Consumers & Plant Genomics

The positioning and acceptance of a new plant breeding practice

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Timon van den Heuvel

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Abstract

Innovative developments in technology, such as the emergence of genomics as a plant breeding practice, hold the potential to change the supply side of the market. The success of these practices not only depends on the improved efficiency and effectiveness it brings, but also on how well they are aligned with consumer perceptions and practices in the market place. This stresses the importance of making the voice of the consumer heard early on in the development and application of these innovative plant breeding practices. The aim of this thesis is therefore to contribute to a better understanding of the consumer behavior perspective in the development of new tomato varieties based on plant genomics.

The first chapter provides the theoretical basis for the four empirical chapters that follow. In this chapter, quality guidance models are discussed that take the consumer as a starting point in the product development. It also includes the role of information, about the product technology, on consumer perception and acceptance of both the technology and the products it brings about.

Chapter 2 develops an elaboration of the Quality Guidance Model to more explicitly include the so-called credence attribute perceptions of consumers as a yardstick for product development. The results confirm that credence attribute perceptions need to be taken into account when the purpose is to develop consumer preferred products. *Chapter 3* explores the extent to which the positioning of plant breeding technologies affect consumer preferences and shows that this effect primarily operates through making the credence attribute perceptions more salient in the consumer decision process. *Chapter 4* explores consumer images for different plant breeding practices in more detail and shows that initial images of genomics may change as a result of further information exchange and elaboration. The final empirical chapter in this thesis (*Chapter 5*) explores how mode of thought and reference point in the decision process affects consumer evaluation. Contrary to expectation it shows that only mode of thought (conscious versus unconscious thought) has an effect on consumer evaluation. *Chapter 6* summarizes the results of the previous chapters and describes the implications and limitations of the research. *Overall*, the results of this thesis contribute to a better recognition of consumer perspective in the development of new plant varieties and subsequently suggest several ways to improve the consumer perspective into this process.

Voorwoord

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Contents

1	**The influence of positioning and communicating new technologies on consumer acceptance**	11
1.1	Introduction	11
1.2	Consumer-oriented approaches for integrating consumer needs and (new) products	16
1.3	Inferences from technology on quality perception	23
1.4	The effects of context and information processing	31
1.5	Aim and scope of the research	34
2	**Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features**	37
	Abstract	37
2.1	Introduction	38
2.2	The Extended Quality Guidance Model	40
2.3	Methodology	42
2.4	Results	46
2.5	Discussion	48
2.6	Appendix	51
3	**Why preferences change: Beliefs become more salient through provide (genomics) information**	53
	Abstract	53
3.1	Introduction	54
3.2	Theoretical background	55
3.3	Methodology	58
3.4	Results	61
3.5	Discussion	63
4	**Consumers' images regarding genomics as a tomato breeding technology: 'maybe it can provide a more tasty tomato'**	71
	Abstract	71
4.1	Introduction	72
4.2	Plant breeding practices	73
4.3	Theoretical background	75
4.4	Material and methods	77

4.5 Results 78
4.6 Discussion 80
4.7 Appendix 83

5 Consumer judgment regarding genomics: exploring the influence initial categorization and different modes of thought 85
Abstract 85
5.1 Introduction 86
5.2 Theoretical framework 88
5.3 Methodology 91
5.4 Results 94
5.5 Discussion 96
5.6 Appendix 99

6 General discussion 101
6.1 Summary and conclusions 101
6.2 Managerial implications 108
6.3 Limitations and future research 110

References 113

Samenvatting (summary) 129

List of Publications 133

Curriculum Vitae 135

Training and supervision plan 136

Chapter 1

The influence of positioning and communicating new technologies on consumer acceptance

1.1 Introduction

Innovation is recognized as a critical capability for companies to survive in today's dynamic (food) markets (Wind & Mahajan, 1997). It is complicated by the fact that the dynamics occur both at the consumer level, in terms of increasingly demanding consumers, as well as at the level of new production and process technologies that deliver new opportunities to fulfill current consumer needs and even anticipate on consumer needs in the (near) future. Companies are faced with the formidable task to align the (dynamic) technological opportunity with the (dynamic) consumer needs. Many companies are struggling with this challenge as is evidenced by the low success rates of new product development, both in general (Booz, Allen, & Hamilton, 1968) and for foods specifically (Stewart-Knox & Mitchell, 2003). Failure rates have been estimated at around 40 percent for all new products (Griffin, 1997) and it is even estimated that 80 percent of all new food products fail within one year of introduction (Rudolph, 1995). There has been a considerable amount of academic research into the critical success and failure factors of new products (Henard & Szymanski, 2001). Generally, this type of research indicates a wide range of factors that can be categorized into four categories: market place characteristics, product characteristics, firm process characteristics, and firm strategy characteristics (Henard & Szymanski, 2001). Studies that investigated the process factors in more detail have identified several key success factors as product advantage, proficiency of predevelopment activities, and a clear protocol for the new development process (Cooper & Kleinschmidt, 1987).

One important factor that both stimulates and complicates the need for innovation is the fact that consumer needs are changing. Consumers become increasingly demanding in terms of what they expect (food) products to deliver to them (Van Trijp & Steenkamp, 2005). At the most basic levels such needs relate to food security and food safety, almost as an indispensable condition. Also, consumers become increasingly demanding in terms of product attributes that provide them with direct satisfaction and gratification, such as good sensory quality, low prices (or value for money), and convenience. These product attributes have in common that, particularly for fast moving consumer goods, they are relatively easily assessed by consumers from their personal experience with products. They are so-called experience attributes (Steenkamp, 1990) for which the consumer can collect direct relevant feedback on the performance of the product by buying, using or consuming the product (e.g. it tastes well, is easy to use, etc.). Consumers can then use this relevant feedback on product performance to help them guide their next product purchase. Not surprisingly then, a lot of innovation in food is based on exactly these factors as they provide an important, directly recognizable product advantage in the market place (Moskowitz & Hartmann, 2008).

