.

Module 2: Investigation of explicit and implicit effects of different communication approaches on acceptance-related indicators

A3. **Walten, L.,** & Wiedmann, K.-P. (2021). How product information and source credibility affect consumer attitudes and intentions towards innovative food products. *Journal of Marketing Communications*. Submitted and under review.

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A4. **Walten, L.,** Wiedmann, K.-P. & Schmidt, S. (2021): When More Information Means Less Consumer Acceptance of Innovative Food Technologies, *Marketing Review St. Gallen, 2021*(3), 14-22.

A1:

The impact of innovation-related perception on consumer acceptance of food innovations - development of an integrated framework of the consumer acceptance process

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The impact of innovation-related perception on consumer acceptance of food innovations – Development of an integrated framework of the consumer acceptance process

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ABSTRACT

Innovations are an important part of the further advancement of societies in general as well as of companies in particular. Individuals can benefit from the advantages of innovations, while companies can maintain or increase their market share and profitability. However, especially in the food sector, scientific or technological innovations often encounter mistrust and rejecting reactions from consumers, resulting in decreasing acceptance of those innovations. Therefore, this paper aims to gain a deeper comprehension of consumer acceptance of innovative food products as well as to identify antecedent factors of innovation-related perception. For the empirical investigation of our conceptualized model, an online survey was conducted in Germany (n = 617) and the collected data were analyzed through structural equation modeling. The results confirmed a high predictive power of the multi-dimensional model of consumer acceptance. Our first major finding indicates that relative advantage, naturalness, novelty, and discomfort are the most important driving factors of the innovation-related perception of food products. Further important findings show that innovation-related perception has a strong positive and highly significant impact on customer perceived value, respectively a strong negative and highly significant impact on the customer perceived risk. In summary, innovation-related perception, customer perceived value, as well as customer perceived risk, are all important variables related to the acceptance of an innovative food product. The food sector can benefit from the insights provided by this study to communicate and market their products accordingly to the results to reduce mistrust and increase acceptance of food innovations on the consumer side.

1. Introduction

Across sectors, it is essential for future-oriented companies to successfully develop and introduce new products to the market (Kühne, Vanhonacker, Gellynck, & Verbeke, 2010). In order to develop new products, companies can fall back on scientific and technological innovations of various domains (Ronteltap, Van Trijp, Renes, & Frewer, 2007). Consumers have adopted many of these technology-based innovations easily whereas other innovations have met with substantial resistance (Ronteltap et al., 2007). Within the food area a similar picture emerges, with some recent technology-based innovations receiving high levels of consumer acceptance (e.g. nutraceuticals or fortified, enriched or enhanced functional foods), and others essentially being rejected by consumers (e.g., genetically modified foods in Europe) (Cardello, 2003; Gaskell et al., 2010; Vanhonacker et al., 2013). Especially, when an innovative food product has been produced by a more or less unfamiliar technology, consumers are often highly skeptical about that product and perceive great consumption risks (Chaudhry et al., 2010). Even though the production of food has never been safer in the Western world and developed countries, consumers of those societies are increasingly uncertain about the safety and quality of food (Bánáti, 2011). This increasing mistrust of consumers toward the food chain led to a decreasing acceptance and boycott of regular and newly developed products (e.g., Shepherd, 2008). From an expert point of view, these behavior patterns appear irrational and inconsistent with expert opinions and scientific knowledge (Verbeke, Frewer, Scholderer, & De Brabander, 2007). Experts are usually more open to innovative food technologies, as they appreciate the many benefits of using the innovation, such as improved food quality or simplified food production processes, more than the small uncertainties related to potentially

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detrimental effects of the technology (Bearth & Siegrist, 2016). Among other reasons, the disparity between experts' and laypeople's perception is the result of different appraisal strategies (e.g., heuristics, mental shortcuts) and the different resources available to them (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003; Kahneman & Tversky, 1979; Krystallis et al., 2007; Tversky & Kahneman, 1992). Therefore, it is necessary for the successful and sustainable introduction of innovative food products to have a good understanding of consumers' perceptions and expectations towards innovations in food products (Grunert, Verbeke, Kügler, Saeed, & Scholderer, 2011; Linnemann, Benner, Verkerk, & van Boekel, 2006).

A number of studies demonstrated that perceived risks and perceived benefits are major determinants of consumer acceptance of new food technologies (e.g., Gupta, Fischer, & Frewer, 2012; Bredahl, 2001; Ronteltap et al., 2007). The trade-off between individual costs and benefits of an innovation is a crucial element in attitudinal models of innovation acceptance, as it contributes to the relevant attitudes, which determine consumer acceptance or rejection (Frewer, 2003). Nevertheless, the determining factors of consumer acceptance of innovative food products cannot be reduced to these two factors (Siegrist, 2008). According to Siegrist (2008), one key driver for a high consumer acceptance of food innovations is the consumer perception of the properties of those food innovations, which significantly influences the perceived risk as well as perceived benefit of innovative food products. Besides intrinsic sensory properties of the product, consumer's perception of food depends also largely on a variety of factors that are extrinsic to the product (Cardello, 2003). Over the past several years, numerous studies have identified several extrinsic factors that affect the perception of innovative food products (e.g., Amin et al., 2011; Connor & Siegrist, 2010; Siegrist, 2008; Stampfli, Siegrist, & Kastenholz, 2010; Verbeke, 2005). These factors can be distinguished between features of the innovation to be adopted (e.g., innovativeness or naturalness), of the prospective consumer potentially adopting it (e.g., knowledge or moral concerns), and the social system in which the innovation is introduced (e.g., social trust) (Ronteltap et al., 2007). However, most previous studies have only considered certain factors that affect the perception and acceptance of (innovative) food products (e.g., knowledge and health expectations (Connor & Siegrist, 2010; Verbeke, 2005), or trust in science and regulation (Bearth, Cousin, & Siegrist, 2014; Zhang et al., 2018)). In order to understand the acceptance of and the intention to buy food products that are new on the market to its full extent, it is necessary to consider the perception of the innovative product with all its extrinsic determinants, as the consumer decision is also made based on these determinants (Grunert et al., 2011).

Against that background, the objectives of the present study were to identify extrinsic determinants of the consumer perception of innovative food products in a first step and, subsequently, to understand the consumer acceptance toward a technology-based food innovation in all its stages.

Therefore, a new multifaceted model of innovation-related perception regarding food products combined with a process of consumer acceptance is developed and empirically tested. We used an innovative taste enhancer, which strengthens the taste of salt, in combination with cheese as a case for our exploratory study that was conducted in Germany. To determine the derivated dependencies of the different dimensions of the consumer acceptance process (i.e. innovation-related perception, customer perceived value and risk, attitude components, implementation, and confirmation), we used structural equation modeling. Knowing about the factors that have an impact on consumer acceptance as well as the dynamic process that leads to acceptance of food-related innovations enables marketing managers to develop marketing concepts and communication material that decrease consumers' uncertainty and skepticism and increase their acceptance of innovative food technologies and product innovations.

2. Literature review

2.1. Dimensions of innovation-related perception

When it comes to the success of innovative products, one always faces the problem that people are confronted with something more or less completely new, meaning that consumers can't rely on their personal knowledge or experiences when they have to evaluate the product (Garcia & Calantone, 2002; Siegrist, 2000). However, the first perception of product properties has an impact on the consumer assessment of new products (Siegrist, 2008). Moreover, in Rogers (2003) theory about the diffusion of innovations, the characteristics of an innovation are a crucial component, as the likelihood of an individual accepting a specific innovation is dependent on the characteristics of the innovation, characteristics of the adoptee and the given information regarding the innovation. For this reason, the identification of determining characteristics of innovations is highly important to be able to anticipate consumer reactions towards innovations (Rogers, 2003). Along these lines, Rogers identified five characteristics of innovations, which play an important role in the adoption of innovations (i.e., relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003)). Nevertheless, Rogers' model is kept fairly general, which results in a wide applicability on the one hand, but on the other hand it is quite difficult to get detailed information in specific cases of innovation (Ronteltap et al., 2007). Moreover and in line with Ronteltap et al. (2007), it can be observed that most studies in this research field are focusing on a subset of determinants, with a dominant focus on consumer characteristics, perceived cost-benefit considerations, perceived risk and uncertainty and the effect of specific features of the innovation. Therefore, in this study, we wanted to compile a broader collection of properties that have an impact on the perception of innovations.

Based on an extensive literature review in the field of food, food innovation and technological innovation research, we found several characteristics regarding the innovation itself, the potential adoptee and the social system in which the innovation is introduced that drive the perception of innovative products. In discussions with researchers from different scientific fields (e.g., consumer behavior, food science) about the relevance of those characteristics, we were able to identify 14 characteristics that can be understood as dimensions of innovation-related perception, which will be investigated in the context of this study.

Firstly, innovative technologies or products that have potential environmental effects often raise negative *environmental expectations* among consumers, as they cannot assess the long-term consequences of using the product (Yee et al., 2008). Similarly, consumers' *health expectations* regarding new technologies influence the perception of innovative food products (Connor & Siegrist, 2010; Frewer et al., 2011), as the frequently promised properties of innovative food products, such as health, safety, or sustainability, cannot be unambiguously verified by the individual consumer (Ronteltap et al., 2007). In contrast, when people have a sense of *controllability* over what they eat and when they know the effects of eating certain food, this has a positive influence on their perception of innovative foods (Amin et al., 2011; Magnusson & Hursti, 2002). As a further influencing factor with a similar impact, we identified *avoidability,* which is referring to the perceived possibility to avoid the innovative product (Miles, Ueland, & Frewer, 2005; Spence & Townsend, 2006).

Especially when it comes to new food technologies, people are suspicious about the products as they are more likely to have confidence in natural food (Huotilainen & Tuorila, 2005). Therefore, another important factor influencing the perception of new technologies is the perceived *naturalness* of the food innovation, whereby a higher perceived naturalness is more positive regarding the innovation-related perception (Siegrist, 2008). Further factors influencing the perception of food innovations are knowledge and familiarity, where *knowledge* captures the extent to which consumers have expertise about the

product and its properties, whereas *familiarity* is the degree to which the consumers are feeling familiar with the product and its handling despite its innovative character (Amin et al., 2011; Frewer et al., 2011; McComas, Besley, & Steinhardt, 2014). In addition, we consider the factor *novelty*, which can be defined "as the perceived discrepancy between the characteristics of a specific product and the characteristics of the typical product in that class" (Blake, Perloff, & Heslin, 1970, p.483). As this discrepancy increases, consumers cannot fall back on previous learned information about the product and are inclined to have a more negative perception of the innovative product (Blake et al., 1970). The *compatibility* of an innovative product describes the extent to which the product is perceived as being consistent with earlier experiences and current requirements of the potential consumer (Kollmann, 2004; Rogers, 2003) and is therefore another driving factor of the innovation-related perception (e.g., Wu & Wang, 2005). A similar positive effect on the perception of an innovative product is caused by the factor *relative advantage*, which determines the extent to which an innovation contributes better to satisfy individual requirements than product alternatives (Kollmann, 2004).

Contrary to this, the factors discomfort, moral concerns and effort tend to lower the perception of innovative products. A sense of *discomfort* can occur, when consumers use an innovative product and are overwhelmed because of feelings of insecurity and uneasiness (Godoe & Johansen, 2012; Parasuraman & Colby, 2001). If consumers have *moral concerns* about the product, (ethical) doubts may arise, which decrease the innovation-related perception (Rosati & Saba, 2000; Yee et al., 2008). The factor *effort* refers to the ease, access, or convenience with which a food can be prepared and consumed, which in turn explains how people perceive innovative foods and which foods people prefer (Wansink, 2004; Wing & Jeffery, 2001). Lastly, consumers often have limited knowledge about the new product or technology. However, to be able to make a decision about the innovation, people rely on experts who they perceive as trustworthy. Therefore, *trust in regulations* (social trust) is an important factor regarding people's assessments of innovative products (Connor & Siegrist, 2010; Siegrist & Cvetkovich, 2000).

According to our understanding, these extrinsic influencing factors, i.e., the dimensions of innovation-related perception, form the starting point for the consumers' perception and acceptance of innovations.

2.2. Phases of the acceptance process

Many previous studies in the area of acceptance of innovations focus on the influencing factors of acceptance and have a rather simple understanding of the construct acceptance itself. For example, the consumer decision to accept or reject the innovation is determined by the willingness to buy or pay, positive attitudes, intention to use or general acceptance of the innovative (food) product (e.g., Bearth & Siegrist, 2016). In our paper, we understand acceptance of innovative products as a dynamic construct that occurs over time and that consists of a series of actions and decisions (Kollmann, 2004; Rogers, 2003). Saying this, we fall back on a combination of Rogers (2003) innovation-decision process, which consists of the five stages knowledge, persuasion, decision, implementation, and confirmation and Kollmann (2004) acceptance process, which consists of the three stages assessment, action and use phase. Thereof, we derive our understanding of acceptance, that in every phase different acceptance constructs can be formed: assessment acceptance, attitude acceptance, action acceptance, use acceptance, and performance acceptance (cf. Fig. 1; see also Wiedmann, 2008).

In the first stage, the *assessment acceptance*, the individual is exposed to an innovation's existence. Due to the first perception (innovation-related perception) of the innovative product, the individual can make an initial assessment based on the trade-off between its benefit and risk perceptions (Rogers, 2003; Ronteltap et al., 2007). This trade-off between the individual perception of costs and benefits of an innovation is a crucial element, as it determines the relevant attitudes toward the innovative product (Bredahl, 2001; Frewer, 2003). In order to get a holistic impression as well as a deeper understanding of the drivers of the benefit and risk perception, we additionally draw on the underlying dimensions of those two constructs. For perceived benefit, we utilize the customer perceived value with its four dimensions economic, functional, affective, and social value according to Wiedmann, Hennigs, Schmidt, & Wüstefeld, 2012 and for perceived risk, we utilize the six dimensions social, temporal, financial, physical, psychological, and performance risk according to Stone and Grønhaug (1993). Among the innovation-related factors, risk and benefit perceptions appear to be vital drivers of the further stages of consumer acceptance (e.g., Gupta et al., 2012; Siegrist, 2008).

Subsequently, the individual forms favorable or unfavorable beliefs or attitudes toward the innovative product (*attitude acceptance*), based on his or her first impression in the assessment phase (Rogers, 2003). Following the classification of such evaluative responses of consumers of Rosenberg and Hovland (1960), where the affective attitude component captures the emotional evaluation of an object and the cognitive attitude component accounts for perceptual responses and verbal statements of beliefs about a certain object, we integrate these two components in the attitude phase. In the third phase, the phase of *action acceptance*, the consumer decides whether to adopt or reject the innovative product. An adoption of the innovation leads consumers to a readiness-to-act with respect to purchasing and the decision for use (Kollmann, 2004; Rogers, 2003). In accordance with Rosenberg and Hovland (1960), such overt actions and verbal statements concerning intended behavior are captured by the conative component.

After the consumer has purchased the product, he decides in the following phase, the *use acceptance*, whether he uses the innovative product regularly and, building on this, if he integrates the product into his everyday life. At this point, the tendencies for actions are converted into a concrete implementation of the product (Kollmann, 2004; Rogers, 2003). In the final phase of the acceptance process, the *performance acceptance*, either the consumer confirms or rejects the further use of the innovation based on his experience during the use of the innovative product. If the innovation meets the requirements of the consumer, he will confirm the usage of the innovative product. This confirmation of the innovation is reflected by satisfaction of the consumer (Kollmann, 2004; Rogers, 2003).

In order to understand which actions and decisions occur during this acceptance process and how they are influenced by the innovation-related perception, we examine an integrated conceptual framework, as illustrated in Fig. 2.

3. Material and methods

3.1. Questionnaire

To measure the constructs as conceptualized in our model we used

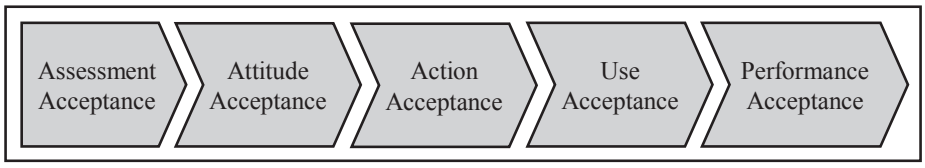

Fig. 1. Process of consumer acceptance.

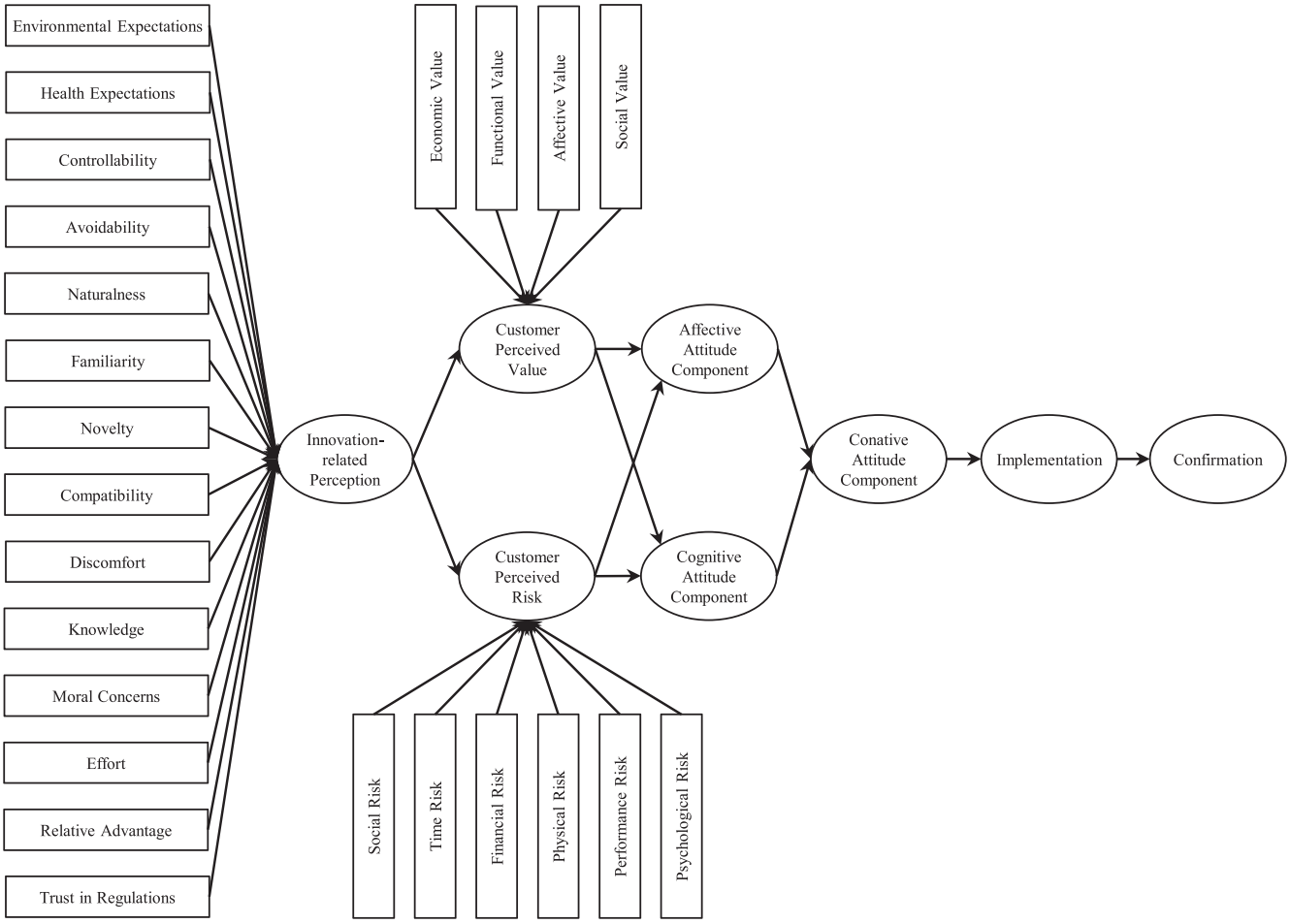

Fig. 2. Conceptual framework.

already existing and tested reflective measures for the constructs affective, cognitive, and conative attitude component, as well as for implementation and confirmation (e.g., Wiedmann, Hennigs, Schmidt, & Wuestefeld, 2011; Wiedmann et al., 2012; cf. Table 4). For the constructs innovation-related perception, customer perceived value, and customer perceived risk we generated measurement instruments based on formative indicators following the guidelines of index construction as described below (cf., Section 3.2). All items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and specified to the context of acceptance of innovative food products. After some introductory questions, the respondents were exposed to a stimulus, which informed them about the innovative taste enhancer that is obtained from by-products using a new biotechnological procedure. More precisely, the taste enhancer strengthens the taste of salt, which makes it possible to reduce the amount of salt in food without changing the accustomed taste of specific foods. As an example of a possible application of the taste enhancer, we have used cheese for our study in order to provide the participants a more tangible product. Taken together, this food additive improves consumers' health and saves environmental resources through that innovative valorization of food processing by-products that are usually burnt, fed to animals or even disposed at cost. Subsequently, innovation-related perception customer perceived value and risk, as well as the further constructs of our conceptualized model were assessed. Lastly, participants answered demographic questions.

3.2. Index construction with formative indicators

The constructs for which we generated measurement instruments based on formative indicators are innovation-related perception, customer perceived value, and customer perceived risk. Following the guide of Diamantopoulos and Winklhofer (2001), we used four steps for constructing indexes based on a formative indicator: content specification, indicator specification, indicator collinearity, and external validity. To cover all facets of the formative constructs, it is extremely important to specify the domain of content, as formative indicators determine the latent variable. Failure to consider all facets of the construct will lead to an exclusion of relevant indicators and parts of the construct itself. Our understanding of the innovation-related perception as the impelling formative construct is based on the assumption that this perception results from a combination of the characteristics that determine the first impression of an innovative product. According to our literature review and the experts' opinion, we identified 14 indicators as driving factors of the first impression of an innovative food product. Given this approach of innovation-related perception, the items used as indicators were selected to cover the entire scope of the perception of innovative food products (cf. Table 1). For the understanding of the remaining formative constructs, we follow Smith and Colgate (2007) for the customer perceived value and with regard to the customer perceived risk we refer to the key elements of risk as proposed by Stone and Grønhaug (1993). Moreover, we followed the guidelines of clarity, length, directionality, lack of ambiguity, and avoidance of jargon during the generation the items related to the indicators (e.g., DeVellis, 1991; Spector, 1992).

As intended by Diamantopoulos and Winklhofer (2001), we checked the multicollinearity among the indicators in a next step. As a result, there was no need for exclusion of indicators; the maximum variance inflation factors (VIF) for innovation-related perception, customer

Table 1
Manifest variables of the formative measurement models.

		Variance inflation factor	Spearman's rank correlation coefficient
Innovation-related Perception			
Environmental Expectations	The product is harmful to the environment.	1.661	−0.144
Health Expectations	The product is harmful to health.	1.896	−0.137
Controllability	I know all the effects that occur when using the product.	1.960	0.295
Avoidability	I can avoid the product.	1.175	−0.192
Naturalness	The product is very natural.	1.414	0.320
Familiarity	The product is very familiar to me.	1.898	0.296
Novelty	The product is based on an innovative idea.	1.259	0.273
Compatibility	I can integrate the product very well into my life.	1.539	0.319
Discomfort	Using the product would be very unpleasant for me.	1.569	−0.113
Knowledge	I have great knowledge about the product.	1.718	0.297
Moral Concerns	Using the product is morally inexcusable.	1.767	0.086
Effort	The product is easy to use.	1.312	0.119
Relative Advantage	The product is an improvement for my life.	1.565	0.480
Trust in Regulations	I trust the responsible authorities that there is no risk from this product.	1.467	0.307
Customer Perceived Value			
Affective Value	This product evokes positive perceptions.	1.750	0.502
Economic Value	This product offers a lot for its price.	1.405	0.407
Functional Value	This product is very suitable.	1.472	0.477
Social Value	People who own this product will be seen in a positive light.	1.588	0.453
Customer Perceived Risk			
Financial Risk	I can spend my money in a better way.	1.800	0.310
Performance Risk	The product will not provide the level of benefits I expect.	1.553	0.283
Physical Risk	The product is associated with potential physical risks.	1.831	0.427
Psychological Risk	The product makes me feel worried.	1.745	0.435
Social Risk	People I appreciate don't like the product.	1.259	0.260
Time Risk	I can spend my time better than with the product.	1.551	0.320

The correlation coefficients were all highly significant with p-values < 0.01, except for the correlation coefficient of the indicator moral concerns ($p < 0.05$).

perceived value, and customer perceived risk are 1.960, 1.750, and 1.831, as shown in Table 1, and were below the restrictive threshold of 3.3 (Diamantopoulos & Siguaw, 2006). Regarding the assessment of external validity of each formative indicator, we examined whether they were significantly correlated with a global item that summarizes the corresponding essence of innovation-related perception, customer perceived value, and customer perceived risk. For that reason, appropriate semantic differentials for (i) the recommendation intention as indicator for a positive product perception (1 = no intention at all, 11 = very high intention), (ii) the perceived extent of the product's value (1 = no value at all, 7 = very high value), and (iii) the perceived extent of the product's risk (1 = no risk at all, 7 = very high risk) were applied. All formative indicators are significantly correlated with these adequate items in supporting their external validity (cf. Table 1). After having followed the four-step guide suggested by Diamantopoulos and Winklhofer (2001), our proposed specification of our formative indicators innovation-related perception, customer perceived value, and customer perceived risk can be regarded as valid measurement instruments.

3.3. Sample

For the empirical investigation of the conceptualized model, an online survey with a snowball sampling method was conducted in Germany in December 2016. Participants were recruited via selected social network pages and with personalized emails with the invitation to actively contribute to the survey. In sum, 617 valid questionnaires were received. Table 2 describes the sample characteristics.

Participants are mainly aged between 18 and 29 years, and those who have a higher education and are single as well as students or fully employed are over-represented. The gender ratio was nearly well balanced with a slight surplus of female participants (female: 52.2 percent, male: 46.2 percent). Furthermore, more than 70 percent of the participants are interested in the topics of food and nutrition and more than half of the participants are concerned about food production.

Table 2
Demographic profile of the sample.

		n	%
Age	18–29 years	445	72.1
	30–39 years	49	7.9
	40 years +	101	16.4
	No answer	22	3.6
Gender	Male	285	46.2
	Female	322	52.2
	No answer	10	1.6
Marital status	Single	446	72.3
	Married	121	19.6
	Divorced	25	4.1
	Widowed	5	0.8
	No answer	20	3.1
Education	Not graduated from high school	14	2.3
	Lower secondary school	15	2.4
	Intermediate secondary school	60	9.7
	A-levels	174	28.2
	University degree	333	54.0
	No Answer	21	3.4
Occupation	Full time	196	31.8
	Part-time	39	6.3
	Pensioner/retiree	11	1.8
	House wife/husband	11	1.8
	Job training	24	3.9
	Student	280	45.4
	Scholar	15	2.4
	Seeking work	6	1.0
	No answer	35	5.7

3.4. Analysis technique

Due to the fact that our conceptual model includes formative as well as reflective measurement models, we considered Partial Least Squares (PLS) structural equation modeling as the appropriate method for the empirical tests (Hair, Sarstedt & Ringle, 2019). PLS-SEM also allows the estimation of relatively complex models (Ali, Rasoolimanesh, Sarstedt, Ringle, & Ryu, 2018) and the assessment of the results' predictive

quality (Sarstedt, Ringle, & Hair, 2017). PLS-SEM is therefore particularly useful when the focus is on estimating a structural model that explains a key target construct (Richter, Cepeda, Roldán, & Ringle, 2015). More specifically, the purpose of composite-based PLS-SEM is to optimize the endogenous constructs' prediction and not the model fit (Hair, Risher, Sarstedt & Ringle, 2019). We used SmartPLS 3 (Ringle, Wende, & Becker, 2015) with case wise replacement and a bootstrapping procedure (individual sign changes) for 617 valid cases to run the empirical analysis. For the evaluation of the PLS estimates and for assessing the reliability and validity of the used measures, PLS-SEM has several rules of thumb that serve as guidelines to evaluate the model results (e.g, Chin, 1998; Henseler et al., 2009; Hair, Hult, Ringle, & Sarstedt, 2017). In general, the PLS estimation follows a two-step approach (Henseler et al., 2009): the first step involves the examination of the measurement models, distinguished by formative and reflective measurement models (outer model). Second, if the measurement models meet the required criteria, the assessment of the structural model (inner model) follows (Hair et al., 2017). In the next sections, we discuss the evaluation of the results with reference to the measurement and structural model.

4. Results

4.1. Measurement model

4.1.1. Evaluation of the formative measurement model

Referring to the evaluation of our formative measurement models, Table 1 presents the manifest variables defined as formative indicators for the constructs of innovation-related perception, customer perceived value, and customer perceived risk.

Following Hair et al. (2017), formative measurement models are evaluated based on convergent validity, indicator collinearity, and statistical significance and relevance of the indicators weights. Saying this, during the process of index construction, we could already confirm convergent validity, by checking the correlation of the indicators with an alternative measure of the same construct, and exclude multicollinearity of the indicators with the variance inflation factor. The third and final step of the evaluation of the formative measurement models includes the assessment of the indicators' outer weights, which can be understood as the indicators' relative importance in respect to forming the formative constructs. In our study, the outer weights explain the latent variables with a small to high impact, as shown in Table 3. Despite the fact that not all indicators are significant and higher than 0.1, the quality of the measurement model is not necessarily poor (Hair, Risher, et al., 2019). Instead, the indicators' absolute contribution to the construct can be taken into account by considering the outer loadings (Cenfetelli & Bassellier, 2009; Hair, Risher, et al., 2019). For the indicators of innovation-related perception with non-significant outer weights, the results of the outer loadings show highly significant ($p < 0.01$) and sufficiently high values with loadings of 0.648 for health expectations, 0.578 for controllability and 0.505 for familiarity. The results of the outer loadings for the dimensions of the customer perceived value with non-significant outer weights confirm that the indicators make an absolute contribution to the construct. In particular, the loadings for financial risk (0.648) and performance risk (0.601) are above the recommended threshold of 0.5 and are significant ($p < 0.05$). These results and the consideration that removing even a single indicator of a formative measured construct can reduce the content validity of the measurement model (e.g., Diamantopoulos & Winklhofer, 2001) leads us to the conclusion that none of the indicators should be eliminated.

A closer look at the outer weights of the indicators reveals the indicators' relative contribution to the construct (cf. Table 3). However, it should be noted that outer weights in formative measurement models are frequently smaller than outer loadings of reflective indicators (Cenfetelli & Bassellier, 2009; Diamantopoulos & Winklhofer, 2001). In our study, first, the indicators with the highest contribution to innovation-related perception are the indicators relative advantage (0.286), naturalness (0.233), novelty (0.222), trust in regulations (0.206), and discomfort (-0.196). Second, the highest outer weights of customer perceived value are the weights of the affective (0.560) and social (0.274) value dimension. And third, the indicators with the highest impact on customer perceived risk are the social (-0.569) and physical (0.469) risk dimension of customer perceived risk.

Table 3
Bootstrapping results for the outer weights.

Formative Indicator → LV	Original Sample	p-Values
Environmental Expectations → Innovation-related Perception	−0.147	0.013
Health Expectations → Innovation-related Perception	−0.020	0.758
Controllability → Innovation-related Perception	0.069	0.276
Avoidability → Innovation-related Perception	−0.119	0.007
Naturalness → Innovation-related Perception	0.233	0.000
Familiarity → Innovation-related Perception	−0.062	0.260
Novelty → Innovation-related Perception	0.222	0.000
Compatibility → Innovation-related Perception	0.171	0.001
Discomfort → Innovation-related Perception	−0.196	0.003
Knowledge → Innovation-related Perception	0.180	0.004
Moral Concerns → Innovation-related Perception	−0.103	0.082
Effort → Innovation-related Perception	0.139	0.009
Relative Advantage → Innovation-related Perception	0.286	0.000
Trust in Regulations → Innovation-related Perception	0.206	0.000
Affective Value → Customer Perceived Value	0.560	0.000
Economic Value → Customer Perceived Value	0.225	0.000
Functional Value → Customer Perceived Value	0.196	0.000
Social Value → Customer Perceived Value	0.274	0.000
Financial Risk → Customer Perceived Risk	0.267	0.120
Performance Risk → Customer Perceived Risk	−0.167	0.278
Physical Risk → Customer Perceived Risk	0.469	0.038
Psychological Risk → Customer Perceived Risk	0.367	0.050
Social Risk → Customer Perceived Risk	−0.569	0.088
Time Risk → Customer Perceived Risk	0.379	0.063

4.1.2. Evaluation of the reflective measurement model

Regarding the evaluation of our reflective measures, Table 4 presents the manifest variables that are reflective indicators for the three measurement models of the attitude components (e.g., Wiedmann et al., 2011, 2012). The remaining reflective constructs implementation and confirmation were measured using two global items that summarize the

Table 4
Manifest variables of the reflective measurement models.

Affective Attitude Component	
Affective_01	The product suits me completely.
Affective_02	I find the product very pleasant.
Affective_03	The product is very distinctive.
Cognitive Attitude Component	
Cognitive_01	In my opinion, the quality of the product is very high.
Cognitive_02	The product keeps to its promise.
Cognitive_03	I am very satisfied with the product.
Cognitive_04	The product meets my expectations.
Conative Attitude Component	
Conative_01	I intend to buy the product in the future.
Conative_02	I am very faithful to the product.
Conative_03	The product is worth a higher price than other products.
Conative_04	I would recommend the product to my friends.
Implementation	
Implementation_01	How willing would you be to use the product?
Implementation_02	How likely is it that you will integrate the product into your everyday life?
Confirmation	
Confirmation_01	How probable is it that you will be satisfied with the product?

Table 5
Assessing the reflective measurement models.

	Factor loadings	AVE (%)	Cronbach's α	Composite reliability	Fornell – Larcker criterion
Affective Attitude Component	0.757 – 0.869	64.00	0.720	0.842	0.683 > 0.524
Cognitive Attitude Component	0.769 – 0.864	68.50	0.847	0.897	0.685 > 0.551
Conative Attitude Component	0.812 – 0.873	71.40	0.866	0.909	0.714 > 0.635
Implementation	0.964	93.00	0.924	0.964	0.930 > 0.684
Confirmation	1.000	100.00	1.000	1.000	1.000 > 0.684

meaning of the actual usage of the product and one global item that summarizes the essence of the confirmation of the usage of the product.

Referring to Hair, Risher, et al. (2019), the assessment of the reflective measurement models follows a four-step scheme: assessing (1) indicator loadings, (2) internal consistency reliability, (3) convergent validity, and (4) discriminant validity. Our results show statistically significant and sufficiently high factor loadings, which exceed the recommended threshold of 0.7 for all factors, with 0.757 being the smallest loading over all indicators (cf. Table 5). Thus, acceptable item reliability is provided (Hair, Risher, et al., 2019). Moreover, the PLS model estimation reveals that all reflective model constructs exhibit satisfactory results in terms of internal consistency reliability (Bagozzi & Yi, 1988). As shown in Table 5, the values for Cronbach's alpha range from 0.720 to 0.924 and the values for composite reliability range from 0.842 to 0.964. To assess convergent validity, the average variance extracted (AVE) for all items on each construct is used (Hair, Risher, et al., 2019). As the AVE estimates range from 64% to 93%, they meet the minimum requirement of 50%.

To assess discriminant validity, we fall back on three measures that have been put forward – the Fornell-Larcker criterion, cross loadings and the heterotrait-monotrait ratio of the correlations (Hair, Ringle, & Sarstedt, 2011; Henseler, Ringle, & Sarstedt, 2015). To fulfill the Fornell-Larcker criterion, the AVE of each latent variable should be higher than the latent variable's highest squared correlation with any other latent variable (Fornell & Larcker, 1981). Each of the tested latent variables satisfies this criterion, as shown in Table 5. The second criterion of discriminant validity, the cross loadings, implies that an indicator's loadings with its corresponding latent construct should be higher than all of its cross loadings with the remaining constructs (Hair et al., 2011). Our results, represented in Table 6, show that the loadings of the indicators are the highest for each of the corresponding constructs, meaning that this criterion is also fulfilled. Table 7 represents our results for the third criterion of discriminant validity, the heterotrait-monotrait ratio of correlations (HTMT), which contrasts the indicator correlations between constructs with the correlations within indicators of the same construct (Henseler et al., 2015). Henseler et al. (2015) suggest different thresholds the HTMT ratio should not exceed, depending on whether the constructs are conceptually similar (0.90) or not (0.85). The results of our analysis show that the HTMT ratio between the affective attitude component and the cognitive attitude component (0.906) as well as between the affective attitude component and the conative attitude component (0.900) is slightly above the threshold for conceptually similar constructs. However, the 95% bias-corrected confidence intervals of HTMT do not cover the value one, indicating that they are significantly different from 1 (cf. Table 7). Taken together, the results of the three different criteria speak in favor of the discriminant validity of the constructs.

4.2. Evaluation of the structural model

Since the evaluation of our measurement models revealed satisfactory results, we can proceed with the second step in evaluating PLS-SEM, the assessment of the structural model. Following Hair, Risher, et al. (2019), the assessment includes the coefficient of determination (R^2), Stone-Geisser's Q2, the model's out-of-sample predictive power, and the statistical significance and relevance of the path coefficients as well as the effect size (f^2). However, in a first instance, multicollinearity must be examined using the variation inflation factor (VIF), before assessing the structural model. With a maximum VIF of 2.032 for the exogenous variables, the results are below the threshold of 3; i.e., multicollinearity does not bias the results of the structural relations (Hair, Risher, et al., 2019).

As shown in Table 8, the coefficients of determination of the endogenous latent variables (R^2) range from 0.270 (customer perceived risk) to 0.684 (conformation). According to Chin (1998), these values are moderate to substantial, except for the weak coefficient of determination of customer perceived risk. Nevertheless, the values suggest a good predictive relevance of the PLS structural model. In addition, all Stone-Geisser's Q^2 values (Geisser, 1974; Stone, 1974) are higher than zero for all endogenous latent variables with a minimum value of 0.103 for customer perceived risk and a maximum value of 0.680 for confirmation. Thus, values for Q^2 depict small to large predictive relevance of the conceptual model (Hair, Risher, et al., 2019).

To assess the predictive power with regard to our model's key

Table 6
Cross-loadings of the manifest variables of the reflective measurement models.

	Affective Attitude Component	Innovation-related Perception	Cognitive Attitude Component	Conative Attitude Component	Customer Perceived Value	Implementation	Customer Perceived Risk	Confirmation
Affective_01	0,869	0,588	0,655	0,696	0,609	0,637	−0,400	0,555
Affective_02	0,769	0,364	0,506	0,513	0,453	0,455	−0,217	0,371
Affective_03	0,757	0,438	0,532	0,501	0,475	0,434	−0,225	0,385
Cognitive_01	0,648	0,568	0,814	0,620	0,606	0,567	−0,368	0,593
Cognitive_02	0,588	0,447	0,769	0,501	0,490	0,439	−0,218	0,453
Cognitive_03	0,541	0,552	0,860	0,667	0,574	0,615	−0,310	0,590
Cognitive_04	0,588	0,548	0,864	0,653	0,571	0,599	−0,328	0,559
Conative_01	0,658	0,564	0,646	0,872	0,566	0,716	−0,391	0,621
Conative_02	0,577	0,458	0,575	0,820	0,495	0,641	−0,353	0,559
Conative_03	0,573	0,550	0,634	0,812	0,573	0,631	−0,318	0,581
Conative_04	0,634	0,606	0,651	0,873	0,622	0,703	−0,414	0,616
Implementation_01	0,641	0,654	0,656	0,792	0,608	0,964	−0,428	0,776
Implementation_02	0,610	0,646	0,649	0,745	0,582	0,964	−0,392	0,819
Confirmation_01	0,559	0,614	0,667	0,704	0,594	0,827	−0,379	1,000

Table 7
Heterotrait-monotrait ratio of the reflective measurement models.