However, in today's markets consumer needs have begun to stretch beyond the so-called experience attributes. Not only do consumers want direct gratification from products that can be ascertained at the very moment of consumption, they also want the product to conform to requirements that relate to how the product is being produced, manufactured and processed, and what the product delivers them in the longer term (Grunert, Bredahl, & Scholderer, 2003). Many of these 'new' consumer requirements are of a so-called credence nature. Credence attributes (Darby & Karni, 1973) are those product features that the consumer cannot directly and personally verify at the moment of consumption. They are largely uncertain (in the sense of not being verifiable) and often manifest themselves in the longer run. Examples include the health effects of food products, the environmental impact, the impact on social relationships within the supply chain, the naturalness of products, etcetera. The increased interest of consumers into credence qualities of food products has not substituted for the 'traditional' requirements on experience attributes. Rather, these 'new' requirements are complementary in that they add onto the needs for high sensory quality and more basic consumer requirements (Deliza, Rosenthal, & Silva, 2003). In their choice behavior, consumers add these needs on top of the traditional focus, thus rendering the innovation process to be even more delicate.

The fact that consumers cannot personally and unambiguously verify the credence qualities of food products does not mean that they do not develop perceptions and expectations of the products' credence quality. Since Fishbein and Ajzen (1975), it is known that consumers are equipped with two important belief formation processes to assess (or develop expectations about) the credence qualities of food products. The process of inferential belief formation states that consumers will use their own rules of thumb to infer credence qualities from observable characteristics of the product. This can be very explicit as in the case of a food label or more subtle as in the case where naturalness is consciously or unconsciously inferred from the color or shape of a food product (e.g. ecological products have a less attractive appearance). An alternative belief formation process that is important for credence qualities is the information belief formation. In such cases, credence attribute beliefs (e.g. 'product is environmentally friendly') are formed on the basis of information that is provided by others, such as friends, advertisements, the internet, television programs, and consumer magazines (Steenkamp, 1990). The information provided could be an advertisement that contains a statement about the absence of child labor in the production of leather footballs. The processes of inferential belief formation (consumer may (un)consciously infer product quality from subtle product cues) and informational belief formation (consumers are sensitive to social interaction and communication in their product quality assessments) complicate the process of consumer-focused innovation because of the uncontrollable outcomes, either positive or negative, of these formation processes. It is nonetheless important to understand them and to take these processes into account in the design process because these belief formation processes of consumers are covering the 'new' requirements consumers have regarding the product, and hence preference formation and choice.

Information on the technology with which the product is produced can affect consumer decision making and choice (Da Costa, Deliza, Rosenthal, Hedderley, & Frewer, 2000). Production technology can serve as a cue on which consumers build their inferential belief formation. Probably the most prominent example within the food context is that of genetic modification (GM). Although this technology may be highly instrumental in bringing about food products of better quality and value, the GM products were rejected in the European market because of negative connotations with the technology and how it was being implemented. Consumers had negative attitudes towards this technology and the products emerging from it because they inferred that it is: unsafe, because they relate it to pesticide (Verdurme & Viaene, 2001), unethical, because it interferes with God' creation (Verdurme & Viaene, 2001), unnatural, because it is an artificial procedure (Tenbült, De Vries, Dreezens, & Martijn, 2005), and alienates them from the marketplace, because they do not understand the process anymore (Grunert, et al., 2003). This is an important insight for producers considering the application of new plant breeding science & technology as consumer

attitudes towards the applied production method can have severe implications for consumer acceptance of the products enabled by new plant breeding technologies. Many of these attitudes are built on 'new' consumer requirement in terms of credence qualities.
For plant based foods, there is a long history of plant breeding practices in the development of food products with consumer-desired attributes. Traditional plant breeding practices cross plants with different genetic compositions to combine positive attributes of two plants into the new variety. These traditional plant breeding practices are however on a cross-road of a major innovation (Varshney, Graner, & Sorrells, 2005). This is largely caused by a spin off of the successful sequencing of genomes. Today, not only the human genome has been successfully sequenced, but also the genome of a large variety of plants (Edmeades, McMaster, White, & Campos, 2004). It is now possible to cross plants not only on the basis of their phenotypic features, but also on the basis of their genotypic features. Knowing the genetic material of the progenies (i.e. parent plants) in detail, can help to reduce the traditional trial-and-error approach and reduce the uncertainty and enhance the successfulness of the plant breeding practices by making it more efficient (precise) and effective (faster). Based on this newly acquired knowledge two plant breeding practices are on the forefront in producing new plant varieties. First of all, the before mentioned genetic modification (GM), which changes hereditary material by transferring proprieties of one organism into another organism (Tenbült et al., 2005), and genomics which uses the descriptive information on the genome of progenies for better-informed crossings (Varshney et al., 2005). In genomics, the knowledge on the plants' genetic material is not used to actually manipulate the genetic structure of the new plant. New plants are still obtained from traditional but better informed breeding practices. Hence, it is called genomics-enabled plant breeding to differentiate it from GM.
Genomics enabled plant breeding is essentially different from genetic modification, but nonetheless it may share many properties with GM in the perceptions of consumers. This may be quite problematic and delicate with regard to the positioning and hence the acceptance of genomics enabled products. After all, the processes of informational and inferential belief formation may lead to the situation where consumers can develop (un)expected associations with the new breeding practice leading to negative consumers attitudes and products that lack consumer acceptance in the market place.

In sum, recent developments in plant genomics provide new opportunities for innovative products (Edmeades et al., 2004). These new products based on genomics may have an impact on both the experience qualities and the credence qualities of food products. For both producers and consumers it is important that the voice of the consumer is heard in order to have a fit between the product offering and the consumers' needs. In this process there is room for a more explicit recognition of how new food innovations on the basis of genomics affect the consumers' perception on credence attributes. Furthermore, this process is influenced by how the new technology is positioned. Positioning of a technology will most likely influence the belief formation processes of consumers, because consumers can use this information as a cue for their belief formation. Another effect of the positioning is that it not only affects the perceptions of consumers, but also their preferences for and acceptance of the products. The positioning of a technology or product can evoke associations and images which can influence these processes. Therefore it is important to better understand how the new technology of genomics can best be positioned and communicated to ensure that it lives up to its full potential and that it better aligns to consumer needs. As part of a larger research program on the application of plant genomics, this research project focuses on consumer acceptance of tomato varieties produced with genomics-enabled production technology. More specifically, and in line with the analysis above, the project addressed four key research questions:

- How can credence attributes be more explicitly incorporated into models that relate the voice of consumers to new product development. These models will be elaborated to include credence attributes and to incorporate communication and positioning elements
- How are consumers' credence attribute perceptions affected by the positioning of breeding technologies, such as plant genomics
- What are the specific images consumers hold regarding (new) technologies, such as plant genomics
- How is consumer perception and evaluation of (new) technologies, such as plant genomics, affected by the way in which consumers process available information.