	Original Sample	Bias-Corrected Confidence Intervals	
		2.5%	97.5%
Cognitive Attitude Component → Affective Attitude Component	0.906	0.844	0.957
Conative Attitude Component → Affective Attitude Component	0.900	0.831	0.960
Conative Attitude Component → Cognitive Attitude Component	0.861	0.816	0.901
Implementation → Affective Attitude Component	0.779	0.713	0.838
Implementation → Cognitive Attitude Component	0.758	0.702	0.805
Implementation → Conative Attitude Component	0.890	0.850	0.924
Confirmation → Affective Attitude Component	0.643	0.571	0.711
Confirmation → Cognitive Attitude Component	0.721	0.652	0.778
Confirmation → Conative Attitude Component	0.756	0.702	0.803
Confirmation → Implementation	0.860	0.824	0.891

Table 8
Assessing the structural model.

Endogenous LV	R^2	Q^2
Customer Perceived Value	0.435	0.235
Customer Perceived Risk	0.270	0.103
Affective Attitude Component	0.450	0.278
Cognitive Attitude Component	0.491	0.329
Conative Attitude Component	0.628	0.443
Implementation	0.636	0.588
Confirmation	0.684	0.680

construct confirmation, we used the PLSpredict technique (Shmueli, Ray, Velasquez Estrada, & Chatla, 2016, Shmueli et al., 2019). The result for the $Q^2_{predict}$ statistic shows that the PLS-SEM-based prediction outperforms the most naïve benchmark, as the indicator yields a value above zero ($Q^2_{predict} = 0.260$). Therefore the assessment of the prediction statistics can be performed. When comparing the root mean squared error (RMSE) value of the PLS-SEM analysis to the linear regression model benchmark, we find that the former produces a higher value for the key construct's indicator. In particular, we find a PLS-SEM-based RMSE value of 2.250, compared to a value of 2.062 in the linear regression. Consequently, the result indicates that the model lacks predictive power (Shmueli et al., 2019). However, this might be attributed to the fact that using single-item measures for abstract concepts has a deteriorating effect on the predictive power of a model (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012; Salzberger, Sarstedt, & Diamantopoulos, 2016; Sarstedt, Diamantopoulos, Salzberger, & Baumgartner, 2016).

In order to test the assumed relations between the latent variables of our conceptual model, we applied a nonparametric bootstrapping procedure (individual sign changes, 617 cases and 5000 subsamples) to assess the significance of the path coefficients as presented in Table 9. The results reveal a highly significant positive effect of innovation-related perception on customer perceived value ($\beta = 0.660$, $p < 0.01$) and a significant negative effect on customer perceived risk ($\beta = -0.520$, $p < 0.05$). Both constructs, customer perceived value and risk, have a significant effect on the affective and cognitive attitude components, which represent the phase of attitude acceptance. Subsequently, the affective and cognitive attitude component reveal a highly significant impact on the conative attitude component, with the cognitive attitude component having a slightly stronger impact on the selected outcome ($\beta = 0.460$, $p < 0.01$). In addition, the results indicate a strong significant impact of the conative attitude component on implementation and of implementation on confirmation. The results of the f^2 effect size confirm these findings. Following Cohen (1988) rule of thumb, which indicates that values higher than 0.02, 0.15 and 0.35 depict small, medium and large f^2 effect sizes, our results show small effect sizes for the relationships of customer perceived risk and the affective attitude component ($f^2 = 0.053$), customer perceived risk and the cognitive attitude component ($f^2 = 0.057$). For the remaining relationships in our structural model, we observed large f^2 effect sizes (cf. Table 9). Thus, we found support for all our postulated relations, since the results reveal significant path coefficients between all our latent variables.

In sum, the overall model assessment shows that the PLS estimation model is reliable and valid according to the criteria associated with the formative and reflective outer model as well as the inner path model.

5. Discussion

In this study, we aimed to better understand the perception and acceptance of innovative food. As a result, we developed a framework, including innovation-related perception and an acceptance process, which consists of five phases representing different sequential levels of acceptance: assessment acceptance, attitude acceptance, action acceptance, use acceptance, and performance acceptance.

Our study revealed five main factors that are important predicting people's innovation-related perception. These factors are relative advantage, naturalness, novelty, trust in regulations, and discomfort. The importance of these factors has also been identified by other studies. The impact of relative advantage has been confirmed in studies that are

Table 9
Bootstrapping results for the structural relations.

Independent LV → Dependent LV	Original Sample	p-Values	f^2
Innovation-related Perception → Customer Perceived Value	0.660	0.000	0.771
Innovation-related Perception → Customer Perceived Risk	−0.520	0.027	0.370
Customer Perceived Value → Affective Attitude Component	0.592	0.000	0.576
Customer Perceived Value → Cognitive Attitude Component	0.623	0.000	0.688
Customer Perceived Risk → Affective Attitude Component	−0.180	0.050	0.053
Customer Perceived Risk → Cognitive Attitude Component	−0.179	0.038	0.057
Affective Attitude Component → Conative Attitude Component	0.396	0.000	0.208
Cognitive Attitude Component → Conative Attitude Component	0.460	0.000	0.280
Conative Attitude Component → Implementation	0.797	0.000	1.747
Implementation → Confirmation	0.827	0.000	2.165

related to food innovations (e.g., Frewer, Howard, & Shepherd, 1998; Yusuf, Xie, & Trondsen, 2015) as well as to technological innovations (e.g., Greer & Murtaza, 2003; Rogers, 2003). Naturalness is not only an important factor for the perception of food products, it has also been used by the advertising industry as a sales argument for food for a long time (Rozin et al., 2004; Siegrist, 2008). Natural foods are considered as save, while unnatural foods are associated with different kind of risks (Evans, de Challemaison, & Cox, 2010). Consequently, several studies have shown that naturalness is an important predictor of people's perceptions (e.g., Connor & Siegrist, 2010; Siegrist, 2008). Furthermore, social trust or trust in regulation plays a particularly important role in the perception and acceptance of innovative food technologies and products. Previous studies have confirmed this effect as well (e.g., Bearth et al., 2014; Frewer et al., 2011; Siegrist, Cousin, Kastenholz, & Wiek, 2007). Trust is especially important, as consumers have to believe in the arguments provided by the industry, due to their limited knowledge about new or complex food technologies (Bearth et al., 2014; Siegrist, 2008). These findings provide valuable insights for organizations and companies, by identifying dimensions that can help to enhance the acceptance of beneficial food innovations resulting in an increased likelihood of a successful market introduction. In our case, the example of the innovative taste enhancer, marketing concepts should, for example emphasize the natural origin of the taste enhancer in order to enhance the perception of this innovation. In addition, advantages of using the taste enhancer over conventional alternatives should be demonstrated, such as the possibility to reduce the amount of salt without sacrificing taste (health advantage). Highlighting these factors could also reduce the discomfort perceived by the consumer and thus reduce the negative impact on the innovation-related perception. Therefore, a deeper analysis of the discomfort perceived by the consumer and its origins should be conducted in order to counteract these consumer perceptions.

The further results of our model showed that customer perceived value and customer perceived risk affect both dimensions of the attitude acceptance (affective and cognitive attitude component). However, the influence of customer perceived value on the subsequent dimensions is considerably higher. This result is in line with previous studies (e.g., Amin et al., 2011; Bearth et al., 2014; Siegrist et al., 2007). And although the effects of customer perceived risk seem to be less important, it doesn't mean that perceived risks can be neglected. For this reason, we have also considered the dimensions of the customer perceived value and customer perceived risk in order to identify opportunities to increase the value and decrease the risk customer associate with an innovation. We identified the dimensions affective and social value as the most driving factors. These results suggest that addressing emotional perceived values based on customer's feelings as well as values on a social level, like customer's personal orientation and personal matters, should increase the overall customer perceived value. For the customer perceived risk, we identified the dimensions social and physical risk as the factors with the highest impact on the overall perception of risk. Since social risk does not increase the overall risk, marketing concepts should focus on the factor physical risk. For our food innovation in particular, marketers should underline that the taste enhancer is not a health hazard for the consumer, but that using the taste enhancer has a positive effect on the products containing it by reducing the salt content of the products, which is even healthier. In line with this, studies have proven that emphasizing the potential benefits of food instead of focusing on the misperceptions of risk lead consumers to rethink their fears about food (Messer, Kaiser, Payne, & Wansink, 2011; Wansink, Tal, & Brumberg, 2014). In addition, providing more information about an innovative and therefore unknown ingredient or product may reduce risk perceptions, as the food product appears less foreign to the consumer (Wansink et al., 2014). However, some research suggests that information can also amplify perceived risk, whereby labeling of food products with used technologies could be interpreted as a warning signal for potential danger (Siegrist, 2008; Wiedemann & Schütz, 2005). Therefore, it is important to embed the innovative product in a trustworthy context by providing information about its history, its production, or other general applications, so that this would might foster a sense of familiarity (Wansink et al., 2014).

In general, the proposed model is an approach towards a better understanding of the innovation-related perception and the dynamic process of acceptance of innovative food technologies and products. However, studies including several different food technologies have shown, that different technologies possess different characteristics in laypeople's perception (Frewer et al., 2011). Furthermore, various adoption theories assume that the adoption of an innovation is mainly an individual decision based on individual evaluation (Aubert & Hamel, 2001). Nevertheless, these individual evaluations will not only be influenced by the innovation itself, but also by the surrounding environment, such as the social environment, for example (Henson, 1995). Both of these aspects underline the challenge associated with innovations for which a wide-ranging multiple-group adoption is required, such as an innovation that is socially desirable. To counteract dynamic social processes that may generate public concerns, distribution mechanisms must be established that ensure that each individual or group obtain the necessary information regarding the benefits of the specific innovation (Aubert & Hamel, 2001; Verdurme & Viaene, 2003). In doing so, different approaches can be used to enhance the desired effects. On the one hand, information about the innovative technology or the innovative product should be framed positively. A positive framework could include, for example, the factors of innovation-related perception and could emphasize the imitation of natural processes without evoking associations related to tampering with nature (Siegrist, 2008; Sjöberg, 2000). On the other hand, it is important that the information is distributed from a trustworthy source. Therefore, institutions or agents are particularly suitable, if the public judges their values similar to their own (Siegrist et al., 2007). Due to that, it is more likely that information spread by independent scientists or consumer organizations will positively influence the perception of a novel food product (Siegrist, 2008).

Additionally, some implications for future research as well as some limitations of the present study should be mentioned at this point. First, only one innovation, an innovative food additive, was involved in this study. Thus, further innovative (food) products or production methods should be investigated, in order to test the performance of the introduced conceptual model in a broader context. On the one hand this should be taken into consideration as there are already considerable differences regarding the consumer perception of different food additives (Bearth et al., 2014). On the other hand, consumers consider food additives with suspicion for being unnatural or unhealthy (Bearth et al., 2014) regardless of whether or not the additive is innovative and potentially health enhancing as in our case. Therefore, an innovation that is in general less perceived as a source of insecurity and anxiety might yield alternative results. In addition, the socio-cultural context of the participants of the survey should also be varied in replication studies, as our results may reflect the values of German culture. These two aspects might have an influence on the generalizability of the results of our study. Second, even though our model is quite extensive and contains many variables, which have been shown to be important for consumers' acceptance of food in previous literature, further variables might play a role. Therefore, additional variables that are related to consumer food choices, such as sensory perception or price perception, can be included to gain a holistic understanding of the perception of innovative food products. Third, it should be noted that according to the results the model lacks predictive power with regard to the key construct confirmation. As already noted, this could be due to the single-item measure for this abstract construct. Therefore, the measurement model for the key construct confirmation should be extended in future studies to achieve better results regarding the predictive power. Finally, for a deeper comprehension of underlying mental mechanism and consequences for the acceptance of innovative food

products, the appliance of implicit measures (e.g., reaction time measurement) should shed further light on the automatic processing of consumers' acceptance regarding innovative food products.

6. Conclusion

This study offers insights into consumer acceptance of innovative food products. We introduced a new extensive model of consumer acceptance including food innovation-related perception, customer perceived value and risk, and other dimensions which reflect our understanding of the process of consumer acceptance. In summary, the findings of our empirical study suggest that relative advantage, naturalness, novelty, trust in regulations, and discomfort are driving factors of the perception of innovative food products. In addition, innovation-related perception, customer perceived value as well as customer perceived risk are all important variables related to the acceptance of an innovative food product. Marketing managers can use these results to improve the consumers' product perception and the acceptance of innovations as a whole, and thus contributing to the success of new products. Furthermore, these findings are the starting point for further research on consumer acceptance of food innovations and for the development of communication approaches that enable consumers to make objective food choices.

CRediT authorship contribution statement

Levke Albertsen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Visualization, Project administration. **Klaus-Peter Wiedmann:** Conceptualization, Methodology, Writing - review & editing. **Steffen Schmidt:** Conceptualization, Methodology, Investigation, Writing - review & editing.

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A2:

Turning Waste into Smoky Taste:
Identifying Consumer Acceptance Drivers of an Innovative Food Flavoring

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Abstract

Throughout the entire food supply chain, large volumes of food waste are produced. This high level of inefficiency is especially problematic in light of the rising global demand for food; thus, it is important to promote the use of already existing food at the current production level. Technological innovations that aim to counteract this problem do exist, but they are rarely used in the food industry because their application often meets with a lack of acceptance in society. Therefore, this paper aims to provide a deeper understanding of consumer acceptance of technology-based food innovations as well as to identify driving factors of consumer value and risk perception based on the example of an innovative smoke flavor, which is derived from byproducts from potatoes with a biotechnological process. For the empirical investigation of our conceptualized model, an online survey was conducted in Germany (n = 539), and the collected data were analyzed through structural equation modeling. The results confirmed the high predictive power of the multidimensional model of consumer acceptance. With the use of importance-performance map analysis, the dimension compatibility for value perception and the dimension health expectation for risk perception were identified as especially promising for improving consumer acceptance. Our study findings may help marketing managers to understand which factors determine consumer acceptance and which aspects should be addressed in communication strategies to increase consumer acceptance.

Keywords

Consumer acceptance, Food innovations, Customer perceived value, Customer perceived risk, Structural equation modeling, Importance-performance map analysis

1. Introduction

The food system, including all processes related to agriculture, production, trade, retail, transport, and consumption of food products, produces large volumes of waste (Laufenberg *et al.*, 2003; Caldeira *et al.*, 2019). According to the Food and Agriculture Organization of the United Nations (FAO), roughly one-third of the edible part of all food produced in the world for human consumption is lost or wasted, amounting to approximately 1.3 billion tons per year (FAO, 2011; Flanagan *et al.*, 2019). Food waste occurs throughout the entire food supply chain, starting with agricultural production and ending with final household consumption (FAO, 2011).

The very high level of inefficiency in the food supply chain, leading to a high amount of food waste, has significant negative economic, environmental, and social impacts (Lipinski *et al.*, 2013; FAO, 2014; Flanagan *et al.*, 2019). Regarding the economy, the value of products lost and wasted reduces the incomes of farmers and other stakeholders within the food value chain and increases expenses for consumers (Lipinski *et al.*, 2013; FAO, 2014). Environmentally, the impacts of food loss and waste vary, including unnecessary greenhouse gas emissions and depletion of natural resources such as soil nutrients, water and energy (Lipinski *et al.*, 2013). Concerning the social impact of food waste, food security is of particular importance, as the demand for food production will continue to increase in order to supply a growing population (Flanagan *et al.*, 2019). In this context, food security in some regions refers to the ability of farmers to earn a good living and, at times, to feed their families, whereas in other regions (including Europe and North America), it refers to household nutrition and spending (Flanagan *et al.*, 2019). Improving the use of already available food at the current production level, i.e., a reduction in food waste, would help to meet the future demand in all its facets, with less of an increase in agricultural production (FAO, 2017).

Although there are few economically and environmentally viable recovery or recycling options for most industrial food waste, some promising industrial waste management techniques can create a secondary use for "waste products" (Laufenberg *et al.*, 2003; Esparza *et al.*, 2020). For instance, food waste, especially fruit and vegetable waste, can contain many reusable substances of high value, making it a sustainable source of value-added products (Esparza *et al.*, 2020). Depending on adequate technologies, wastes, residues, and byproducts can be recovered and converted into commercial products either as raw material for secondary processes or as ingredients of new products (Laufenberg *et al.*, 2003). One example relates to biotechnological processes that enable the utilization of potato processing byproducts (e.g., peel and off-cuts) (Jorissen *et al.*, 2018). Although this is only one specific approach to using food waste, large amounts of potato processing byproducts are available, as potato is the fourth main crop behind rice, wheat and corn worldwide and is often processed into many different products. The resulting byproducts are traditionally used for the production of low-value animal feed, fertilizer, or as a raw material for biogas, wasting nutritious material that could have been used as a sustainable source of value-added products (Wu, 2016).

However, in practice, such technologies have been insufficiently implemented in the food industry. The lack of large-scale implementation of these technologies is a consequence of various factors (Esparza *et al.*, 2020). In addition to economic and technological limitations, the attitudes and actions of a range of stakeholders throughout the food supply chain, particularly consumers, play a decisive role (FAO, 2017). Considering consumers in the Western world and developed countries, there is an ever-increasing demand for products with highly appreciated properties and simultaneously an increased uncertainty about the safety and quality of food (Tonkin *et al.*, 2016; Esparza *et al.*, 2020). Especially when an innovative food product has been produced by a more or less unfamiliar technology, consumers are often highly skeptical about that product and perceive great consumption risks (Vilella-Vila *et al.*, 2005; Chaudhry *et al.*, 2017). This and the increasing mistrust of consumers toward the food chain

have led to negative societal responses, such as decreasing acceptance and boycotting of regular and newly developed products (e.g., Gupta *et al.*, 2017).

Against this background, the aim of the present study was to identify the determinants of customer perceived value (CPV) as well as customer perceived risk (CPR) as decisive factors for consumer acceptance. Therefore, we refer to the dimensions of innovation-related perception identified by Albertsen *et al.* (2020) and focus on the direct effects of those dimensions on CPV and CPR to gain a deeper understanding of the dependencies between those variables. Furthermore, we examine the effects on attitude components as further dimensions of the consumer acceptance process. We used salmon induced with an innovative smoke flavor, which is derived from potato byproducts with a biotechnological process, as a case for our exploratory study conducted in Germany. To determine the derived dependencies in our conceptual model, we used structural equation modeling (SEM) extended by an importance-performance map analysis (IPMA) with CPV and CPR as outcome variables and the dimensions of innovation-related perception as the predictors. Knowing about the importance and performance of factors influencing value and risk perception enables the identification of targeted communication strategies and marketing concepts to reduce consumer uncertainty and skepticism and increase their acceptance of innovative food technologies and product innovations that have the potential to contribute to food waste reduction.

2. Literature Review

2.1 Dimensions of innovation-related consumer perception as drivers of consumer acceptance

The acceptance of an innovative food product is determined by many individual factors. In addition to the intrinsic sensory characteristics of the product, the consumer's perception of (innovative) foods also depends largely on a variety of factors that are extrinsic to the product (Cardello, 2003). These extrinsic factors range from overall judgments such as environmental

or health expectations to product-oriented clues such as innovativeness or naturalness and to the characteristics of the assessing individual, such as moral concerns or familiarity (e.g., Ronteltap *et al.*, 2007; Stampfli *et al.*, 2010). Based on the extensive literature in the research fields of food and food innovations and technologies and in light of previous research (e.g., Albertsen *et al.*, 2020), this study focuses on 11 dimensions of innovation-related perception (cf. Figure 1). These dimensions can be understood as the starting point for consumers' perception and acceptance of food innovations.

For consumers, concerns such as food safety play a significant role when considering innovative food technologies (Miles & Frewer, 2001). In this regard, consumers' *health expectations* are the primary factor, as the frequently promised properties of innovative foods, such as health or sustainability, are not clearly verifiable by individual consumers (Ronteltap *et al.*, 2007). However, food safety not only refers to concerns limited to human health but also includes concerns regarding the environment (Miles & Frewer, 2001; Matin *et al.*, 2012). Thus, innovative food technologies often raise negative *environmental expectations* among consumers because they cannot assess the long-term consequences of using such a product (Yee *et al.*, 2008). On the other hand, when people have a sense of *controllability* over what they eat such that their own exposure to such innovations is not perceived as involuntary, they are likely to have more positive perceptions of innovative foods and to see more value in such products (Amin *et al.*, 2011; Gupta *et al.*, 2017). Especially in regard to new food technologies, people are suspicious of such products, as the preference for *naturalness* in one's diet can be particularly important (Sodano *et al.*, 2016). Natural foods tend to be viewed as more desirable than nonnatural foods because more benefits are attributed to them (Siegrist, 2008). At the same time, the perception of using innovative technologies to tamper with nature seems to be an important predictor of perceived risk (Sjöberg, 2000).

Further factors influencing the perception of food innovations are *knowledge* and *familiarity* (Frewer *et al.*, 2011). Knowledge, in our study, captures the extent to which consumers think they have expertise about a product and its properties. A higher level of knowledge about the innovative product enables the consumer to make more analytical judgments about the product and thus, for example, to better assess the benefits or value of the product and to improve risk perception (Miao *et al.*, 2020). Familiarity, on the other hand, in our study is a measure that indicates the extent to which consumers feel familiar with the product and its handling despite its innovative character. Similar to knowledge, an increased level of familiarity can positively influence perceived benefit, whereas perceived unfamiliarity is related to perceived risk (Amin *et al.*, 2011; Frewer *et al.*, 2011). Familiarity with a food brings with it the certainty about what kind of food it is and reduces anxiety and distrust of the food, which is why familiar products tend to be liked more than unfamiliar products (Tuorila & Hartmann, 2020). In addition, we look at the factor *novelty* to understand whether a high degree of innovativeness of a food technology triggers fear in consumers and thus an increased perception of risk or whether they put the benefits of the innovation above their fears and thus perceive increased value (Matysik-Pejas, 2017; Alphonce *et al.*, 2020). Alongside these factors, the *compatibility* between the innovation and existing standards, consumers' earlier experiences and current requirements is an important factor in the diffusion and acceptance of innovations (Rogers, 2010). The degree to which a new product is compatible with consumer lifestyles, values and beliefs plays a crucial role in how consumers perceive a product's value and risks (Yusuf *et al.*, 2015; Matysik-Pejas, 2017).

Moreover, the factors *moral concerns* and *effort* play an important role in the perception of innovative foods. If consumers have moral concerns about a product, they can experience (ethical) doubts that increase perceived risks and reduce perceived value (Yee *et al.*, 2008; Amin *et al.*, 2011). A similar effect is assumed for the factor effort, which refers to the ease, accessibility or convenience with which a food can be prepared and consumed (Wing & Jeffery,

2001; Wansink, 2004). Last, when consumers have limited knowledge about an innovative product or technology, they rely on experts they perceive as trustworthy to help them make a decision about the innovation. Therefore, individuals' trust in the government and its regulations is an important factor in their perceptions of the risks and value of innovative products (Sapp & Downing-Matibag, 2009; Connor & Siegrist, 2010; Chen, 2013).

2.2 Consumer acceptance process

According to previous studies, we consider consumer acceptance of innovative products to be a dynamic process involving a series of actions and decisions (Rogers, 2010; Albertsen *et al.*, 2020). More precisely, according to our understanding of acceptance, different acceptance constructs can arise at each stage: assessment acceptance, attitude acceptance, action acceptance, use acceptance, and performance acceptance. However, since the last two phases of consumer acceptance, use acceptance and performance acceptance, refer to the time after the purchase and to experiences that cannot yet occur in the product context in this study, these two phases are not considered here.

Building on an individual's first contact with an innovative product and the perception of innovation-related dimensions, the consumer can form an initial perception of value and risk regarding the product in the first stage, *assessment acceptance* (Rogers, 2010). To capture value and risk perception holistically and obtain a deeper understanding of the two variables, we additionally draw on the underlying dimensions of those two constructs. For perceived value, we rely on the customer perceived value with its four dimensions of economic, functional, affective, and social value according to Wiedmann *et al.* (2012), and for perceived risk, we rely on the six dimensions of social, time, financial, physical, psychological, and performance risk according to Stone and Grønhaug (1993).

Among the many factors that determine the acceptance of an innovation, risk and benefit perceptions appear to be key drivers (e.g., Hossain & Onyango, 2004; Bearth & Siegrist, 2016). Indeed, the trade-off between perceptions of innovation benefit and risk is a crucial element in the formation of attitudes toward the innovative product (Frewer, 2003). An individual forms this attitude toward the innovative product in the second stage (*attitude acceptance*), based on his or her first impression in the evaluation stage (Rogers, 2010). Following Rosenberg and Hovland's (1960) classification of such evaluative consumer responses, where the affective attitude component captures the emotional evaluation of an object and the cognitive attitude component captures the perceptual responses and verbal beliefs about a particular object, we integrate these two components in the attitude phase.

In the third phase, *action acceptance*, the consumer decides whether to adopt or reject the innovative product. If the consumer decides to accept the innovation, the decision leads to a willingness to act with respect to purchasing and deciding to use the innovation (Rogers, 2010). Consistent with Rosenberg and Hovland (1960), such overt actions and verbal statements of intended behavior are captured by the conative attitude component.

Based on the literature review and the preceding considerations, we derived the conceptual model illustrated in Figure 1 to understand what actions and decisions occur during the consumer acceptance process and how they are influenced by the dimensions of innovation-related perception.

3. Methodology

3.1 The measurement instrument

With regard to the conceptualized model introduced, the constructs presented above are conceptualized as either formative or reflective (cf. Figure 1). In particular, CPV and CPR are measured formatively, whereas the innovation-related dimensions and the attitude components

are measured reflectively. To measure the constructs as conceptualized in our model, we used existing and tested reflective measures for the constructs of affective, cognitive, and conative attitude components (e.g., Wiedmann *et al.*, 2012; Albertsen *et al.*, 2020). Regarding the eleven dimensions of innovation-related product perception, we used the scale of Albertsen *et al.* (2020) as a starting point and extended it with additional items to enable a reflective measurement of these various dimensions. In doing so, measures for the dimensions were adapted from items used in the literature (e.g., Yee *et al.*, 2008; Connor & Siegrist, 2010; Amin *et al.*, 2011), and where necessary, new items were generated. During the generation of these items, we followed existing guidelines for clarity, length, directionality, lack of ambiguity, and avoidance of jargon (e.g., DeVellis, 2017). With regard to the remaining formative constructs, we relied on the scale of Wuestefeld *et al.* (2012) to measure the four dimensions of CPV (i.e., affective, economic, functional, and social value) and adapted the original scale developed by Stone and Grønhaug (1993) to measure the six dimensions of CPR (i.e., social, temporal, financial, physical, psychological, and performance risk). Finally, all items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and specified for the context of the acceptance of innovative food products. The measures for the reflective constructs are presented in Table 2, and those for the formative constructs are shown in Table 5.

3.2 Data collection and sample

For the empirical investigation of the conceptualized model, an online survey was conducted with a snowball sampling method in Germany in February 2018. Participants were recruited via selected social network pages and with personalized emails with the invitation to actively contribute to the survey. To participate in the study, however, it was required that the respondents consume salmon with some regularity. To ensure this, a filter question was used at the beginning of the survey to filter out respondents who consumed salmon rarely.

A total of 539 valid questionnaires were received. Table 1 describes the sample characteristics. The participants' ages ranged from 17 to 69 years, with an average age of 29.86 years. The gender ratio was nearly well balanced, with a slight surplus of female participants (female: 53.1%, male: 45.6%). Most participants were single (76.4%), had a higher educational level (86.6%), and were students (49.0%) or full-time employees (32.8%). Furthermore, more than 80% of the participants were interested in food and nutrition topics, and more than half were concerned about environmental protection and food production. Therefore, we can assume that the sample is suitable for obtaining meaningful results regarding our research objective.

The questionnaire was divided into four parts. After some introductory questions, the respondents were exposed to a stimulus that informed them about the innovative smoke flavor that is obtained from food byproducts using a new biotechnological procedure. As an example of a possible application of the smoke flavor as a food additive, we used salmon in our study to provide the participants with a more tangible product. More precisely, the participants were given the information that the salmon had been enriched with a natural flavoring to impart the characteristic taste of the smoking process. In addition to information about the origin of the natural flavoring (food byproducts), the participants were informed about food byproducts and their ranges of applications, as these are still largely unknown in Germany. Subsequently, the constructs of our conceptualized model, i.e., the dimensions of innovation-related perception, CPV and CPR, as well as the three attitude components, were assessed. Finally, the fourth section included sociodemographic questions.

3.3 Analysis technique

For the descriptive analysis of the demographic sample profile (i.e., means and frequencies) and for the correlation analysis to evaluate the measurement models, we used the analysis software SPSS 26.0. For further empirical tests, we considered partial least squares (PLS) SEM

to be the appropriate method, as our conceptual model includes both formative and reflective measurement models (Hair *et al.*, 2019). Furthermore, PLS-SEM allows the estimation of relatively complex models and the assessment of the predictive power of the variables (Sarstedt *et al.*, 2017). PLS-SEM is therefore particularly useful when the focus is on estimating a structural model that explains an important target construct (Richter *et al.*, 2015). More specifically, the purpose of composite-based PLS-SEM is to optimize the prediction of endogenous constructs rather than model fitting (Hair *et al.*, 2019). We used SmartPLS 3 (Ringle *et al.*, 2015) with case-wise replacement and a bootstrapping procedure (individual sign changes) for 539 valid cases to run the empirical analysis. Following the PLS two-step approach (Henseler *et al.*, 2009), we first examined the measurement models (outer model), distinguished by formative and reflective measurement models. If the measurement models met the required criteria, the assessment of the structural model (inner model) followed (Hair *et al.*, 2017). In addition to this assessment, we conducted an IPMA that extended the results of the path coefficients of the structural model by adding a dimension that considers the average values of the latent variable scores (Ringle & Sarstedt, 2016).

4. Results

4.1 Assessment of the measurement models

4.1.1 Evaluation of the reflective measurement model

Following the four-step scheme of Hair *et al.* (2019), we started with the assessment of the indicator loadings. Our results show statistically significant and sufficiently high factor loadings that exceed the recommended threshold of 0.7 for all factors, except for one indicator of the factor effort, with a factor loading of 0.445. (cf. Table 2). However, indicators with loadings between 0.4 and 0.7 should not be removed automatically, but the effects of eliminating items on the composite reliability (and the average variance extracted, AVE) should be examined (Hair *et al.*, 2017). As these values already exceed the thresholds for the factor

effort and eliminating the item leads to only a slight improvement, we conclude that the indicator should not be eliminated. Thus, acceptable item reliability is provided overall (Hair *et al.*, 2019). The second step is assessing internal consistency reliability using Jöreskog's (1971) measure of composite reliability (Hair *et al.*, 2019). As shown in Table 2, the values for composite reliability range from 0.753 to 0.953, indicating satisfactory results in terms of internal consistency reliability (Bagozzi & Yi, 1988). To assess convergent validity, as the third step, the AVE for all items on each construct is used (Hair *et al.*, 2017). As the AVE estimates range from 0.521 to 0.834 (cf. Table 2), they meet the minimum requirement of 0.5, enabling us to confirm the convergent validity of our reflective measurement models.

The fourth and final step is to assess discriminant validity. Following Hair *et al.* (2017) and Henseler *et al.* (2015), we used the heterotrait-monotrait (HTMT) ratio of correlations to evaluate the discriminant validity. The results of our analysis, represented in Table 3, indicate a possible problem regarding discriminant validity, as the HTMT ratio between the constructs of environmental expectations and moral concerns (0.895), knowledge and familiarity (0.874), the affective attitude component and cognitive attitude component (0.915), and the constructs affective attitude component and conative attitude component (0.900) are around the threshold for conceptually similar constructs. However, the 95% bias-corrected confidence intervals of the HTMT ratio for these constructs do not include the value one, indicating that they are significantly different from 1 (cf. Table 4). Taken together, the results support the discriminant validity of the constructs.

4.1.2 Evaluation of the formative measurement model

Following Hair *et al.* (2017), formative measurement models are evaluated in three steps: (1) convergent validity, (2) indicator collinearity and (3) the statistical significance and relevance of the indicator weights. Regarding the assessment of convergent validity of each formative

indicator, we examined whether they were significantly correlated with a global item that summarizes the corresponding essence of CPV and CPR. For that reason, appropriate semantic differentials for the perceived extent of the product's value (1 = no value at all, 7 = very high value) and the perceived extent of the product's risk (1 = no risk at all, 7 = very high risk) were applied. As shown in Table 6, all formative indicators are significantly correlated with these items, supporting their convergent validity. For the evaluation of the indicator collinearity of the formative indicators, we used the variance inflation factor (VIF) (Hair *et al.*, 2019). With maximum values of 2.174 and 2.488 for the indicators of CPV and CPR (cf. Table 6), the VIF values are below the threshold of 3 (Hair *et al.*, 2019). These results suggest that multicollinearity does not pose a problem in our study. In the third step, we assessed the indicator weights' statistical significance. As shown in Table 6, all indicator weights are (highly) significant, confirming their relevance regarding the formative construct (Hair *et al.*, 2017).

In addition, a closer look at the outer weights of the indicators reveals the indicators' relative contribution to the construct (cf. Table 6). However, outer weights in formative measurement models are frequently smaller than outer loadings of reflective indicators (Diamantopoulos & Winklhofer, 2001; Cenfetelli & Bassellier, 2009). In our study, the indicators with the highest contribution to the CPV are the affective (0.553) and functional (0.345) value dimensions. Regarding the indicators of CPR, the highest outer weights are the weights of the physical (0.519) and social (-0.478) risk dimensions.

4.2 Evaluation of the structural model

Having established the reliability and validity of the measurement models, we can proceed with the second step in evaluating PLS-SEM, the assessment of the structural model. Following Hair *et al.* (2019), the assessment includes the VIF, the coefficient of determination (R^2), Stone-

Geisser's Q^2, the model's out-of-sample predictive power, and the statistical significance and relevance of the path coefficients as well as the effect size (f^2).

Before assessing the structural relationships, multicollinearity must be examined using the VIF. Our results show that the VIF values for all exogenous variables are close to the threshold of 3, and most are even below this value (cf. Table 7). Therefore, we can assume that multicollinearity does not bias the results of the structural relations (Hair *et al.*, 2019). As presented in Table 7, the R^2 of the endogenous latent variables ranges from 0.400 (cognitive attitude component) to 0.659 (conative attitude component). According to Chin (1998), these values are moderate to substantial, suggesting good predictive relevance of the PLS structural model. Moreover, all Stone-Geisser's Q^2 values (Geisser, 1974; Stone, 1974) are higher than zero for all endogenous latent variables, with a minimum value of 0.218 for CPR and a maximum value of 0.522 for the conative attitude component. Thus, the values for Q^2 depict low to high levels of predictive relevance of the conceptual model (Hair *et al.*, 2019).

To assess the out-of-sample predictive power with regard to our model's key constructs of affective, cognitive, and conative attitude components, we used the PLSpredict technique (Shmueli *et al.*, 2016; Shmueli *et al.*, 2019). The result for the $Q^2_{predict}$ statistic, which must be evaluated first, shows that the PLS-SEM-based prediction outperforms the most naïve benchmark, as all indicators yield a value above zero (cf. Table 8). Accordingly, the prediction statistics can be assessed. When comparing the root mean squared error (RMSE) value of the PLS-SEM analysis to the linear regression model (LM) benchmark, we find different results for our three key constructs. For the affective and cognitive attitude components, we find that a minority of the indicators in the PLS-SEM analysis yields greater prediction errors than the naïve LM benchmark. Regarding the conative attitude component, the results show that the majority of the indicators in the PLS-SEM analysis produces higher prediction errors than the

naïve LM benchmark. Consequently, the results indicate that the model has low to medium predictive power with regard to the key target constructs (Shmueli *et al.*, 2019).

To test the assumed relations between the latent variables of our conceptual model, we applied a nonparametric bootstrapping procedure (individual sign changes, 539 cases and 5000 subsamples) to assess the significance of the path coefficients. As presented in Table 9, the following five dimensions of innovation-related product perception have a significant effect on the CPV: compatibility ($\beta = 0.354$), naturalness ($\beta = 0.171$), novelty ($\beta = 0.159$), familiarity ($\beta = 0.102$), and trust in regulations ($\beta = 0.151$). In addition, the results indicate a strong significant impact of the innovation-related dimensions of health expectations ($\beta = 0.309$), moral concerns ($\beta = 0.148$), compatibility ($\beta = -0.151$), naturalness ($\beta = -0.132$), and familiarity ($\beta = 0.-153$) on CPR. Subsequently, CPV and CPR have significant effects on all three attitude components, with CPV having a stronger impact on the selected outcome. Finally, the affective attitude component ($\beta = 0.504$, $p < 0.001$) shows a highly significant impact on the conative attitude component, whereas the cognitive attitude component has a significant but minor impact on the conative attitude component ($\beta = 0.079$, $p < 0.05$). The results for the f^2 effect size confirm these findings. Following Cohen's (1988) general rule, which indicates that values higher than 0.02, 0.15, and 0.35 depict small, medium, and large f^2 effect sizes, our results show small to large effect sizes for most of the aforementioned relationships.

4.3 Importance-performance map analysis

We conducted an IPMA to generate deeper insights into the key dimensions of innovation-related product perception that predict CPV and CPR. By contrasting the relations in the conceptual model (i.e., the importance of each latent variable) with the constructs' average value (i.e., the performance of each latent variable), using IPMA enables the identification of predecessors that have relatively high importance for the target construct but also relatively low

performance. This enables the identification of opportunities for improvement and effective (marketing) program development (Martilla & James, 1977; Slack, 1994). In both IPMAs, we included only those innovation-related dimensions that exerted a significant impact on CPV and on CPR. As recommended by Ringle and Sarstedt (2016), all indicator codings must have the same scale direction, with higher values indicating a better outcome, to be able to conclude that higher latent variable scores represent better performance. Therefore, we rescaled the dimensions' indicators that have a different coding direction than the other indicators in our model (i.e., health expectations and moral concerns).

From the importance-performance map concerning CPV (cf. Figure 2), we can see that compatibility has the strongest impact on CPV, with an importance value of 0.303. In addition, the performance value (48.498) offers room for improvement. This value combination makes this predecessor a particularly interesting parameter for marketing programs, as an improvement in consumers' perception of compatibility can have a strong effect on CPV. In addition, the predecessors of naturalness, novelty, and trust in regulations should be taken into account, as they also have a relevant, although less powerful, effect on CPV and can be improved in terms of their performance.

The importance-performance map in relation to CPR (cf. Figure 3) shows that the dimension health expectations has the strongest effect on CPR, with an importance value of -0.424, implying that positive perceptions of health expectations can reduce risk perception. The performance value of 64.828 also shows that consumers already have quite positive health expectations. However, there is potential for improvement, and a well-considered communication strategy could eliminate remaining health concerns in order to improve the performance. The performance of the predecessors of familiarity (37.233), naturalness (41.435) and compatibility (48.498) also offer opportunities for improvement that could reduce CPR and increase CPV simultaneously.

5. Discussion

This study aimed to better understand consumer perception and acceptance of innovative food technologies and the resulting innovative food products, in order to decrease possible food safety concerns and consumer skepticism about technology-based food innovations. To reduce the public unease about the health and safety of modern technology-based methods of food production, Hansen *et al.* (2003) propose three interlinked tasks of risk communication: educating the public, avoiding unnecessary food scares, and promoting acceptance of innovative food technologies that offer important benefits. A prerequisite for achieving these goals is not only an understanding of laypeople perceptions, but also an understanding of how these perceptions influence the acceptance of an innovative food technology. Therefore, our study particularly focused on identifying factors that have a significant impact on consumers' value and risk perceptions as determinants of consumer acceptance. In addition, we examined the extent to which the most influential factors are perceived by consumers, i.e., how pronounced the current performance of the factors is. Knowledge about these factors and their performance enables policy makers and marketing managers to realize the greatest potential for effective communication strategies and materials aimed at decreasing possible food safety concerns and increasing consumer acceptance.

Regarding CPV, we were able to identify five determining factors, namely compatibility, naturalness, novelty, familiarity, and trust in regulations, with compatibility having the strongest effect on CPV. With regard to CPR, we identified health expectations and moral concerns as factors that contribute to increasing CPR. However, compatibility, familiarity, and naturalness reduce CPR. The latter is particularly interesting, as these factors simultaneously decrease perceived risk and increase perceived value. Moreover, these factors have already been identified in other studies as relevant factors in the perception of (innovative) foods and in influencing consumer acceptance (e.g., Sulmont-Rossé *et al.*, 2007; Connor & Siegrist, 2010;

Tuorila & Hartmann, 2020). These findings provide valuable insights for organizations and businesses by identifying dimensions that can help increase the acceptance of food innovations. Thus, communication strategies and marketing concepts could emphasize that the use of innovative smoke flavoring does not result in any changes in the actual product in which the flavoring was used. Since the main product characteristics are not affected, the compatibility of the innovation with the current lifestyle of consumers is underlined while creating a feeling of familiarity, since traditional foods can be modernized or upgraded by using this innovation, thus adding value. In addition, the feeling of familiarity with the innovation can be strengthened by using positive information to show similarities to conventional and established products.