Each of these research questions is addressed in one of the following empirical chapters of this thesis. In this general introduction, each of those issues will be addressed in a more introductory fashion. In the next section we will first present several models that try to bridge the gap between product quality and consumer needs. The credence motivations that consumers increasingly take into account will also be discussed. In the third section the positioning of different technologies and the influence of this on consumer preferences will be the focus, because the presented context can alter consumer perceptions of credence qualities. The fourth section will deal with the image formation process of consumers, and the final section will focus on information processing regarding products produced with new production technologies.

1.2 Consumer-oriented approaches for integrating consumer needs and (new) products

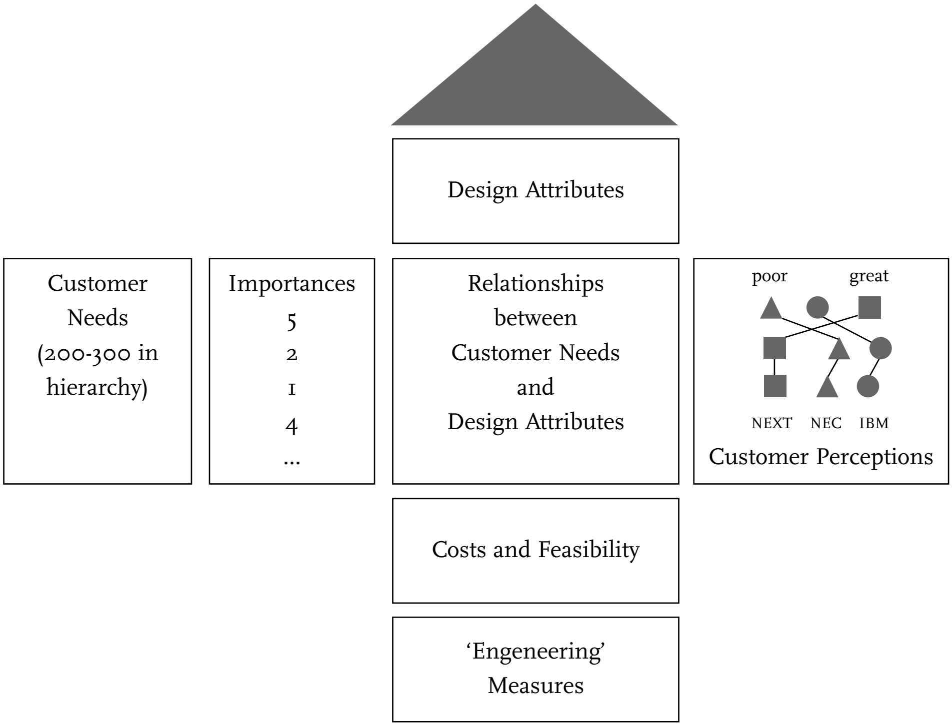
Research on successful versus unsuccessful new product development teams (summarized in Cooper, 1999) has identified a number of key characteristics of successful teams, the most important being: (1) solid up-front homework to define the new product, (2) incorporation of the voice of the customer through a slave-like dedication to the market and consumer input throughout the project, (3) delivery of differentiated products with unique customer benefits and superior value for the user, and (4) sharp, stable, and early product definition, already before development begins. Together, these criteria define what is known as consumer oriented new product development. In consumer oriented new product development consumer needs and motivations are taken as the explicit yardstick against which new products are designed. The reasoning behind this is that 'quality lies in the eyes of the beholder' (Garvin, 1984) and that it is ultimately the consumer that determines the success of the new product (Cooper & Kleinschmidt, 1987). Consumer oriented new product development takes consumer needs and motivations as the starting point (rather than 'afterthought') of the innovation process and such focus on listening to the voice of the consumer is particularly important in the early stages of the NPD process, as in those stages companies deal with the unmet needs and wants of consumers as they search for new areas of opportunities (Van Kleef, Van Trijp, & Luning, 2005).
Consumer oriented new product development has generated considerable interest, both in the marketing (e.g. Urban & Hauser, 1993) and the management (e.g. Griffin & Hauser, 1992; Govers, 2001) literatures. For example, Urban and Hauser's model of the Product Design Process incorporates the voice of the consumer and the voice of the company as two complementary processes in the design of new products that deliver against relevant consumer needs and motivations (see Van Trijp and Steenkamp, 2005). A well defined Core Benefit Proposition (Urban & Hauser, 1993) is crucial within this process as it summarizes the new products' superiority and forms the cornerstone of all elements of the marketing strategy and the vision that underlies the engineering design. The communication between the voice of the consumer and the voice of the company can however be difficult (Sounder, 1987). To be effective and efficient in the consumer-oriented new product development process, the consumer needs must be formulated in such a way that these abstract needs can be made actionable for the product specification, design, and production process. This translation process between the consumer world and the physical world is really an important challenge in this process (Van Trijp and Steenkamp, 2005). Several models have been proposed for this translation process, which will be discussed next.