In combination with the results of the IPMA, these insights can be further extended, as the inclusion of the performance values for different dimensions additionally reveals which dimensions have greater potential for improvement. The IPMA findings confirmed that compatibility has the strongest effect on CPV. In addition, the results showed that the performance in terms of compatibility is perceived at a medium level from the consumer's point of view. Thus, this dimension in particular offers potential for improvement and is therefore particularly interesting for identifying relevant implications and strategies. These results support the previously mentioned approaches of using a strategy to increase compatibility: The use of the flavoring does not change the basic handling of the product in which the flavoring is used. In addition, the production of this flavoring is based on natural materials, and the natural flavor obtained from biotechnology procedures satisfies customers' demands for product quality and safety (especially compared to conventional smoking) (Grosse *et al.*, 2019). Thus, the flavor is also compatible with a healthy lifestyle. This would simultaneously address consumers' health expectations, the most influential dimension related to CPR. The IPMA results also show great potential for improvement in this dimension, even though consumers already tend to have positive expectations regarding the health effects of the product and its innovative features. Further information regarding the general safety of using this flavoring and

the advantages over conventional smoking should be addressed in a communication strategy to address any health concerns in this specific context.

Further results of our model showed that both CPV and CPR affect the further dimensions of our model, the affective and cognitive attitude components (attitude acceptance) as well as the conative attitude component (action acceptance). However, the impact of CPV on the subsequent dimensions is considerably greater than the impact of CPR. This result is in line with previous studies (e.g., Bearth *et al.*, 2014; Albertsen *et al.*, 2020). Thus, strategies should also focus on emphasizing the values and benefits of the innovation and its application in order to create a stronger effect among consumers in the subsequent stages of the acceptance process. For this purpose, the dimensions of CPV (i.e., formative indicators) should also be taken into account, with affective and functional CPV being the strongest driving factors. Addressing emotionally perceived values based on the customer's feelings, as well as values at the functional level, which represent core and basic benefits such as the quality or usability of a particular product, can accordingly increase the overall CPV. Although the effects of CPR seem to be less important, perceived risks should not be neglected. With the results showing that the physical CPR dimension is the most influential dimension on overall risk perception, marketers should emphasize that the flavoring is not a health hazard for consumers, as the flavoring can positively affect products containing it by reducing the risk of harmful substances resulting from the conventional smoking process.

Especially in today's society, where there is a great demand for appropriate nutritional standards, aspects such as cost increases, decreasing availability of raw materials, and strong concern for the environment are becoming increasingly important issues. Consequently, efforts are being made to recover, recycle and upgrade waste with innovative technologies. In the food industry, for example, waste and byproducts are recovered and often processed into higher-value products (Laufenberg *et al.*, 2003). For this effort to be successful for the various

stakeholders in the food industry, consumers must demand and consume the newly developed products. The proposed model can support this by outlining the dimensions that determine consumer perceptions of value and risk. To credibly underline these dimensions and the advantages of this specific innovative application and of innovative food technologies in general, scientists and government regulators should support communication and thus help educate the public. Such actions can help induce changes in society's perception of technology-based food innovations, which can in turn avoid unnecessary food scares and promote the acceptance of innovative food technologies (Hossain & Onyango, 2004). The results of this study, particularly the IPMA results, offer insights into which content-related aspects can be particularly effective in promoting positive changes.

In addition to encouraging communication, policy makers should continue to support research in this area. On the one hand, additional technologies can be developed at the technical level to further reduce food waste, such as more technologies utilizing residual materials from food processing or other stages of the food supply chain. On the other hand, at the societal level, further research can be carried out to, for example, address the acceptance barriers for consumers and other stakeholders in order to obtain an even more comprehensive picture.

With any research, there are limitations and, for this study, only one innovation, an innovative food additive, was included. However, studies show that there are profound differences in consumer perceptions of different food additives (Bearth *et al.*, 2014). Thus, further innovative (food) products or production methods should be investigated to test the performance of the conceptual model in a broader context. In addition, the application of the flavoring should vary, as the application of flavorings is less common in salmon. For example, a product could be used that is also processed with flavorings in conventional production, such as snack food. This could mitigate the effect in which consumers tend to view food additives with suspicion and consider them as unnatural or unhealthy (Bearth *et al.*, 2014). In addition, future studies could also look

at different consumer groups to identify, for example, differences in the impact of acceptance drivers. A more specific consideration of, for example, demographic, cultural, or attitudinal influences on consumer acceptance could enable a more specific targeting of different information materials and/or marketing campaigns to the respective consumer groups.

6. Conclusion

In conclusion, in the food industry, there is much potential for the bioeconomy hidden in waste and byproducts. Making better use of this potential would help meet future demand with less of an increase in agricultural production (FAO, 2014). To realize this potential, however, it must be ensured that consumers also demand the newly developed approaches. Therefore, this study offers insights into consumer acceptance of innovative food technologies and the resulting products. From a managerial point of view, our results can help policy makers as well as marketing managers to better understand which dimensions of innovation-related perception or which aspects of the innovation need to be addressed to encourage consumer acceptance. In particular, by extending the analysis to include IPMA, we were able to show that the dimension compatibility for value perception and the dimension health expectation for risk perception offer the greatest potential for improving consumer perception and thus consumer acceptance. Building on this example, further studies can be conducted to obtain a comprehensive picture of the perception of technology-based innovations and to develop targeted communication strategies for those innovations.

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Table 1: Demographic profile of the sample

		n	*%*
Age	17-29 years	410	76.1
	30-49 years	55	10.2
	50-69 years	68	12.4
	No answer	6	1.1
Gender	Male	246	45.6
	Female	286	53.1
	No answer	7	1.3
Marital status	Single	412	76.4
	Married	92	17.1
	Divorced	12	2.2
	Widowed	2	0.4
	No answer	21	3.9
Education	Did not graduate from high school	6	1.1
	Lower secondary school	4	0.7
	Intermediate secondary school	50	9.3
	A-levels	152	28.2
	University degree	315	58.4
	No answer	12	2.2
Occupation	Full-time	175	32.8
	Part-time	35	6.5
	Pensioner/retiree	8	1.5
	Homemaker	10	1.9
	Job training	10	1.9
	Student	264	49.0
	Scholar	4	0.7
	Seeking work	5	0.9
	No answer	28	5.2

Table 2: Assessing the reflective measurement models

Reflective indicators	*Factor loadings*	*Composite reliability*	*AVE*
Environmental Expectations (EE)		0.872	0.694
The product has a negative impact on the environment.	0.787		
The product is harmful to the environment.	0.866		
Our environment is endangered by this product.	0.844		
Health Expectations (HE)		0.891	0.731
The product is harmful for people's health.	0.840		
The product is very dangerous for people's health.	0.868		
My health is endangered by this product.	0.857		
Moral Concerns (MC)		0.854	0.661
Using the product is morally inexcusable.	0.740		
The product completely contradicts my moral principles.	0.855		
I would feel very guilty buying this product.	0.839		
Knowledge (KN)		0.888	0.725
I have great knowledge about the product.	0.866		
I have intensively looked at the properties of this product.	0.829		
I am well informed about the product.	0.859		
Compatibility (COM)		0.880	0.710
The product is very compatible with my lifestyle.	0.843		
I can integrate the product very well into my life.	0.836		
The product fits well with my way of life.	0.850		
Naturalness (NA)		0.869	0.690
The product is made from natural ingredients.	0.791		
The product is in perfect harmony with nature.	0.843		
The product is natural.	0.856		
Novelty (NO)		0.863	0.679
The product is innovative.	0.883		
The product is based on an innovative idea.	0.859		
The product is very new in its category.	0.722		
Familiarity (FA)		0.893	0.736
I am familiar with the product.	0.874		
The product is very familiar to me.	0.874		
I am used to handling this product.	0.826		
Effort (EF)		0.753	0.521
It is complex to use the product.	0.445		
The product is easy to use.*	0.780		
The product can be used immediately without having to get used to it for a long time.*	0.870		
Controllability (CON)		0.859	0.672
I can control whether I consume the product.	0.716		
The decision of whether to use the product is entirely up to me.	0.847		
I can decide if and when I use the product.	0.886		
Trust in Regulations (TR)		0.867	0.685
Any risk arising from this product is excluded from the official regulations.	0.757		
I trust the responsible authorities that there is no risk from this product.	0.878		
The government ensures that this product is completely risk free.	0.843		
Affective Attitude Component (AFF)		0.895	0.741
In my opinion, the quality of the product is very high.	0.869		
The product suits me completely.	0.840		
I find the product very pleasant.	0.872		

Cognitive Attitude Component (COG)		0.831	0.621
The product is very famous.	0.741		
The product is very distinctive.	0.795		
The product keeps to its promise.	0.825		
Conative Attitude Component (CONA)		0.953	0.834
I would recommend the product to my friends.	0.860		
I would prefer this product over a comparable product.	0.896		
I intend to buy the product in the future.	0.948		
It is very likely that I will use the product in the future.	0.947		

All factor loadings are highly significant with $p < 0.001$, except from the first indicator of effort ($p < 0.010$).
** These indicators were recoded prior to the analysis.*

Table 3: Assessing the HTMT ratio of correlations

	AFF	COM	CON	EF	EE	FA	HE	KN	COG	CONA	MC	NA	NO	TR
AFF														
COM	0.795													
CON	0.094	0.150												
EF	0.254	0.365	0.607											
EE	0.333	0.283	0.100	0.291										
FA	0.566	0.758	0.065	0.233	0.046									
HE	0.382	0.441	0.344	0.535	0.734	0.186								
KN	0.445	0.543	0.062	0.277	0.055	0.874	0.068							
COG	0.915	0.629	0.079	0.245	0.205	0.605	0.180	0.529						
CONA	0.900	0.724	0.036	0.176	0.266	0.584	0.275	0.469	0.748					
MC	0.421	0.502	0.213	0.416	0.895	0.136	0.839	0.071	0.179	0.320				
NA	0.732	0.698	0.114	0.219	0.490	0.500	0.496	0.477	0.587	0.637	0.489			
NO	0.399	0.276	0.158	0.189	0.191	0.091	0.138	0.141	0.374	0.412	0.103	0.392		
TR	0.506	0.404	0.118	0.232	0.317	0.399	0.306	0.365	0.465	0.467	0.256	0.607	0.303	

Table 4: Bias-corrected confidence intervals of the HTMT ratio

	HTMT ratio	*Bias-corrected confidence intervals*	
		2.5%	*97.5%*
Environmental Expectations → Moral Concerns	0.895	0.830	0.952
Knowledge → Familiarity	0.874	0.813	0.928
Affective Attitude Component → Cognitive Attitude Component	0.915	0.853	0.971
Affective Attitude Component → Conative Attitude Component	0.900	0.863	0.931

This extract of the results takes a closer look at the critical values of the HTMT ratio.

Table 5: Manifest variables of the formative measurement models.

Affective Customer Perceived Value
This product creates positive feelings for me.
This product evokes positive perceptions.
Economic Customer Perceived Value
This product offers a lot for its price.
This product is worth its price.
Functional Customer Perceived Value
This product is very useful.
This product is very suitable.
Social Customer Perceived Value
I will be seen in a positive light if I own this product.
As the owner of this product, I will be perceived positively by others.
Financial Customer Perceived Risk
I can spend my money in a better way.
The product is not worth the money.
Performance Customer Perceived Risk
The product will not provide the level of benefits I expect.
The product does not deliver what it promises.
Physical Customer Perceived Risk
The product is associated with potential physical risks.
The product is not safe for my body.
Psychological Customer Perceived Risk
The product makes me feel worried.
The product evokes an inner disquiet.
Social Customer Perceived Risk
People I appreciate don’t like the product.
People I care about wouldn't like it if I use this product.
Time Customer Perceived Risk
I have better uses of my time than this product.
Using the product is a waste of time.

Table 6: Assessing the formative measurement models

Formative indicators	*Outer weights*	*p-Values*	*Variance inflation factor (VIF)*	*Spearman's rank correlation coefficient*
Customer Perceived Value				
Affective CPV	0.553	0.000	2.174	0.632
Economic CPV	0.092	0.024	1.399	0.445
Functional CPV	0.345	0.000	1.743	0.617
Social CPV	0.188	0.001	1.879	0.518
Customer Perceived Risk				
Financial CPR	0.214	0.016	2.195	0.433
Performance CPR	0.265	0.001	2.488	0.496
Physical CPR	0.519	0.000	2.444	0.615
Psychological CPR	0.208	0.013	2.172	0.532
Social CPR	-0.478	0.000	1.523	0.345
Time CPR	0.195	0.016	2.258	0.415
The correlation coefficients were all highly significant with p-values < 0.001.				

Table 7: Assessing the structural model

Endogenous LV	*VIF*	R^2	Q^2
Environmental Expectations	2.207		
Health Expectations	2.230		
Moral Concerns	2.492		
Knowledge	2.230		
Compatibility	2.426		
Naturalness	1.980		
Novelty	1.326		
Familiarity	2.849		
Effort	1.360		
Controllability	1.286		
Trust in Regulations	1.375		
Customer Perceived Value	2.434	0.454	0.262
Customer Perceived Risk	1.518	0.423	0.218
Affective Attitude Component	3.504	0.655	0.465
Cognitive Attitude Component	2.015	0.400	0.234
Conative Attitude Component		0.659	0.522

Table 8: Assessing the model's predictive power

Item	*PLS-SEM*		*LM*
	RMSE	$Q^2_{predict}$	*RMSE*
Affective Attitude Component			
Affective 1	0.779	0.344	0.786
Affective 2	0.836	0.368	0.803
Affective 3	0.864	0.369	0.878
Cognitive Attitude Component			
Cognitive 1	0.837	0.204	0.833
Cognitive 2	0.742	0.223	0.773
Cognitive 3	0.943	0.114	0.949
Conative Attitude Component			
Conative 1	0.842	0.368	0.837
Conative 2	2.173	0.394	2.167
Conative 3	2.127	0.402	2.097
Conative 4	2.200	0.343	2.235

Note: RMSE = root mean squared error, LM = linear regression model

Table 9: Bootstrapping results for the structural relations

Independent LV → Dependent LV	*Original Sample*	*p-Values*	*f^2*
Environmental Expectations → CPV	0.028	0.591	0.001
Environmental Expectations → CPR	-0.016	0.749	0.000
Health Expectations → CPV	0.005	0.924	0.000
Health Expectations → CPR	0.309	0.000	0.074
Moral Concerns → CPV	0.022	0.667	0.000
Moral Concerns → CPR	0.148	0.020	0.015
Knowledge → CPV	0.024	0.633	0.000
Knowledge → CPR	0.098	0.067	0.008
Compatibility → CPV	0.354	0.000	0.094
Compatibility → CPR	-0.151	0.004	0.016
Naturalness → CPV	0.171	0.000	0.027
Naturalness → CPR	-0.132	0.008	0.015
Novelty → CPV	0.159	0.000	0.035
Novelty → CPR	-0.075	0.055	0.007
Familiarity → CPV	0.102	0.050	0.007
Familiarity → CPR	-0.153	0.010	0.014
Effort → CPV	0.025	0.852	0.000
Effort → CPR	0.009	0.632	0.001
Controllability → CPV	0.024	0.548	0.001
Controllability → CPR	-0.022	0.623	0.001
Trust in Regulations → CPV	0.151	0.000	0.030
Trust in Regulations → CPR	-0.038	0.354	0.002
Customer Perceived Value → AFF	0.621	0.000	0.911
Customer Perceived Value → COG	0.549	0.000	0.410
Customer Perceived Value → CONA	0.209	0.000	0.053
Customer Perceived Risk → AFF	-0.316	0.000	0.236
Customer Perceived Risk → COG	-0.156	0.000	0.033
Customer Perceived Risk → CONA	-0.125	0.000	0.030
Affective Attitude Component → CONA	0.504	0.000	0.212
Cognitive Attitude Component → CONA	0.079	0.032	0.009

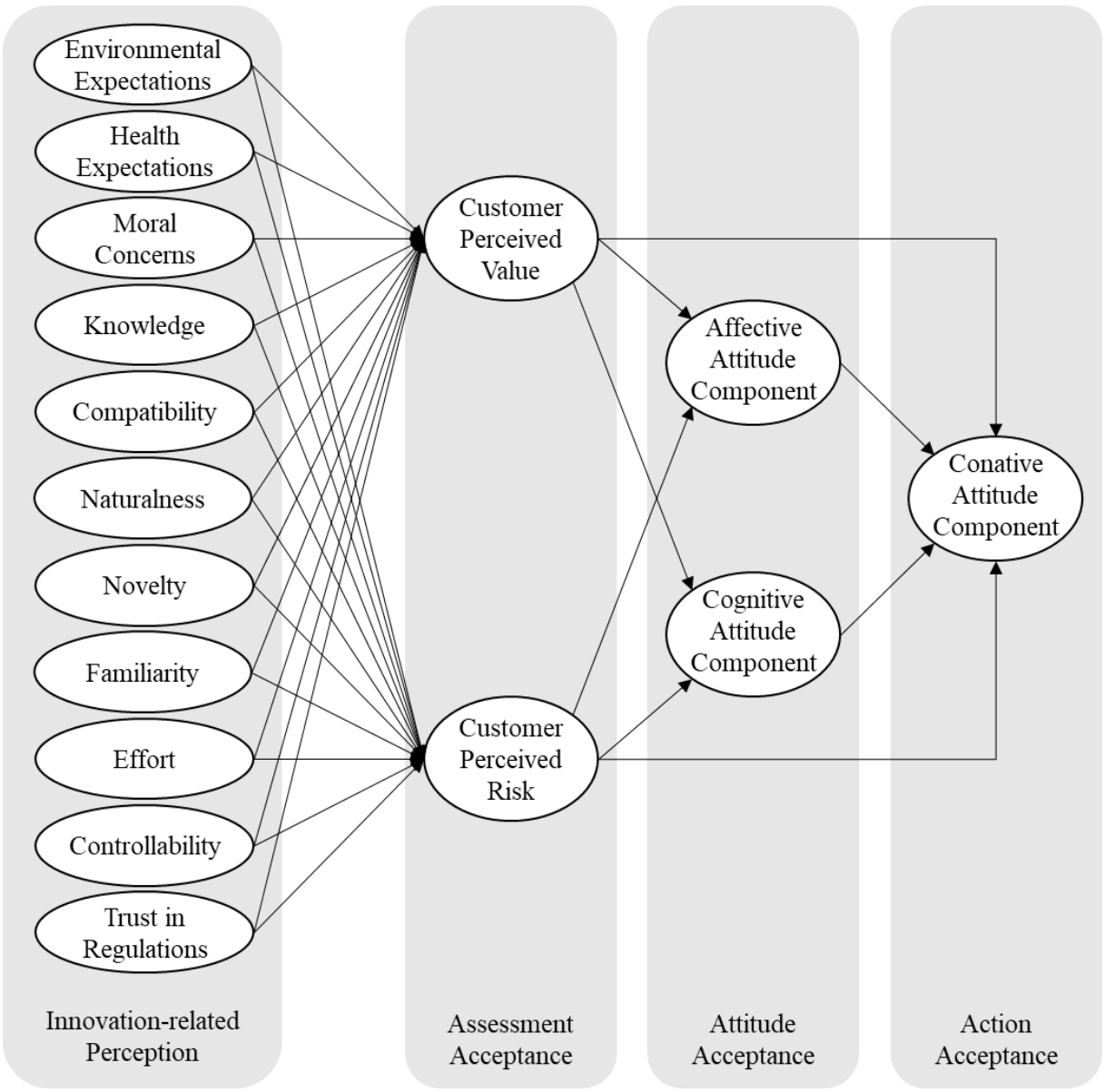

Figure 1. Conceptual framework.

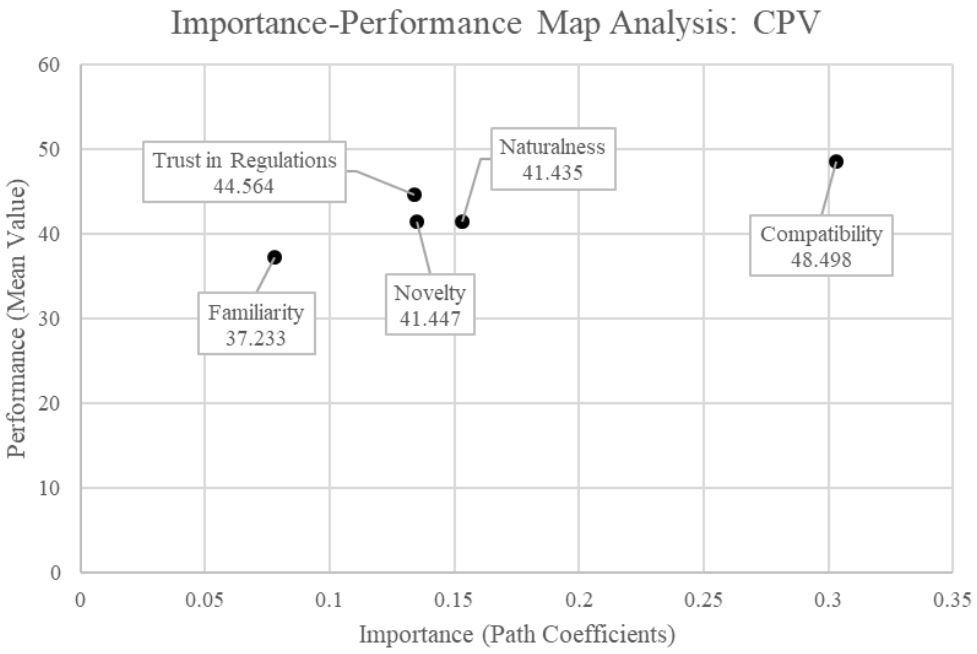

Figure 2. Importance-Performance Map: Customer Perceived Value.

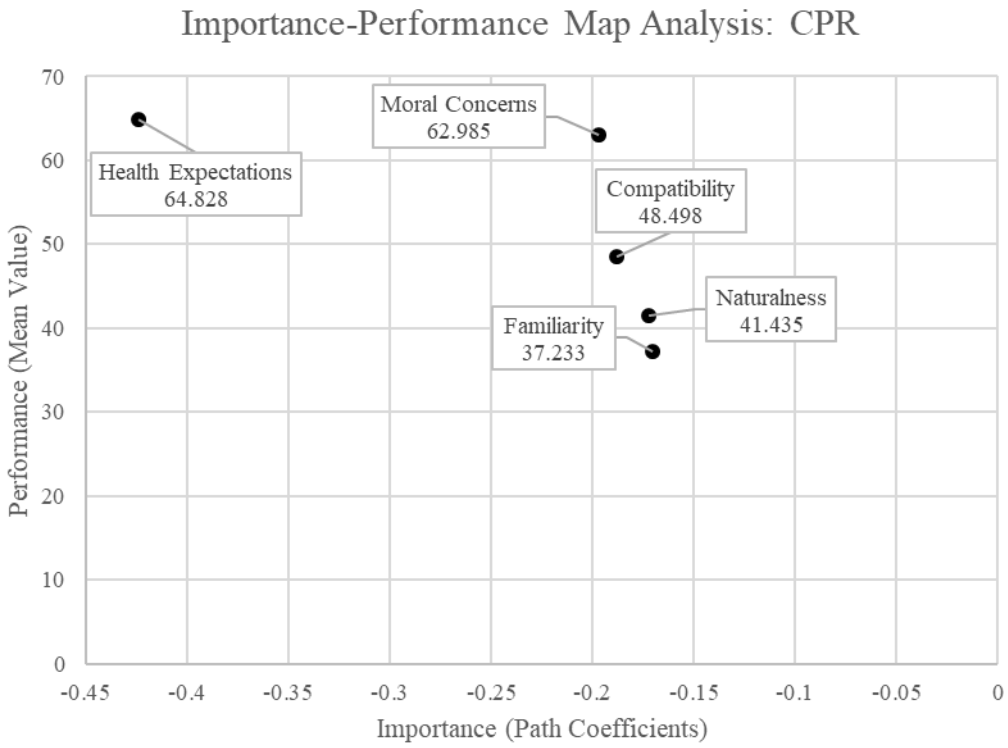

Figure 3. Importance-Performance Map: Customer Perceived Risk.

A3:

How product information and source credibility affect consumer attitudes and intentions towards innovative food products

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How product information and source credibility affect consumer attitudes and intentions towards innovative food products

Innovative foods often offer consumers an important contribution to their quality of life. Nevertheless, consumers often encounter technology-based food innovations with a certain degree of scepticism. To counteract this scepticism, information about the innovative product is often communicated. However, two elements must be taken into account to ensure that the given information does not reinforce the scepticism: first, the right amount of information and, second, the source of information and its credibility. In order to be able to implement these elements effectively in a communication strategy, this paper uses two online experiments and analyses of variance to investigate the impact of different amounts of information and different sources of information on consumers' product evaluations (i.e., affective attitude, cognitive attitude, and behavioural intention). Study 1 found that more information does not always lead to better product evaluations. Furthermore, the results of study 2 show that independent or scientific sources of information are perceived as more credible and tend to lead to a higher product evaluation. Moreover, higher credibility measured by attractiveness, trustworthiness and expertise leads to a significantly higher product evaluation. From these results communication strategies can be designed that gain higher consumer acceptance for technology-based food innovations.

Keywords: product evaluation, food innovations, product information, information source, source credibility, credibility dimensions

Introduction

Consumers tend to be sceptical of innovations, especially in the food sector, which often triggers a certain reluctance to buy technology-based food innovations, even if they make a major contribution to people's quality of life (Ronteltap et al. 2007). This reluctance is deeply rooted in humans due to genetically-based constraints and predispositions, which include a fundamental interest in new potential foods (neophilia),

but at the same time a cautiousness to consume them (neophobia) (Rozin 1999). Given that consumers already have access to a wide variety of potential foods and that wise food choices are ingrained in their genes, passive resistance driven by an individual's preference for the current status quo can occur, which inhibits consideration and adoption of new products (Heidenreich and Spieth 2013; Rozin 1976). It is therefore important for the success of an innovative product to choose the right strategy for communicating information about the product so that the consumer can make sense of the product and its benefits generated by the innovation (Nijssen, Reinders, and Banovic 2021). For communicating information, food product labels are often used to provide consumers with specific and expert-verified product information (Rupprecht et al. 2020). However, these labels often differ in terms of the amount of information, the informational content, and the source of the information. In addition, the occurrence of food tampering, intentional mislabelling and scandals in the food industry have made it difficult for consumers to trust food labels and sources of food information (Moussa and Touzani 2008).

Studies have shown that information about the product plays an important role in product evaluation and thus has a positive impact on consumers' acceptance of innovative food products (Deliza, Rosenthal, and Silva 2003; Lee et al. 2016). However, this effect is in contrast to the poor image that many innovative technologies, such as GMO, irradiation, or nano-technologies, have among consumers. This negative image is reinforced by the current efforts of the food industry to remove or replace these technologies by alternatives, as it implicitly communicates the message that indeed there is something wrong with those technologies. Moreover, this negative image may generalize to other products and innovative food technologies (Dijksterhuis 2016). So,

on the one hand, the question arises as to what influence the communicated information has on the consumers' product evaluation.

In addition to the information itself, however, the source of the information is also a crucial element of the communication strategy, as the communication process begins with the source and so it affects how the message is perceived by the target audience (Belch and Belch 2001). Information sources can be both public and private sources, such as third-party certifiers, government bodies, and producers (Rupprecht et al. 2020). Different sources of information are perceived differently by consumers and thus cause different reactions. In this context, credibility is also an important aspect, because it serves as a means for the recipient of the information to evaluate the source of the communication and subsequently the information itself (Hovland, Janis, and Kelley 1953). Therefore, on the other hand, there is the question of how consumers perceive different sources of information and what influence the source of information as well as its credibility has on consumers' product evaluation.

In summary, the aim of this paper is twofold. In the first step, the effect of different amounts of information on consumers' evaluation of the innovative food product is investigated as a basis. In the second step, building on this, the extent to which different sources of information and their credibility can influence the effect of information is investigated. For this purpose, two online studies are conducted with an experimental design, each dedicated to one of the two aims. In both studies, the object of investigation is a ham product that has been processed with an innovative flavouring and one-way analyses of variance (ANOVAs) are conducted to determine the effects on consumers’ product evaluation (i.e., affective attitude, cognitive attitude, and behavioural intention). In study 1, different amounts of information are provided about this innovative flavouring, and in study 2, different sources of information are used to

communicate the information. The results of these studies should help marketing managers to decide to what extent information about a technology-based innovation in the food sector should be communicated and which information sources are perceived as particularly credible and thus have a positive impact on consumers' evaluation.

Theoretical background

The role of information in consumer perception of innovative food products

When it comes to consumer perception of food products (prior to its consumption) or to food choices, various informational stimuli play a determining role regarding consumers' product expectations that are typically classified as intrinsic and extrinsic quality cues (Olson and Jacoby 1972; Steenkamp 1990). Intrinsic cues are sources of information, which physically belong to the product and cannot be changed without changing the physical properties of the product itself, like sensory properties. However, when consumer buy food products, extrinsic cues, which are somehow related to the product, but are not physically part of it, such as price, origin, production and nutritional information, food safety and environmental pollution also influence consumer choices (Napolitano et al. 2010; Olson and Jacoby 1972; Steenkamp 1990). The cues that consumers are exposed to and those they perceive are affected by the shopping situation, with the amount of information in the store or on the product also influencing their perception, for example (Grunert, Bredahl, and Brunsø 2004). Furthermore, as consumers become increasingly interested in non-sensory food qualities, with particular interest in the methods of production, consumers' cognitive mechanisms and their perceptions of product attributes can be significantly influenced by information about the product itself or about the production process (Lappo et al. 2015; Napolitano et al. 2010). Many studies have demonstrated how specific information affects affective

judgments, such as liking/disliking, preference, expectations of food products. Among these are studies by Cardello (2003) showing that information about the method of processing and preserving may be an important variable influencing the expected liking/disliking for the food product; Deliza, Rosenthal, and Silva (2003) showing that the presentation of information about the used technology may be useful in the promotion of a positive attitude towards the product and a higher likelihood to buy; Caporale and Monteleone (2004) showing that information about the manufacturing process (organic vs. OGM) can affect product acceptability; and Tarancón et al. (2014) showing that nutrition information affected the expected liking as well as the purchase intention of food products. Therefore, information related to the product, its ingredients, or related to its production process can change perceptions and may even lead consumers to overcome their prejudgments regarding specific aspects of the product (Pereira et al. 2019). Thus, the following hypothesis can be derived from the theory:

H1: The more information consumers receive about the innovative food product, the better the consumers' product evaluation in terms of (a) affective attitude, (b) cognitive attitude, and (c) behavioural intention.

The impact of information sources and source credibility

In addition to information in general, however, the source of information also plays an important role in consumers' information and decision-making processing (Ronteltap et al. 2007). Thus, when evaluating and making purchasing decisions about products, it is also important that consumers not only understand the information, but also successfully interpret the source of the information so that the information is incorporated into the decision to purchase (Rupprecht et al. 2020). And especially when consumers are unable to verify the information given, a simplistic strategy for

consumers is to decide based on the source of the claim whether or not to trust the claims made (Atkinson and Rosenthal 2014). In this regard, previous research suggests that consumers interpret messages from companies and government agencies or independent consumer organizations differently, with consumers being more likely to believe information when it is issued by a government agency or independent review body than by the manufacturer (e.g., Lirtzman and Shuv-Ami 1986; Ozanne and Vlosky 1997). In addition, independent, neutral researchers and their scientific techniques for reviewing foods, who have no interest in selling products, are described in the literature as an ideal source of food-related information (Rupprecht et al. 2020). Based on these remarks, it is assumed that different sources of information coming from the described fields will lead to different product evaluations, which is why the second hypothesis of this paper is postulated as follows:

H2: Different types of information sources lead to different consumer evaluations in terms of (a) source credibility (i.e., attractiveness, trustworthiness, and expertise) as well as (b) affective attitude, (c) cognitive attitude, and (d) behavioural intention towards the product.

Moreover, certain characteristics of the source can further enhance the effect on consumers' product evaluation. For example, previous studies indicate that a credible source of information can be particularly persuasive for consumers when considering the purchase of a new product. At this stage, consumers, for one thing, have usually not yet formed an opinion about the product in question and can therefore be easily influenced (Isaac and Grayson 2017; Pornpitakpan 2004). On the other hand, the information shared is often information that cannot be verified directly by the consumer through personal experience or information search (Bottega and Freitas 2009). In these

moments of consumer uncertainty, consumers must use simplifying strategies to decide whether to accept the information as truthful. Credibility and trust in the source of information play a crucial role in this process. If consumers perceive the source of information to be credible, they are more likely to accept the information as honest (Atkinson and Rosenthal 2014). And given that the hurdle of consumers incorporating the given information into their purchasing decision can only be overcome if consumers successfully interpret the source of the information, understand the information, and trust it enough, it is especially important to achieve consumer assessment of the information as true (Rupprecht et al. 2020).

Regarding the credibility of the source of the information, this study relies on two models, the Source Credibility Model (Hovland, Janis, and Kelley 1953; Hovland and Weiss 1951; Ohanian 1990) and the Source Attractiveness Model (McGuire 1968, 1985), which make credibility measurable through the main attributes of expertise, trustworthiness, and attractiveness. According to Hovland, Janis, and Kelley (1953), expertise has been defined as the extent to which an information source is perceived to be a source of correct assertions, and trustworthiness refers to the degree of confidence in the information source to communicate the assertions which have been considered to be most valid. In addition to the positive relationship with credibility, research has further shown that sources attributed with expertise and trustworthiness influence both consumers' attitudes and behavioural intentions (e.g., Sternthal, Phillips, and Dholakia 1978; Willemsen, Neijens, and Bronner 2011; Yoon, Kim, and Kim 1998). Following McGuire (1968, 1985), source attractiveness, which refers to similarity, familiarity, and likeability of the source, leads to persuasion through a process of identification, whereby the receiver is motivated to establish an affective relationship with the source and therefore adopts similar attitudes, preferences, or behaviours. In addition, previous

research has shown that people are particularly effective as sources of information when they fulfil these characteristics (e.g., Erdogan 1999; Kamins 1990; Reichelt, Sievert, and Jacob 2014). Therefore, the following hypothesis is derived:

H3: A high (low) consumer perception of the credibility dimensions, leads to a high (low) consumer product evaluation in terms of (a) affective attitude, (b) cognitive attitude, and (c) behavioural intention.

Methodology

Procedure and measures

To test the research hypotheses, two quantitative online studies were conducted both involving an experiment and a survey. Participants were recruited in Germany via selected social network pages and personalized emails requesting active participation in the survey. A smoked ham processed with an innovative smoke flavouring was used as the object of investigation. With respect to the objective of the present research, in study 1 an experiment was designed to evaluate the effects of different information conditions – low, medium and high informational content – considering the innovative food additive. The second study aims to extend the findings of the first study by including different information sources and their perceived credibility. Study 2, therefore, seeks to investigate the extent to which the source of information has an impact on the consumers' evaluation of the innovative food product.

The questionnaires were structured very similarly in both studies. After some introductory questions, including the measurement of the consumption frequency of ham on a 6-point scale from "never" to "several times per week", the respondents were randomly exposed to one of the three conditions of the respective study. Subsequently, affective attitude, cognitive attitude, and behavioural intention were assessed in both

studies, and the three dimensions of credibility (attractiveness, trustworthiness, and expertise) were additionally assessed in study 2. To measure the constructs affective attitude, cognitive attitude, and behavioural intention already existing and tested measures from Wiedmann et al. (2012) were used. All items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and specified to the context of innovative food products. To assess participants' perceptions regarding the dimensions of the source credibility scales developed by Ohanian (1991) were used for the dimensions trustworthiness and expertise. For assessing attractiveness, four items based on the source attractiveness model (McGuire 1985, 1968) were developed. All credibility items were measured on five-point semantic differential scales with bipolar labels (see Table 1). Demographic variables at the end of the survey include participants' gender, age, marital status, educational level, and current occupation.

[Table 1 near here]

To test item reliability and internal consistency of the selected scales factor analysis, including factor loadings and average variance extracted (AVE) and Cronbach's alpha were used. Subsequently, in accordance with the experimental design, one-way analyses of variance (one-way ANOVAs) were utilized to investigate if there were significant differences among the dependent variables in both studies. All statistical analyses were performed using IBM SPSS version 26.0.

Stimulus material

The objective of study 1 was to empirically investigate the impact of different informational content on the evaluation of innovative food products. Therefore, three stimuli were developed, each showing the same ham product, but providing different amounts of information – low, medium and high information – about the innovative

smoke flavouring with which the ham was processed. Participants within the low information level received only the information that the ham has been enriched with an innovative natural flavouring for the characteristic taste of the traditional smoking process, but they were not informed about the origin of the flavouring. In the second condition, the medium information level, participants received the additional information that the innovative flavouring that enriched the ham has been extracted from by-products of food processing. Participants in the third experimental condition, the high information level, also received the previous information, but also further information on the essence of by-products of food processing.

Subsequently, study 2 was designed to analyse the effect of different sources of information and their credibility on consumers' product evaluations. Again, three different stimuli were developed, each showing the same ham product and information from the high information condition, but with different information sources (see Figure 1). The three sources of information used in this study are an in-house product developer, a person from the quality control department of a well-known German consumer organization, and an independent food scientist who holds two titles (professor and doctorate).

[Figure 1 near here]

Results

Study 1

The first study tests for significant differences between the three amounts of information (low, medium and high degrees of information) with regard to affective and cognitive attitude and behavioural intention. In total, 181 valid questionnaires were received. Participants are mainly aged between 18 and 29 years with an average age of

32.1 years. The gender distribution was nearly well balanced with a slight surplus of male participants (female: 42.5%, male: 56.9%). Furthermore, most participants are single (65.7%), have a university degree (53.0%) and/or are current students (48.1%). In addition, only those who regularly (at least once a month) consume ham were included in the analysis. Moreover, preliminary analyses showed that the three sub-samples were homogeneous in terms of ham consumption (F (2,178) = 1.016, p = 0.364), interest in food (F (2,178) = 0.333, p = 0.717), and joy in food shopping (F (2,178) = 0.306, p = 0.737).

First, item reliability (factor loadings and AVE) and internal consistency (Cronbach's alpha) were checked to evaluate the selected items for affective and cognitive attitude and buying intention. The results revealed satisfactory values for all factors with factor loadings ranging from 0.538 to 0.919, the AVE showing a minimum value of 52.795%, and Cronbach's alpha of 0.695 to 0.893. Subsequently, to test for significant differences between the three types information conditions one-way ANOVAs were conducted. As shown in Table 2, the analysis revealed significant differences between the different groups for affective attitude (F (2,178) = 2.599, p < 0.1) and behavioural intention (F (2,178) = 2.425, p < 0.1). Furthermore, Scheffé post hoc tests were run to identify significant differences between the three information conditions. The results indicate significant differences between the low and high information condition for behavioural intention (M_{low} = 2.741 vs M_{high} = 2.351, p < 0.1). In addition to the result regarding the significance of the differences, it is striking that the mean values of all three variables decrease with an increasing amount of information. Consequently, hypotheses H1a-c, which assumed an opposite trend with increasing amount of information, are not supported based on the results.

[Table 2 near here]

Study 2

The purpose of study 2 was to analyse the effect of different sources of information and their credibility on consumers' product evaluations. Therefore, the text with the high informational content was combined with three different information sources. To test the manipulation of the credibility of the information sources used in the experiment, a one-way ANOVA with the grouping variable (different information sources) as the independent variable and a global item that measures credibility on a nine-point scale as the dependent variable was performed. The result indicated that the different information sources evoked significantly different levels in terms of credibility (F (2,158) = 3.621, $p < 0.05$).