Quality Function Deployment
The Japanese shipyard and car industry were very early in recognizing the importance of a focus on consumer needs and motivation, and translating them back to product design, technology and process design, and manufacturing feasibility. This approach, known as Quality Function Deployment (e.g. Griffin, 1992), emerged already in the early 1970's (Costa, Dekker, & Jongen, 2001) and found its way into the food industry in the late 1980s (Hofmeister, 1991; Charteris, 1993: Viaene & Januszewska, 1999; Benner, Linnemann, Jongen, & Folstar, 2003).
Central to the QFD approach is a very structured and formalised way of incorporating the voice of the customer into the new product design and development process (Cristiano, Liker, & White, 2000). QFD is a product (service) development process based on inter-functional teams (marketing, manufacturing, engineering, and R&D) and it guides product managers and design teams through the conceptualization, creation, and realization of new products (Govers, 1996). The incorporation of the voice of the customer is not limited to the marketing department but every other function within the company is encouraged to bring their own demand for data regarding the customer's voice (Griffin, 1992). This input from consumers is used throughout the design, manufacturing, and service delivery (Griffin & Hauser, 1993).
QFD uses a series of matrices, which look like 'houses' to present data. The first house is the 'House of Quality' which links consumer needs to design attributes. Design attributes are engineering measures of product performance (Griffin & Hauser, 1993). The second house of QFD links these design attributes to actions the firm can take. The third house of QFD links actions to implementation decisions such as manufacturing process operations (Griffin & Hauser, 1993). The fourth house links the implementation to the production planning.

House of Quality
Particularly relevant to the marketing and consumer behavior function, is the first house of the QFD process, the so-called House of Quality (Hauser & Clausing, 1988). The House of Quality (see Figure 1.1) is an important element of the QFD because the consumer needs are translated into measurable design attributes with the purpose of defining the product before the development begins (Bech, Hansen, & Wienberg, 1997).
The foundation of the House of Quality is that the different business units of an organization have to work closely together to satisfy the consumer needs (Hauser & Clausing, 1988). The House of Quality relates data generated from market research on customer needs and wants to proposed design attributes of the product (Griffin, 1992).
The House of Quality starts with listing the consumers' needs at the left hand side. A consumer need is a description, in its own words, of the benefit to be fulfilled by the product or service (Griffin & Hauser, 1993). Usually, the consumer

needs in the House of Quality are obtained by means of qualitative research, i.e. focus groups (Hauser & Clausing, 1988). Besides the needs that are obtained, the importance ratings of these needs are collected as well, because the needs can have different priorities to consumers.

Figure 1.1: The House of Quality from Quality Function Deployment (Griffin & Hauser, 1993).



On the right hand side, the consumer perceptions are listed. Consumer perceptions are formal market-research measurements of how consumers perceive products that currently compete in the market place (Griffin & Hauser, 1993). Knowledge of which products fulfill which needs best, how well those needs are fulfilled, and whether there are gaps between the best product and 'our' existing product, provide further input into the product-development decisions being made (Griffin & Hauser, 1993).
The measurable aspects of the product or service which, if modified, would affect consumers' perceptions are called design attributes in the House of Quality (Griffin & Hauser, 1993). The judgments indicating which design attributes affect which consumer needs and by how much are presented in the relationship matrix of the House of Quality. This matrix, which forms the body of the house, indicates the strength of the relationships between the consumer needs and the design attributes. To depict the strength of the relationships, symbols can be used

for prioritizing efforts and making trade-off decisions (Govers, 1996). Some commonly used symbols are triangle, circle, and dot, standing for weak, medium, and strong relationships (with equivalent weighing factors of 1, 3, and 9). The design teams use their own expertise, or data from controlled experiments to seek consensus between the depicted design attributes and consumer needs (Costa et al., 2001). This relationship matrix is an important checkpoint in the translation process from consumer needs towards product characteristics since blank rows in the matrix indicate that there is no relation between a specific consumer need and the design attributes. This would imply that this consumer need is not addressed by any of the product's technical characteristics (design attributes). The same accounts for blank columns which would imply that the chosen design attribute is not satisfying any of the listed consumer needs and is thus a waste of resources.

Once the relationships between the design attributes and consumer needs are established, together with the strength of the relationships, the company adds objective measures to the process. These objective measures are placed at the bottom of the house and with these measures the team can establish target values for the design attributes, in accordance with the consumer needs. The distinct part of the House of Quality is the attic or often only called the roof of the house. In the attic of the house supporting and conflicting design attributes are identified by a correlation matrix. If one design attribute is changed, it might affect other design attributes. This roof visualizes these possible correlations between the design attributes and if the effects are positive or negative.

When the House of Quality has been completed, the company should have information on the consumer needs and their importance, the competitive assessment of the product, the relationships between consumer needs and design attributes, priorities for improvement based on a cross functional approach, and the means to facilitate communication (Govers, 1996).

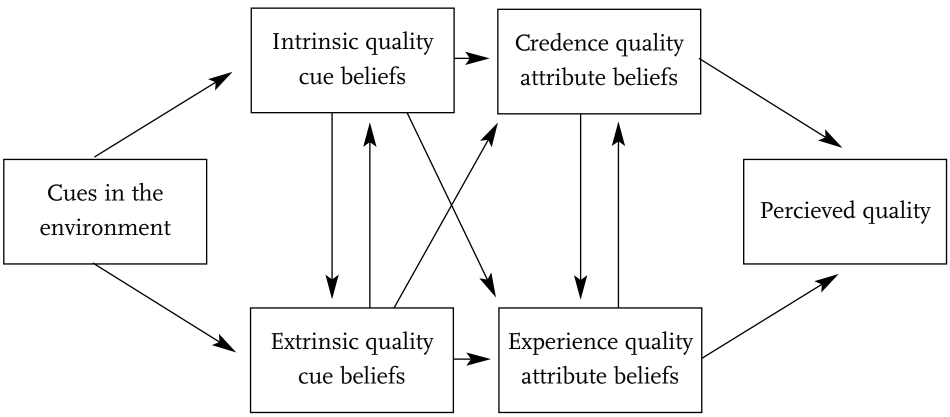
Despite its very structured approach, one shortcoming of the QFD approach is that it is highly qualitative in nature in that it uses focus groups as input and symbols in the matrixes. This limits its usefulness in providing sharp, stable, and early product definition in the new product development process. Also, the model focuses very much on physical product features as a basis for the delivery of utilitarian or functional product benefits to the consumer and is therefore mainly used in car and the electronics industries (Bech et al., 1997). Building on the QFD philosophy, quality guidance models have been developed to provide more precise and actionable guidance on the functional relationships in the relationship matrix. Such quantification is important to identify and do justice to the nature and intensity of the consumer-product relationships, revealing its complexity and multidimensional nature. These models will be discussed next.