In total, 161 respondents participated in the study. The participants ages ranged from 17 to 85 years, with an average age of 29.8 years and the gender distribution was well balanced (female: 51.6%, male: 47.2%). Furthermore, most participants are single (80.7%), have a university degree (46.6%) and/or are current students (55.9%). Again, participants who do not consume ham on a regular basis (at least once a month) were removed from the data set, as they are not the target group of this research. In addition, preliminary analyses showed that the three sub-samples were, again, homogeneous in terms of ham consumption (F (2,158) = 0.667, p = 0.621), interest in food (F (2,158) = 0.405, p = 0.668), and joy in food shopping (F (2,158) = 0.359, p = 0.699).

The first step in this study was also to check the item reliability and internal consistency to evaluate the selected items for the three credibility dimensions (attractiveness, trustworthiness, and expertise), affective and cognitive attitude, and buying intention. The results revealed satisfactory values for all factors. The factor loadings were found to be medium (> 0.5) to high (> 0.8), with values from 0.495 to 0.915. Furthermore, the AVE with a minimum value of 55.432% for affective attitude

also shows satisfactory results for all factors. Finally, Cronbach's alpha as an indicator for internal consistency showing values from 0.708 to 0.915, indicates reliability for all factors. In the second step, one-way ANOVAs were conducted to explore the effects of the different information sources on the three credibility dimensions (attractiveness, trustworthiness, and expertise), affective and cognitive attitude, and buying intention. The analysis revealed significant differences between the groups for attractiveness, trustworthiness, expertise, and cognitive attitude (see Table 3). In detail, the source of information has a significant impact on attractiveness (F (2,158) = 2.747, $p < 0.1$), trustworthiness (F (2,158) = 4.540, $p < 0.05$), expertise (F (2,158) = 3.255, $p < 0.05$), and cognitive attitude (2,158) = 3.116, $p < 0.05$). The results of the Scheffé post hoc tests showed significant differences between the consumer organisation and the in-house product developer for attractiveness ($M_{\text{organisation}} = 2.750$ vs $M_{\text{developer}} = 2.391$, $p < 0.1$) and trustworthiness ($M_{\text{organisation}} = 3.056$ vs $M_{\text{developer}} = 2.529$, $p < 0.05$). Furthermore, participants receiving the information from the food scientist rated the trustworthiness significantly higher than those receiving the information from the in-house product developer ($M_{\text{scientist}} = 2.942$ vs $M_{\text{developer}} = 2.529$, $p < 0.1$). The same applied for expertise ($M_{\text{scientist}} = 3.330$ vs $M_{\text{developer}} = 2.865$, $p < 0.05$) and cognitive attitude ($M_{\text{scientist}} = 2.696$ vs $M_{\text{developer}} = 2.385$, $p < 0.1$). The mean values also show that the evaluation is the lowest for all variables for the "product developer" group and that the "independent consumer organization" group has the highest evaluation for most variables (except expertise and cognitive attitude). As a result, hypotheses H2a and H2c received full empirical support and hypotheses H2b and H2d were not supported.

[Table 3 near here]

In a subsequent step, the effect of source credibility on attitude and behavioural intention was analysed. For this purpose, the participants were first divided into groups

with regard to their evaluation (high vs low) of the three dimensions of credibility of the information sources and finally one-way ANOVAs were conducted to analyse the effect of source credibility on the product evaluation. As shown in Table 4, a high perception of attractiveness, trustworthiness, and expertise leads to highly significant ($p < 0.01$) higher ratings for all three dependent variables (affective attitude, cognitive attitude, and behavioural intention). Consequently, hypotheses H3a-c received full empirical results.

[Table 4 near here]

Discussion

Key findings

The two presented studies examined the effect of different amounts of information and different information sources and their credibility on consumers' credibility perception and product evaluations. Study 1, which focused on the differences between consumers' product evaluations with regard to the three types of information conditions, showed significant differences for affective attitude and behavioural intention, but the effects on consumers' evaluations (i.e., the mean values) were contrary to the hypothesized effect. Thus, consumers' product evaluations were found to decrease with increasing informational content. So in this context, more is not necessarily more. One possible explanation for this effect, are the by-products used as explanation in the stimulus, which are still quite unknown in Germany. By mentioning the by-products as origin of the innovative flavouring probably caused confusion rather than understanding; and understanding is, in turn, an important aspect when it comes to the acceptance of novel and/or unfamiliar food products (Deliza, Rosenthal, and Silva 2003). This is also consistent with the results of the study by Scholderer and Frewer (2003), which looked at technology-driven information strategies and showed that more detailed information

can activate pre-experimental attitudes in consumers, which, if negative, can contribute to reduced product evaluations.

However, since the source of information also plays an important role in the perception of information and subsequent product evaluation, a further study that included an information source next to the informational text was performed. The results show significant differences for the three dimensions of credibility (attractiveness, trustworthiness, and expertise) as well as for cognitive attitude. Compared to the two more independent information sources, the in-house product developer in particular achieves significantly lower values for the dimensions of credibility and with regard to consumers' product evaluation. In the final analysis, the effect of source credibility on attitude and behavioural intention, it was found that high credibility also leads to better product evaluation by consumers. Consistent with this, Atkinson and Rosenthal (2014) found that corporate-sourced labels are less credible to consumers compared to government ones. Especially for ingestible products that affect personal health and safety, the source of information plays an important role and because producers and retailers may have interests that compete with ensuring product safety, consumers are sometimes suspicious of corporate-sourced information. In addition, Rupprecht et al. (2020) showed in their cross-national study that independent scientific experts who ensure the safety and quality of food were rated as highly trustworthy and credible across all countries investigated. In terms of the descriptive statistics, however, it should also be noted that the results with regard to product evaluations were only in a neutral value range, regardless of the source of information and even with high perceived source credibility. This could again be due to the by-products of food processing, which are quite unknown in Germany so far and which are mentioned in the information text. Therefore, when communicating with consumers, it

should always be checked in advance that the information is understandable and that no new questions arise because of the given information. Such an improved communication between industry and consumer can increase the acceptance of different food technologies and methods of processing (e.g., the addition of a flavouring) of a food product (Pereira et al. 2019).

Practical implications

This study provides some valuable insights for marketing managers regarding communication strategies for innovative food products. First, as the product evaluations decreased with increasing informational content and were rather moderate for the different information sources, it can be assumed that simply providing the public with information will not lead to acceptance of the technology-based food innovation. To avoid creating scepticism among consumers, the information provided must focus on the uncertainties and what is not known of an innovative technology as much as on the benefits and what is known (Frewer 2003; Scholderer and Frewer 2003). In this context, information dissemination should be driven, not only by science and by technology, but also compellingly by public needs to increase consumer acceptance of new technologies and innovative foods, because it is not enough to simply provide more information to consumers and hope for more acceptance and better product evaluations. Second, the communication strategy should not be equated with education, i.e. a one-way process from expert to layperson, focusing mostly on the benefits of the innovation selected by experts rather than on the actual concerns of laypersons. Rather, the communication strategy must be understood as an iterative, two-way process that proactively engages the public and makes it possible to understand what information is actually relevant to the public (Scholderer and Frewer 2003). Third, the information sources in this study were perceived differently regarding their credibility and the source credibility in turn

had a significant impact on the consumers' product evaluations. Thus, marketing managers need to employ credible sources when designing informational campaigns and/or provide information on the product itself to maximize the effects of the information source on the product evaluation. Numerous studies have shown that scientific experts are perceived as credible sources who could therefore play an important role in the increasingly complex global food system (e.g., Lang and Hallman 2005; Rupprecht et al. 2020). Fourth, the communication strategy for innovations must also take into account contextual effects. For example, attention should be paid to which topics are currently attracting particular public attention and whether or to what extent these are connected with the innovation and therefore need to be taken into account. Another contextual effect in this context would be the degree of innovation, because incremental innovations, which tend to be congruent with consumers' previous perceptions, differ from radical innovations, which are often incongruent with consumers' previous mental representations (Nijssen, Reinders, and Banovic 2021). And lastly, also product-related factors (e.g., perceived familiarity and expected health) and personal factors of the target group (e.g., food neophobia and health interest) must be taken into account in the strategy development.

Limitations and future research

Several limitations of the present study offer interesting possibilities for future research. First, the study used only included one product, a smoked ham, as the specific product studied. Alternative product examples, in which, for example, additives such as flavourings are also used in conventional processing and/or which, due to the flavouring, bring a higher consumer benefit, e.g. in terms of sustainability or health, could lead to different results with regard to the evaluation of different amounts of information and information sources. Therefore, it might be insightful to examine the

effects analysed in this study also for other food products. Similar arguments apply to the selection of information examples for the present study. Other informational content, as well as other approaches to providing the information, could have a stronger impact on attitudes and product evaluations. Hence, subsequent studies may analyse the effectiveness of further combinations of informational content. In this particular case, the risk associated with smoking in conventional ham production could be reduced to a minimum by adding the natural smoke flavouring instead. This would be an advantage of the innovative product that could be communicated, for example. However, it should be considered whether this is actually relevant for the consumers in connection with the product in question. Therefore, the actual needs of the public could first be determined in a further study, in order to then include corresponding information in the communication strategy and test its effectiveness. When investigating consumer information processing, dual-process theories of social cognition can also be included, which typically distinguish implicit (unconscious, fast, and automatic) information processes from explicit (conscious, slow, and deliberate) information processes (e.g., Evans 2008), to explain consumer reasoning and behaviour. Consequently, in addition to explicit self-report measures, future studies could also incorporate implicit measures to capture the consumers' unconscious information processes (e.g., response latency measure) to gain an even better understanding of the processing of different informational content. Finally, the data analysis was limited to group comparisons using one-way ANOVAs. To examine the effect of source credibility on product evaluation, the application of other statistical analysis methods (e.g. structural equation modelling to investigate causal relationships between the dimensions of source credibility and product evaluation) may provide further interesting results.

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Table 1. Measures.

Factor	**Items**
Attractiveness	dissimilar / similar, unfamiliar / familiar, unlikable / likable, unpleasant / pleasant
Trustworthiness	unreliable / reliable, dishonest / honest, insincere / sincere, not trustworthy / trustworthy
Expertise	not an expert / expert, inexperienced / experienced, unknowledgeable / knowledgeable, unqualified / qualified
Affective attitude	The product suits me completely. The product is very likeable. The product is very distinctive. I find the product very pleasant.
Cognitive attitude	I am very satisfied with the product. The product meets my expectations. In my opinion, the quality of the product is very high. The product keeps to its promise.
Behavioural intention	I intend to buy the product in the future. It is very likely that I will use the product in the future. I would prefer this product to a comparable product. I would recommend the product to my friends.

Table 2. Results of the one-way ANOVAs testing the effects of the different information conditions (low, medium, high) on food product evaluation (attitude and behavioural intention) (study 1).

	Means (SD)				
Dependent variables	**Low (*n* = 64)**	**Medium (*n* = 60)**	**High (*n* = 57)**	***F***	***p***
Affective attitude	2.766 (0.771)	2.713 (0.823)	2.465 (0.690)	2.599	0.077
Cognitive attitude	2.688 (0.803)	2.554 (0.728)	2.465 (0.730)	1.336	0.266
Behavioural intention	2.741 (1.004)[a]	2.621 (0.913)	2.351 (1.046)[a]	2.425	0.091

Notes: Same letters (a) indicate significantly different means for that dependent variable based on Scheffé post hoc tests. For behavioural intention, the differences are significant at the $p < 0.1$ level (a: $p = 0.099$).

Table 3. Results of the one-way ANOVAs testing the effects of different sources of information (consumer organization, product developer, food scientist) on perceived credibility (attractiveness, trustworthiness, expertise) and food product evaluation (attitude and behavioural intention) (study 2).

	Means (SD)				
Dependent variables	**Consumer organization (*n* = 54)**	**Product developer (*n* = 52)**	**Food scientist (n = 55)**	***F***	***p***
Attractiveness	2.750 (0.887)[a]	2.391 (0.745)[a]	2.639 (0.777)	2.747	0.067
Trustworthiness	3.056 (1.007)[b]	2.529 (0.923)[b, c]	2.942 (0.903)[c]	4.540	0.012
Expertise	3.074 (1.000)	2.865 (0.994)[d]	3.330 (0.834)[d]	3.255	0.041
Affective attitude	2.333 (0.710)	2.120 (0.750)	2.241 (0.571)	1.307	0.274
Cognitive attitude	2.486 (0.675)	2.385 (0.708)[e]	2.696 (0.591)[e]	3.116	0.047
Behavioural intention	2.208 (0.934)	2.005 (0.940)	2.114 (0.668)	0.752	0.473

Notes: Same letters (a, b, c, d, e) indicate significantly different means for that dependent variable based on Scheffé post hoc tests. The differences are significant at the $p < 0.05$ level (b: $p = 0.018$; d: $p = 0.048$) and at the $p < 0.1$ level (a: $p = 0.075$; c: $p = 0.081$; e: $p = 0.054$).

Table 3. Results of the one-way ANOVAs testing the effects of perceived source credibility (low vs. high perception of attractiveness, trustworthiness, and expertise) on food product evaluation (attitude and behavioural intention) (study 2).

	Means (SD)			
Dependent variables	**Attractiveness low**	**Attractiveness high**	***F***	***p***
Affective attitude	1.956 (0.573)	2.500 (0.674)	30.401	0.000
Cognitive attitude	2.231 (0.611)	2.808 (0.596)	36.786	0.000
Behavioural intention	1.858 (0.774)	2.354 (0.860)	14.771	0.000
	Trustworthiness low	**Trustworthiness high**	***F***	***p***
Affective attitude	1.965 (0.555)	2.485 (0.696)	27.296	0.000
Cognitive attitude	2.186 (0.550)	2.843 (0.611)	51.282	0.000
Behavioural intention	1.760 (0.738)	2.440 (0.826)	30.217	0.000
	Expertise low	**Expertise high**	***F***	***p***
Affective attitude	2.050 (0.625)	2.357 (0.693)	8.212	0.005
Cognitive attitude	2.189 (0.571)	2.753 (0.633)	33.275	0.000
Behavioural intention	1.858 (0.820)	2.281 (0.837)	10.094	0.002

Figure 1. Experimental stimulus used in the study 2.

A4:

When More Information Means Less Consumer Acceptance of Innovative Food Technologies

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When More Information Means Less Consumer Acceptance of Innovative Food Technologies

Many technological food innovations that offer desirable added value tend to be rejected by consumers. This study investigates explicit and implicit consumer acceptance and the role that information about innovative food products plays in consumer decision making. The results show that both explicit and implicit processes influence consumer acceptance.

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Every period has social trends – currently, for example, sustainability and self-optimization (e.g., IBM, 2020; Mintel, 2021) – which also influence individual eating behaviors and thus the product development and marketing of the food industry. After decades of high demand for ready-to-eat and long-shelf-life products, which are often processed with various food additives with a technological or sensory function, demand has been changing to more natural and less processed products (Euromonitor International, 2019). To meet the resulting challenges, the food industry, like any industry, must regularly reinvent itself and develop new innovations (Aschemann-Witzel, Varela, & Peschel, 2019). Although innovations usually offer strong and obvious benefits for consumers, as well as further progress for society, the rate of novel food products that are rejected by consumers when launched on the market is very high (approximately 80%) (Aqueveque, 2015).

Specifically, many consumers are skeptical of products with food additives because they are generally perceived as unnatural or unhealthy, even though additives play an important role in the food industry and their safety is extensively tested (Bearth, Cousin, & Siegrist, 2014). In this context, studies have shown that information about a product plays a fundamental role in consumer perception and has a significant impact on the product evaluations of consumers (e.g., Lee, Lusk, Mirosa, & Oey, 2016; Pereira, Honorio, Gasparetto, Lopes, Lime, & Tribst, 2019). Moreover, acceptance also tends to be greater when consumers understand what they are consuming, especially if they are not very familiar with the product (Deliza, Rosenthal, & Silva, 2003). In the food sector, in particular, consumers react to a greater extent with mistrust or even rejection of technological innovations, often due to a lack of knowledge about such innovations (Siegrist & Hartmann, 2020).

Against this background, the present work aims to investigate consumer acceptance of innovative food additives in processed foods. An empirical study experimentally tests how different levels of information to increase consumer product knowledge affect consumer acceptance of innovative food additives for the purpose of better understanding consumer decision making.

Theoretical Conceptual Background

Risk and Benefit Perception as Drivers of Consumer Acceptance

Various aspects of consumer acceptance of new (food) technologies have been identified and discussed intensively in the existing literature (e.g., Connor & Siegrist, 2010; Frewer et al., 2011). Among the most frequently studied drivers of consumer acceptance of different food technologies, perceptions of risk and benefit are considered particularly relevant (Bearth & Siegrist, 2016). In this respect, the perceptions of experts and laypeople of risk and benefit in relation to food technologies often do not match; this can have potentially negative consequences for technology implementation due to an overlooked or misunderstood acceptance gap (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). Scientific experts dealing with food safety issues generally welcome the use of innovative food technologies due to the advantages that these innovations fundamentally offer (Bearth

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& Siegrist, 2016). Based on their many years of qualified experience, these experts have increased their explicit knowledge and can therefore reflect on and evaluate innovations in detail. In comparison, laypeople rely mainly on their implicit and less explicit knowledge and use mental shortcuts (heuristics) when making evaluations, especially under uncertain conditions when they have little or no knowledge about a product, e.g., a food innovation (e.g., Kahneman & Tversky, 1979). Evidence-based marketing communications must take into account the different levels of knowledge so that society in general, and consumers in particular, can benefit from the advantages of innovative technologies and not automatically reject them. For this reason, this study examines both the explicit and implicit information processing involved in consumer acceptance.

According to Bearth and Siegrist (2016), acceptance is composed of two facets: active components and passive components. They postulate that asking consumers about their active and passive acceptance is likely to elicit different cognitive and behavioral decision-making processes. Therefore, the present study incorporates both acceptance facets. The passive component is defined here as consumer attitude (see Bohner & Dickel, 2011 for a detailed discussion about attitude) toward the product as a result of perceived risk and benefit, which in turn determines the general acceptance of the product (Ronteltap, van Trijp, Renes, & Frewer, 2007). This more passive general acceptance, in turn, influences the subsequent active component of acceptance – the willingness to buy (Rogers, 2010) – understood here as a positive product choice concerning the food innovation.

Impact of Information on Consumer Product Perception

Various aspects play a decisive role in consumers' product expectations prior to consumption. In this context, inherent cues that physically belong to the product, such as sensory properties, are often mentioned (Cardello, 2003). However, extrinsic cues, which are nonphysical elements associated with the product, such as price, origin and food safety, also influence consumer decision making to a substantial extent (Napolitano, Braghieri, Piasentier, Favotto, Naspetti, & Zanoli, 2010). In the recent past, consumer interest in non-sensory food attributes has increased, especially in terms of manufacturing methods (Deliza et al., 2003; FAO, 2015). Thus, consumers' information processing of product attributes can be significantly influenced not only by information about the product itself (e.g., quality) but also about the manufacturing process (Deliza et al., 2003; Napolitano et al., 2010). Several studies have been able to show how targeted information influences consumers' evaluation of food, such as the effect of revealing the origin of food additives, which changed consumer attitudes toward these additives (Caporale & Monteleone, 2004). In fact, information related to a product, its ingredients or the manufacturing process can influence perceptions in such a way that consumers change their prejudicial opinions about certain aspects of the product and thus view it in a more positive light with an increased level of acceptance (Pereira et al., 2019).

Management Summary

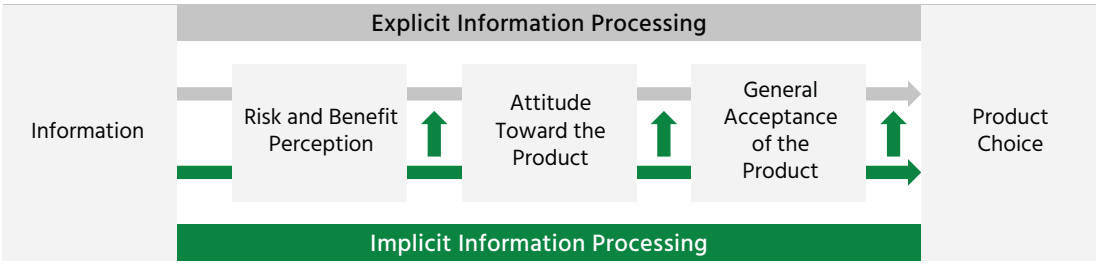
New measures to capture implicit and explicit information processing with respect to food acceptance were conceptually developed and successfully tested. The results show that both explicit and implicit processes influence consumer acceptance. Given the predictive power of the combined implicit–explicit method, marketing managers of food brands can use the presented approach to assess consumer acceptance of (innovative) food products.

Conceptual Framework

A prerequisite for promoting the acceptance of innovative food technologies is, first, knowledge of consumer perceptions and, more importantly, an understanding of the influence of these perceptions on consumer acceptance of an innovative food technology at an implicit and explicit information processing level. Based on the above discussions and a critical literature review, the conceptual model shown in figure 1 was used to investigate consumers' acceptance of innovative food additives in processed foods.

To date, little research has involved dual-process theories of social cognition, which typically distinguish implicit (unconscious, fast, and automatic) information processes from explicit (conscious, slow, and deliberate) information processes (e.g., Evans, 2008), to explain consumer reasoning and behavior regarding innovative foods. Therefore, the present study focuses specifically on capturing (dual) implicit–explicit processes to understand consumer decision making more holistically (see Chaiken & Trope,

Fig. 1: Conceptual Framework of Explicit and Implicit Consumer Acceptance



Source: Own illustration.

1999 for a detailed discussion of dual processes). Here, consumer acceptance of a (food) innovation, which drives product choice, is the consequence of activated attitudes toward the innovation, which in turn are influenced by the perceived risk and benefit level of the corresponding innovation. Perceived risk and perceived benefit are in turn influenced by the level of information that determines the consumers' knowledge about the innovation, i.e., what they have learned or experienced. Learning itself is a process that takes place at an implicit and explicit level of information processing (see Ellis, 2009 for a detailed discussion).

Methodology

Study Design and Material

With respect to the objective of the present study, an experiment was designed to evaluate the effects of different information conditions – low, medium and high degrees of information – considering the food additive used. A smoked ham processed with a natural smoke flavoring was used as the object of investigation. Participants were randomly assigned to one of three conditions and received the respective information, including a picture of smoked ham, as illustrated in figure 2.

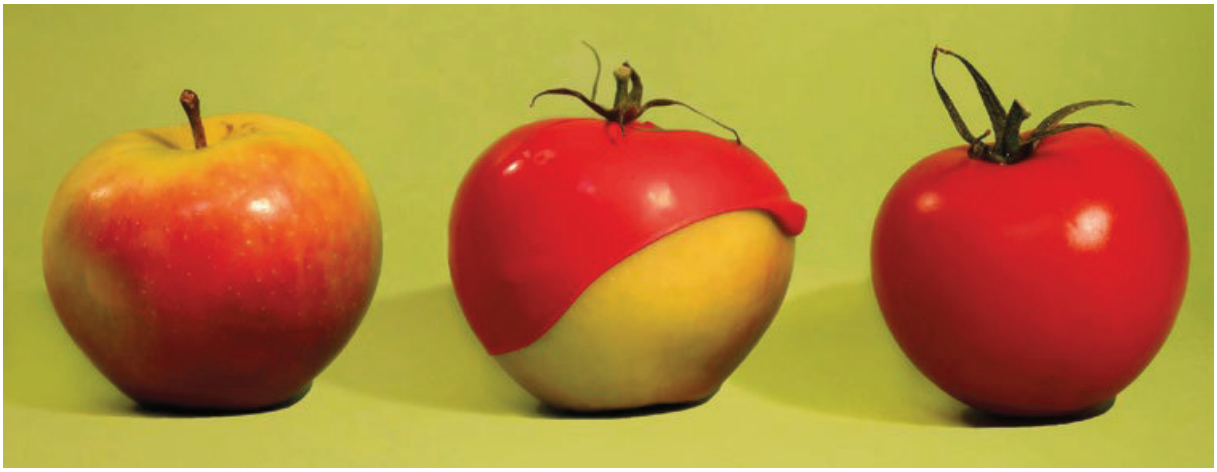
Measures and Data Analysis

The assessment of the participants' product-related risk and benefit perceptions as well as their attitudes toward and acceptance of the product was conducted on an explicit and implicit information processing level. Specifically, an explicit self-report measure was used to capture an analytic-deliberative product assessment on a five-point Likert scale (1=strongly disagree to 5=strongly agree). Additionally, a response latency measure (BrandReact by eye square, 2020) was

Fig. 2: Experimental Stimuli for Each Condition

Low Information Condition	Medium Information Condition	High Information Condition
This ham has been enriched with natural flavorings for the characteristic taste of the traditional smoking process.	This ham has been enriched with natural flavorings extracted from the byproducts of food processing for the characteristic taste of the traditional smoking process.	This ham has been enriched with natural flavorings extracted from the byproducts of food processing* for the characteristic taste of the traditional smoking process.
		
		* The byproducts of food processing are substances that are not used in the food processing process but are still suitable for further processing.

Source: Own illustration.



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used as a qualified implicit measure of the consumers' spontaneous product assessment. This implicit measure is similar to the response latency approach used to capture human associative learning processes, as discussed by Craddock, Molet, and Miller (2012). The basic principle of this implicit technique is that participants are forced to decide whether a certain adjective fits a product (or brand) or not. For each adjective, two response indicators are recorded, namely the agreement rate ("yes" vs. "no" categorization) and the reaction time. Based on these response indicators, a single implicit score is calculated for each adjective, ranging from 0 (no spontaneous association) to 100 (very high spontaneous association). The items (adjectives) for the explicit and implicit assessment of risk (risky, dangerous), benefit (valuable, beneficial), attitude (great, good), and acceptance (commendatory, appreciatory) were developed as new scales, following the guidelines of Diamantopoulos and Winklhofer (2001) to ensure content specification, indicator specification, indicator collinearity, and external validity. To test the external (here: convergent) validity of these measures, corresponding global items were used to measure participants' overall perceptions on a seven-point scale (risk and benefit) or an eleven-point scale (attitude and acceptance). External validity is given if the implicit and explicit measure correlates with the corresponding global measure.

Regarding product choice as a behavioral response indicator influenced by explicit and implicit information processing, a choice measure was used in which participants could choose among three product options with different specifications: regular smoked ham, smoked ham enriched with natural flavorings, or smoked ham enriched with natural flavorings derived from food processing byproducts. If participants chose the same smoked ham product that had been presented to them in advance (low information condition: choice of smoked ham enriched with natural flavorings; medium or high information condition: choice of smoked ham enriched with natural flavorings derived from food processing byproducts), then this was rated as a positive product choice, and vice versa.

Main Propositions

1. Perceived risk, in contrast to perceived benefit, is a less critical factor for a positive customer decision.
2. Except for explicit risk, all other variables exhibit at least an indirect effect on product choice.
3. Significant differences of the exposed information level are identified for implicit benefit and implicit acceptance.
4. Contrary to findings of previous research, a negative impact of presenting more information is revealed.

Table 1: Coefficient of Determination (R-Squared Value) and Average Simulated Direct Effect

IV** ↓ / DV** →	Implicit Attitude (R^2 = 0.44)	Implicit Acceptance (R^2 = 0.50)	Explicit Risk (R^2 = 0.23)	Explicit Benefit (R^2 = 0.28)	Explicit Attitude (R^2 = 0.56)	Explicit Acceptance (R^2 = 0.65)	Product Choice (R^2 = 0.42)
Implicit Risk	-0.14*	-0.01	0.52*				-0.11
Implicit Benefit	0.69*	0.34*		0.56*			0.06*
Implicit Attitude		0.25*			0.35*		-0.04
Implicit Acceptance						0.09*	0.22
Explicit Risk					0.04	-0.07	-0.47
Explicit Benefit					0.31*	0.49*	-0.20
Explicit Attitude						0.23*	0.07*
Explicit Acceptance							0.31*

* significant average simulated direct effect (significance level of $p < 0.10$)
** IV= independent (explaining) variable, DV = dependent (explained) variable

Source: Own illustration.

Sample and Procedure

Participants from across Germany were recruited using opportunity sampling. Invitation links for active participation in the online survey were distributed on selected social networks and via e-mail. Participants were randomly assigned to one of the three experimental conditions. After participants had answered questions about their general food consumption behavior, the respective information about the food additive with which the ham was processed was shown. Next, subjects had to perform the implicit measurement test and then the explicit measurement test to evaluate their product associations. Finally, participants were asked to identify their preferred processing option for the ham product.

A total of 304 completed questionnaires from participants who regularly consume ham products was used for the further data analyses (females = 46.1%, males = 52.6%, no gender answer = 1.3%; average age: 31.98 years; low information level: n = 110, medium information level: n = 96, and high information level: n = 98).

Results

Empirical Findings

All explicit and implicit multi-item measures reached satisfactory values in terms of item reliability, namely, factor loading (value range: 0.829 to 0.934) and average variance extracted (value range: 75% to 89%), and internal consistency, namely, Cronbach's alpha (value range: 0.663 to 0.872) and composite reliability (value range: 0.920 to 0.986). Additionally, the results indicate both convergent (value range of Spearman's rank correlation: 0.272 to 0.679) and discriminant validity (value range of Spearman's rank correlation: 0.431 to 0.610), suggesting that the corresponding implicit and explicit measures refer to related but different facets of the respective construct, which is in accordance with implicit cognition research (Nosek & Smyth, 2007). Overall, the results suggest that the quality of the newly developed implicit–explicit measurement instrument is adequate.

Against the background of the conceptual model, the estimated model parameters show a satisfactory level of predictive performance of the applied universal structure modeling approach (Buckler & Hennig-Thurau, 2008; Turkyilmaz, Oztekin, Zaim, & Demirel, 2013) when using the causal analytics software Neusrel (2020). In particular, the explanatory power with respect to the coefficient of determination

> Sometimes "less is more": i.e., less information may lead to better product evaluations and to higher product acceptance, depending on the information context.

(R-squared value) for the difficult-to-estimate product choice (intention), calculated as a 0/1 binary variable, reaches a remarkable level of 0.42. In contrast, an alternative partial least squares (PLS) approach revealed an R-squared value of .08 for the product choice estimate, indicating no explanatory power.

Product choice is directly affected by the implicit benefit, explicit attitude and explicit acceptance, as shown in Table 1. However, except for explicit risk, all other variables exhibit an indirect effect via explicit acceptance. The highest total effect on product choice, as measured by the overall explained absolute deviation (OEAD), is indicated for implicit benefit (OEAD: 0.23) and explicit benefit (OEAD: 0.21), both showing a medium effect size with an OEAD considerably above 0.15. The other significant variables show a small-to-medium effect, with an OEAD ranging from 0.02 to slightly above 0.15 (implicit risk: 0.13, implicit attitude: 0.13, implicit acceptance: 0.14, explicit acceptance: 0.17).

Considering potential differences in the information processing among the three experimental groups, one-way ANOVA showed significant group differences for implicit benefit ($F = 4.108$, $p < 0.05$) and implicit acceptance ($F = 5.412$, $p < 0.01$), while no differences were identified at the explicit level. Based on a subsequent Wilcoxon rank-sum test, a medium effect size difference with an r value above 0.30 was observed between the low and medium information conditions ($\Delta M = 3.709$, $p = 0.001$, $r = 0.317$) and between the low and high information conditions ($\Delta M = 8.928$, $p = 0.001$, $r = 0.381$) regarding the perceived implicit benefit, with a higher value for the low condition. In contrast, no substantial difference between the medium and high information conditions was identified ($\Delta M = 5.219$, $p = 0.371$, $r = 0.064$). With reference to implicit acceptance, a medium effect size difference was revealed between the low and medium ($\Delta M = 7.302$, $p = 0.001$, $r = 0.387$) and between the low and high information conditions ($\Delta M = 10.135$, $p = 0.001$, $r = 0.417$), again with higher acceptance values for the low information condition and no observable difference between the medium and high conditions ($\Delta M = 2.833$, $p = 0.994$, $r = 0.01$).

In terms of product choice as the key indicator of a positive behavioral response, the low information condition group shows a preference value of 13.64%, almost twice as high as that of the medium information condition group with 7.29% ($\Delta M = 6.344$, $p = 0.001$, $r = 0.291$) and the high condition group with 8.16% ($\Delta M = 5.473$, $p = 0.001$, $r = 0.248$), which corresponds to a small-to-medium effect size.

Lessons Learned

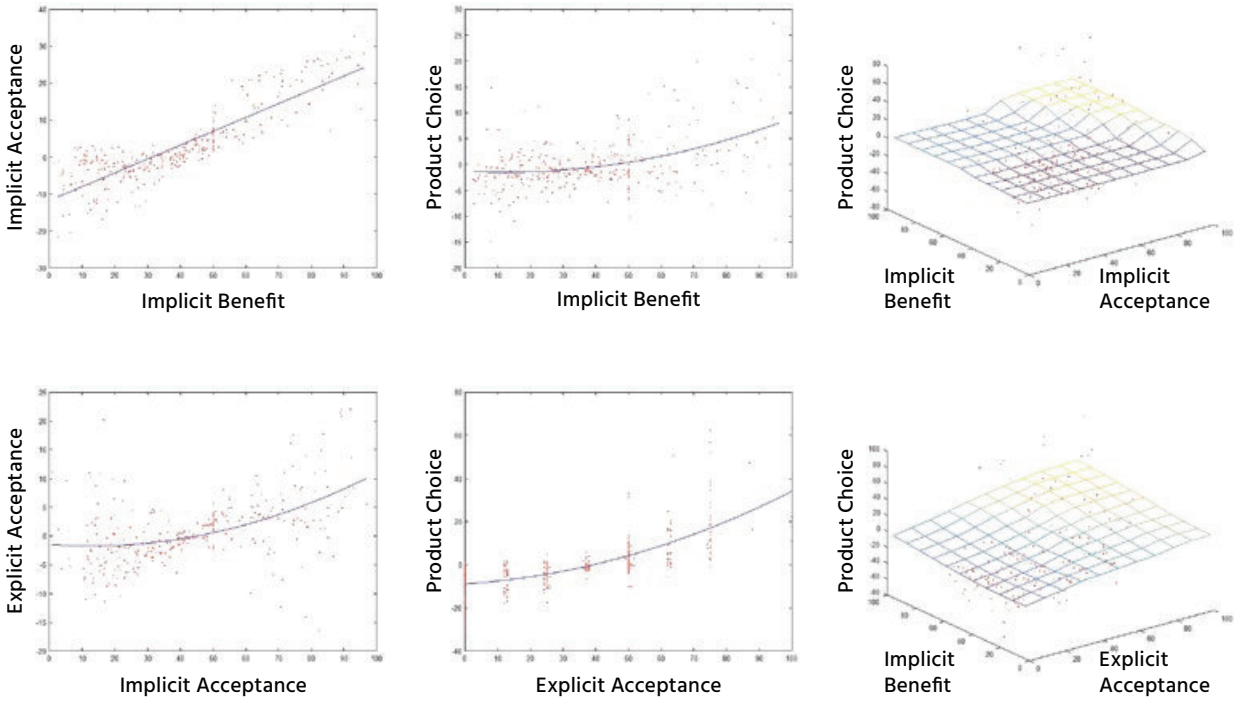
1. Marketing managers can use the implicit–explicit approach to identify essential prerequisites to avoid limited consumer understanding that might otherwise lead to consumer rejection of innovative food products.
2. The knowledge of this prerequisite also enables the development of targeted communication strategies aimed at educating the public to increase the societal acceptance of innovative food technologies.
3. Regarding different information levels, sometimes "less is more"; i.e., less information may lead to better product evaluations and to higher product acceptance, depending on the information context.

Discussion

The results of the experimental investigation show a significant effect of the level of information on the implicit benefit perception and the implicit acceptance but not on the other implicit and explicit measures. In contrast to the results of previous studies (e.g., Lee et al., 2016; Pereira et al., 2019), the present study reveals a negative impact of providing more information on consumers' product assessment. In the low information condition, the product was assessed highest in terms of implicit benefits and implicit acceptance, while in the medium and high information conditions the products were evaluated similarly but significantly less positively. A possible explanation for this effect may be the mentioning of byproducts, the applications of which are still quite unknown in Germany. Presumably, the naming of byproducts as the origin of flavor in the stimulus led to confusion rather than a better understanding among the participants, with the latter being a critical aspect in regard to the acceptance of novel foods (Deliza et al., 2003). Thus, future research should examine this aspect more carefully and in more detail.

Figure 3 provides further insights into selected direct effect pathways and interaction effects to better understand the mechanism behind the analyzed decision-making processes. Several nonlinear relationships with increasing effects are observed, e.g., higher values of implicit benefit are associated with significantly higher product choice intention. Similar effects can be observed

Fig. 3: Selected Direct Effect Pathways and Interaction Effects



Source: Own illustration.

for the influence of implicit acceptance on explicit acceptance and of explicit acceptance on product choice. Additionally, implicit benefit shows interaction effects with both acceptance dimensions with regard to product choice. Concretely, product choice intention is significantly greater when implicit benefit, explicit acceptance and implicit acceptance reach high levels. These findings stress the relevance of ensuring spontaneous (i.e., implicit) strong association activation regarding the perceived benefit for positive customer decision making in the context of innovative food products. At the same time, the results of the present study provide empirical evidence that perceived risk, as a counterpart of perceived benefit, is a less critical factor for a positive customer decision with reference to the byproducts of innovative food processing, both on an implicit and explicit information processing level.

Conclusion

The present work provides valuable contributions and significant insights for science and business practice. First and foremost, new measures to capture implicit and explicit information processing with respect to food acceptance were conceptually developed and successfully tested. From a scientific point of view, a conceptual model was derived and presented that emphasizes the existence of two information processing pathways, an explicit and an implicit pathway, when consumers come into contact with information about (innovative food) products. The model provides an initial frame of reference to further investigate explicit and implicit information processing related to (food) consumption in future research.

Given the predictive power and practicality of the combined implicit–explicit method, food brand marketing managers can use the presented approach to assess consumer acceptance of food, in general, and of food processed with innovative technologies, in particular, to ensure an evidence-based management foundation. Capturing the perceived implicit benefits of a food product seems to be an essential prerequisite to avoid a limited consumer understanding that could otherwise lead to, for example, the over- or underestimati-

on of both the opportunities and threats of the development and launch of a product. Knowledge of this prerequisite also enables policy makers to develop communication strategies and materials aimed at educating the public, thereby indirectly increasing the overall societal acceptance of innovative food technologies by addressing this predictive factor. Additionally, the findings regarding different information levels in the sense of "less is more" (i.e., less information may lead to a better product evaluation and thus to higher product acceptance) should be taken into account.

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Evidence of co-authorship and definition of responsibilities

The presented research articles were jointly developed by co-authors. All content is completely based on collective and collaborative elaboration, whereby the following responsibilities were defined within the respective modules:

Module 1: Development and validation of an integrated framework of the consumer acceptance process

Responsibilities of *"The impact of innovation-related perception on consumer acceptance of food innovations - development of an integrated framework of the consumer acceptance process"*: Levke Walten: Literature review, material and methods, results, discussion; Klaus-Peter Wiedmann: Supervision; Steffen Schmidt: Introduction.

Responsibilities of *"Turning Waste into Smoky Taste: Identifying Consumer Acceptance Drivers of an Innovative Food Flavoring"*: Levke Walten: Introduction, literature review, methodology, results, discussion, conclusion; Klaus-Peter Wiedmann: Supervision.

Module 2: Investigation of explicit and implicit effects of different communication approaches on acceptance-related indicators

Responsibilities of *"How product information and source credibility affect consumer attitudes and intentions towards innovative food products"*: Levke Walten: Introduction, theoretical background, methodology, results, discussion; Klaus-Peter Wiedmann: Supervision.

Responsibilities of *"When More Information Means Less Consumer Acceptance of Innovative Food Technologies"*: Levke Walten: Introduction, theoretical conceptual background, conceptual framework, methodology, results; Klaus-Peter Wiedmann: Supervision; Steffen Schmidt: Discussion, conclusion.

Further publications

Wiedmann, K.-P., & **Walten, L.** (2020). Consumers' Perception of Product Information and its Effect on Product Evaluation and Behavioral Intention. Paper presented at the *2020 Academy of Marketing Science (AMS) Annual (Virtual) Conference*, December 14-19, 2020.

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