Quality Guidance Model

Building on a variety of sources such as Brunswik's (1943, 1952) Lens model and the Conceptual Model of the Quality Perception Process (Steenkamp, 1990), Steenkamp and Van Trijp (1996) developed the Quality Guidance Model: an integrated consumer-based quality improvement philosophy that relates perceived quality judgments to physical product characteristics, to formalize the psychophysical relationships in the QFD relationship matrix.

The central element in the Quality Guidance Model is the perceived quality of a product (Van Trijp & Steenkamp, 2005). The perceived quality of food products can be assessed by consumers at two different moments in time. First, at the moment of purchase and second, at the moment of consumption (Steenkamp & Van Trijp, 1996). At the moment of purchase, the consumer forms an impression about the product's expected quality, while during the consumption, the consumer is able to experience, at least to some extent, the quality of the product. The Quality Guidance Model elaborates, based on the Conceptual Model of Quality Perception Process, on the processes that consumers use both in the formation of quality expectations and quality performance (see Figure 1.2). First of all, the model makes an important distinction between product related features (quality cues) and the inferences that consumers make from those features in terms of (expected) quality and defining benefits (the so-called quality attributes). Quality cue beliefs are beliefs regarding the quality cues or otherwise called the search attributes of products (Nelson, 1970). These search attributes are those product features that can be observed by the consumer prior to consumption. These may either be intrinsic product quality cues (physically related to the product) or extrinsic product quality cues (marketing-added features).

Figure 1.2: Conceptual Model of Quality Perception Process (Steenkamp, 1990)

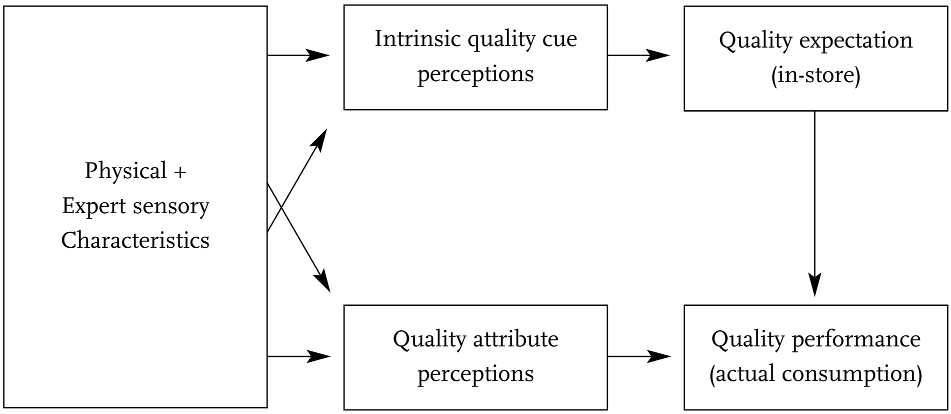


A quality cue is an informational stimulus about the product that can be ascertained through the senses prior to consumption (Olson, 1978). Intrinsic product

cues are part of the physical product and cannot be changed without also changing the product itself (Steenkamp, 1990). Examples of intrinsic quality cues are the shape, color, and size of a product (e.g. tomato). Extrinsic product cues are related to the product, but are physically not part of it. Examples of extrinsic cues are price and packaging cues.
Quality cues have, according to the consumer, predictive validity for the quality attributes of the product (Monroe & Krishnan, 1985). Quality attributes are the functional and psychosocial benefits of the product (Steenkamp, 1990). These attributes represent what the product is perceived as doing or providing to the consumer in relation to the consumer's wants, and form the basis of consumer preferences (Van Trijp & Steenkamp, 2005). Quality attributes are categorized as either experience or credence attributes (e.g. Darby & Karni, 1973; Nelson, 1970). Quality attributes that can be ascertained on the basis of an actual experience with the product can be regarded as experience attributes (Steenkamp, 1990). Other quality attributes cannot be ascertained even after normal use for a long time and/or without consulting an expert. These attributes are the credence attributes (Steenkamp, 1990).
Quality attribute beliefs are formed by consumers to arrive at a quality judgment about the product in question. Two important processes in forming the quality attribute beliefs are inferential and information belief formation (Fishbein & Ajzen, 1975). Both formation processes are explicitly taken into account in the Quality Guidance Model to relate the quality cues to perceived quality. Informational belief formation results in attribute beliefs based on accepted information about the quality attributes, while inferential belief formation is based on inference made about the quality cues of a product (Steenkamp, 1990).
Quality cues and quality attributes (to a lesser extent) find their basis in the product and processing characteristics that are directly or indirectly related to the product (Van Trijp & Steenkamp, 2005). Also, the quality cues are the crucial variables that can be influenced by the new product and process design process in an attempt to influence consumer perceived product quality in a more desirable direction. Understanding the relationships between the physical product features (both intrinsic and extrinsic), consumer attribute perceptions, and overall quality judgments is crucial to the new product development process. The House of Quality acknowledged this and did link the consumer needs (i.e. overall judgments) to the voice of the company (i.e. physical product features) in a relationship matrix that was qualitative of nature. The Quality Guidance Model is more a quantitative (multivariate) approach with regard to this process in that it relates quantitatively measured quality judgments (and perceptions) to the physical product characteristics. The quantitative data allows the model to attach weights to the relationships instead of indicating the strength of these relationships with symbols.
The Quality Guidance Model distinguishes between two important sub processes in understanding the relation between consumer needs and product characteristics: cue abstraction and cue integration. The first sub process of the model posits

that the physical product characteristics are abstracted to form the basis for consumer perception about the (intrinsic) quality cues and quality attributes (see Figure 1.3). The second sub process models the way (intrinsic) cue perceptions and quality attribute perceptions are integrated into a judgment about quality expectation and quality performance, respectively (Steenkamp & Van Trijp, 1996).

Figure 1.3: Quality Guidance Model (Steenkamp & Van Trijp, 1996).



The Quality Guidance Model is a theory based model that provides substantial promise for the more quantitative and formalised translation of consumer needs into product and process design. It is an integrative model that uses quantitative data to link and determine the strength of the relations between consumer needs and product characteristics. The model can be conceived as a quantified relationship matrix, providing the development teams with concrete numbers instead of symbols with regard to the relationships between consumer needs and product characteristics. Steenkamp and Van Trijp (1996) provide an illustration of the use of the model in the context of sensory quality optimisation of meat and show that Partial Least Squares analysis can provide an integral quantification of the model. In this illustration, they focus on the intrinsic quality cues of the product in translating perceived quality towards product characteristics. The Total Food Quality Model has extended this focus to include a wider range of factors. This model will be discussed next.

Total Food Quality Model

The Total Food Quality Model (Grunert, Larsen, Madsen, & Baadsgaard, 1996) distinguishes, just as the Quality Guidance Model, between before and after purchase evaluations. In the before purchase part of the TFQM, the expected quality of the product is not an aim in itself, but is desired because it helps to satisfy the purchase motives of consumers (Brunsø, Bredahl, Grunert, & Scholderer, 2005). The trade-off between the positive and negative consequences of different purchase motives and especially the fulfilment of these motives determine the intention to buy the product. This intention to buy the product is the key dependent variable in the before purchase part of the TFQM, where it was expected quality in the QGM.

After the purchase, where the quality experience begins, the consumers can relate their expectations to their experiences. The relationship between quality expectation and quality experience is commonly believed to define product satisfaction and consequently the probability of re-purchasing the product (Brunsø, et al., 2005). Just as in the QGM, experienced quality is a dependent variable of the after purchase part of the model, but in the TFQM this experience quality is further linked to future purchase decisions.

The TFQM is based on the quality guidance principle and also assumes that the dependent variables are based on a number of perceived quality cues, which may be both physical characteristics of the product and other characteristics such as brand name, price, and distribution outlet (Grunert, 2002, Grunert 2005, Grunert, Bredahl, & Brunsø, 2004). Bredahl, Grunert, & Fertin (1998) provide an illustration of the use of the TFQM in the context of meat, as did Brunsø, et al. (2005). Both these studies limited the research to intrinsic quality cues in the TFQM. Other illustrations of this model did include the extrinsic cue characteristics in their model. Grunert (1997) and Bredahl (2003) used extrinsic quality cues as brand name, price, product label, etc in the judgment about meat.

The TFQM shows it is possible to focus on the intrinsic quality cues and extrinsic quality cues of the product in translating perceived quality towards product characteristics. The aim of the present research is to focus more on the inclusion of credence attributes perceptions, with respect to a genomics based food innovation, into these models. Given the fact that genomics-enabled tomatoes are not on the market, extrinsic quality cues, real purchase motives, and intention to buy the product are not yet considered. Therefore the Quality Guidance Model is used to extend the focus on intrinsic quality cues with credence attribute perceptions for new food innovations based on genomics.

1.3 Inferences from technology on quality perception

Previous applications of the Quality Guidance Model (e.g. Poulsen, Juhl, Kristensen, Bech, & Engelund, 1996; Steenkamp & Van Trijp, 1996) have tended to focus on sensory product quality and how this translates back to intrinsic product features (e.g. sarcomere length of meat). From these so called intrinsic product features, consumers may build intrinsic quality cue perceptions. Intrinsic quality cue perceptions might be used by consumers to infer beliefs about the experience and credence attribute perceptions, which in turn may affect their product quality perceptions (see Figure 1.4). For example, the color of a tomato

might lead to inferences about the sweetness of taste, as well as about the sustainability. However, research has shown that it is not only the intrinsic quality cues that affect the quality attribute perceptions. Other, so called extrinsic product quality cues also play a role, both in relation to experience and credence quality perception (Steenkamp, 1989; 1990). Extrinsic quality cue perceptions are based on extrinsic product features. Extrinsic product features are features which are physically not part of the product, but are related to it (Steenkamp, 1990).
One such extrinsic quality cue that can have a profound impact on consumer perception is information on the production technology that is applied in the product (Deliza, Rosenthal, & Silva, 2003; Caporale & Monteleone, 2004).
Increasingly, consumers have become more interested in not only what the product is and delivers, but also in how the product has been brought about. Consumers take information on production technology as an indicator for both experience and credence quality perceptions. In establishing these extrinsic cues to (experience and credence) quality attribute perceptions, consumers can use two fundamental processes: inferential and information belief formation (Fishbein & Ajzen, 1975).
Consumers can form beliefs about the quality attributes by accepting information provided by some outside sources, such as friends and advertisements, i.e. information belief formation (Steenkamp, 1989), while in inferential belief formation (Fishbein & Ajzen, 1975) consumers use a priori beliefs, activated from memory (e.g. 'tomatoes are vegetables'), to infer the quality of the product (Steenkamp, 1990). For example, based on the knowledge that vegetables are healthy, consumers might infer that a tomato is healthy. So, through inferential belief formation, consumers fill in missing information (i.e. knowledge about the healthiness of the tomato) simply by making inferences from the present information (i.e. tomato is a vegetable) (Brown & Dacin, 1997).
A difference between the experience and credence attribute perceptions is that the experience attribute perceptions can be verified by consumers. If consumers infer that a tomato will be tasty or receive information of a friend that the tomato is tasty, consumers can verify their experience attribute perceptions by tasting the tomato. This is however impossible with the credence attribute perceptions. The healthiness of a tomato, for example, can not be verified by tasting the tomato.
Table 1.1 provides an overview of studies that explored consumer inferences from information on the applied production technologies, both in perception and evaluative terms. In the middle column, the table shows the net effect of information about the production technology on the evaluations of consumers [1]. This net effect is based on the positive and negative experience and credence attributes perceptions. The perceptions, if mentioned in the articles are presented in

1 Except for the Cox et al. (2007) study where different clusters were used and the Townsend and Campbell (2004) study where the evaluation resulted in willingness to taste).

column five and six. In each of these studies, the associations were compared between a conventional technology and the application of a new or controversial technology. The table shows that, in general, the provided extrinsic cue of production technology alters the product evaluation of consumers.

However, the valence of the inference making processes is not known upfront and this process may provide consumers with partially contradictory information. For example, knowledge that biotechnology is applied to tomatoes, may lead to inferences that (1) the tomato is more tasty, but at the same time that (2) the tomato may be less safe. Such cue-belief relationships largely emerge from subjective knowledge (associations) stored in the consumer's memory with regard to production technologies. For example, in Europe, associations regarding biotechnology, especially when used as production technology in food production, are negative in terms of the acceptability of the technology (Frewer, Howard, Hedderley, & Shepherd, 1997; Pardo, Midden, & Miller, 2002; Marris, Wynne, Simmons & Weldon, 2001; Moses, 1999). For genomics as a production technology, the inference making process is not all that clear. On the one hand, due to the genetics component consumers may associate genomics with genetic modification, and all its (negative) associations. On the other hand, because genomics is different from genetic modification, genomics may also be primarily associated with conventional breeding technologies, and all its (positive) associations. An important research question in this respect is how knowledge on the fact that the product is produced with the help of modern genomics technology will affect consumers' inference making processes. In this research we specifically focus on consumer perceptions and evaluations of tomatoes produced with the help of modern genomics breeding technologies.

When consumers are confronted with a familiar product (such as tomato) produced with an innovative production technology, they will draw on two sets of stored knowledge: that on the tomato and that on the new production technology. When the new technology is unknown (as in the case of genomics), stored associations, for example regarding other production technologies, are helpful for consumers to identify the new product and to interpret the new product. These processes are known as categorization (what is it?) and inference making (what specific expectations do I have about it?). Categorization research builds on the assumption that consumers' existing knowledge in memory is organized in structured, but flexible, schemata: networks of knowledge with relevant concepts (e.g. brands, attributes and attribute levels) represented as nodes and nodes being interconnected through links (e.g. associations between brands and attributes) which may differ in strengths and valence (Van Trijp & Van Kleef, 2008) The categorization of objects occurs (simultaneously) at different levels of abstraction, ranging from a superordinate level (e.g. vegetables), to a basic level categorization (e.g. tomatoes), to the lowest subordinate level (e.g. cherry tomatoes) (Sujan & Dekleva, 1987).

Table 1.1: Studies comparing consumer's evaluations after receiving information about tradi-

Reference	*Technology*	*Product*	*Affect*
Caporale & Monteleone, 2004	Genetic modification Organic	Beer (Yeast)* Beer (Barley & Hops)*	√ (-)• √ (+)•
Cardello, 2003	20 conventional and novel food processing technologies	Chocolate pudding*	√ (-)• √
Cox et al., 2007	Irradiation Triploidy 'electron beam'	Prawn	√ √ √
Da Costa et al., 2000	Genetic modification 'environment friendly'	Vegetable oil	√ (+) √ (+)
Deliza et al., 1999	Genetic modification 'environment friendly'	Vegetable oil	√ (-) √ (+)
Deliza et al., 2003	High pressure processing	Fruit juice (pineapple)	√ (+)
Fox et al, 2002	Irradiation	Pork	√ (-)
Frewer et al., 1997	Genetic modification Protein engineering	Cheese	√ (-) √ (-)
Johansson et al., 1999	Ecological grown	Tomato*	√ (+)•
Kihlberg et al., 2005	Organic production	Bread (flour)*	√ (+)•
Lahteenmaki et al., 2002	Genetic modification	Cheese*	√ (-)•
Townsend & Campbell, 2004	Genetic modification	Apple*	√ •

tional and non-traditional production technologies.

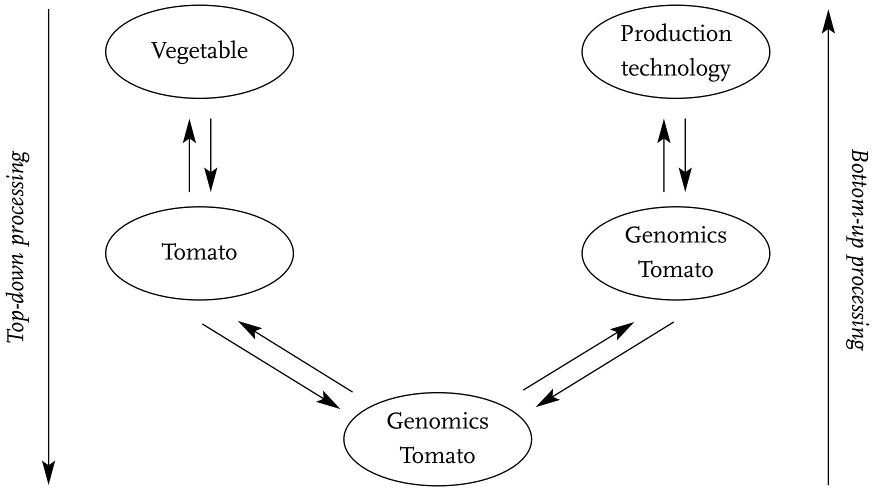
Experience attributes	*Credence attributes*	*Research Design*
		Experiment
	Safety	Experiment
	Environmental impact	Conjoint
		Cluster & Conjoint
		Conjoint
Taste and quality	Trustiness, healthiness	Focus groups
		Experimental auction
Flavor	Animal welfare, environmental damage, listeria	
Acidulous, sweet, bitter taste, firmness, juiciness		
Wheat aroma, cereals aroma, earthy aroma, elasticity, compressibility, deformability, juiciness, wheat flavor, cereals flavor, earthy flavor, astringent		
Taste	Health	
Taste appearance		

(+) positive effect; (-) negative effect; ⋆ actual product (vs. label, text descriptions, etc); • actual tasting of products

Specifically applied to tomatoes produced with modern genomics techniques, the initial categorization will occur at the basic level (after all, it is a tomato). The stored knowledge on tomatoes serves as an important benchmark for making sense of the newly encountered stimuli and contains a lot of detailed information, including typical attributes, relationships among attributes, and relationships between the category and other categories (Stayman, Alden, & Smith, 1992). However, in this specific case, the knowledge will be augmented with specific information arising from the production technology schema. Subjective knowledge about the used production technology and its implications for typical product associations come together in the consumer perception process when interpreting the new type of tomato. This cumulative knowledge of such a category, like risks and benefits of the technology, the trade-off between these risks and benefits, and links towards other technologies, becomes activated when consumers are confronted with the object or by actively thinking about them (Tenbült, De Vries, Dreezens, & Martijn, 2007). The activation of stored associations to make sense of a product or technology is regarded as top down processing of information, while the attachment of meaning towards incoming information, i.e. genomics tomato, is considered as bottom-up processing (Brunsø, Scholderer & Grunert, 2004). In practice, consumers most often combine these two processes (see Figure 1.4), whereby the top-down processing ability indicates that consumers are able to make sense of incoming information (bottom-up processing) (Huczynski & Buchanan, 2001). See Kardes, Posavac, & Cronley (2004) for a more detailed elaboration on these processes in combination with inference making.

When consumers are confronted with a new instance that (slightly) deviates from their previous experiences, any resemblance with stored knowledge in memory has an effect on the way consumers process and evaluate information (Van Trijp & Van Kleef, 2008). Consumers have a number of mechanisms to interpret and learn about new products (e.g. Michaut 2004; Fiske and Neuberg, 1990). If a product appears sufficiently consistent with a current knowledge structure, consumers may attempt to fit the new product into the known category (Ozanne, Brucks, & Grewal, 1992). The category can be used as reference against which the encountered product is projected (Gregan-Paxton, Hoeffler, & Zhao, 2005). The associations stored in the category are activated and projected upon the new instance (Kardes, et al., 2004). For example, if the new tomato is similar enough to existing expectations about what a tomato typically is, consumers will categorize it as a tomato and fill in all missing information as they would typically expect from a 'normal' tomato (i.e. healthiness). If there is substantial but not perfect overlap with existing knowledge and expectations, consumers will still attempt to 'force-fit' the new product into an existing category (assimilation) (Michaut, 2004). If such assimilation cannot be successfully achieved, consumers have the ability to turn to accommodation, i.e. adapt or re-organize the schema (Van Trijp & Van Kleef, 2008). In those instances, they will make changes in their knowledge structure to accommodate for the new stimulus. For example, if consumers are confronted with a cherry tomato for the first time, they recognize a tomato, but experience a moderate mismatch with the schema of a tomato due to of the small size and shape of the tomato. They have to re-organize their schema with additional information to accommodate for the cherry tomato, for example by defining a subcategory with some overlap to the main category. When an existing knowledge category cannot be adequately accommodated to capture the new stimulus, consumers will need to re-categorize or even convert to so-called piece meal processing and evaluate the new product on an attribute by attribute basis (Van Trijp & Van Kleef, 2008).

Figure 1.4: Top down and bottom-up processing for tomatoes produced with a new technology.



A key question is how existing knowledge and hence inferences from the new production technology enter the equation. The knowledge structures about production technologies are schemata and these schemata are often referred to as (production technology) images (Boulding, 1956). Consumers draw from these production technology images when confronted with a product produced through that technology. However, in the literature there is not a full consensus about how these product technology images should be conceived. Different levels are possible, ranging from fairly basic affective responses to quite elaborated and detailed structures (Poiesz, 1989). Poiesz argues that images can be operationalized ranging from (1) a high elaboration approach through (2) a medium elaboration to (3) a low elaboration approach. The most elaborate view on images is reflected in a detailed (hierarchical) network of meanings as advocated within the means-end chain orientation (e.g. Reynolds and Gutman, 1984). In this approach images are defined as a rich network of connections between the attributes of the product, consequences of product use, and personal values (Pieters, Baumgartner, & Allen, 1995). The medium elaboration approach to images is to view them as a combination of salient beliefs and belief evaluations, thus as the operational equivalent of attitudes in the Fishbein (1967) tradition (Poiesz, 1989). Images in this view are not only a summation of the various perceptions of attributes, but are also a function of the importance weights and interactions among these attributes (Hartman & Spiro, 2005). Images in the limited elaborated fashion are defined as general, holistic impressions of the relative position of the object among its perceived neighbors (Poiesz, 1989). The defining of the relative position of the object concerns the finding the location of the object on one or more dimensions that are used to classify it. Because of the nature of the classification process the number of dimensions is likely to be limited (Poiesz, 1989).

New production technologies as they are applied to foods (e.g. genetic modification), have in common that they are highly technical in nature and their full impact is not easily understood by the consumer (Pardo et al., 2004). As a consequence, it seems unlikely that consumers have very elaborate beliefs and extensive knowledge about them. This does not mean that they are not impactful on product perception, but rather that the inferences arising from them are highly affective in nature without too much detail and underlying reasoning. The considerations regarding a new technology are thus most likely based on a limited amount of dimensions, suggesting that, in general, the low elaboration view on product technology images is the most accurate one, although of course it cannot be ruled out that some consumer segments base their technology images on detailed considerations about the specific positive and negative implications that the new technology may have for the product's performance on specific evaluation dimensions.

In summary, when consumers are confronted with a product together with information on its product technology, their inference making about the quality of the product (e.g. tomato) will be affected by the a priori information stored in both the tomato schema and the (new) technology schema. Information about the technology activates the technology-based associations, which are mapped onto the perceptions of the product, i.e. tomato. This is where the bottom-up information on the perceived product features is combined with the top-down inferences made from the product technology image. The inference making of consumers is not longer only based on the knowledge structure regarding the product, but also on the image regarding the production technology. This may also account for information about genomics as a technology applied in tomato breeding. This information could lead to a diversity of associations regarding the technology which is mapped onto the perceived quality perception process of the tomato. It is not known, a priori, what these technology-inferred associations will be, nor how they affect the quality perception of the tomato brought forward with this new technology. Therefore, as part of this thesis, we provide an exploratory study in an attempt to map the effects of product technology information on consumers' quality perception processes of the tomato. An elementary part of this exploration is to discover which specific technology images consumers hold towards several production technologies.

1.4 The effects of context and information processing

The technology schemata, which consumers use to map onto their product perceptions, are not always rich in detail and well articulated in the consumers' mind. This is particularly true for production technologies that are complex and relatively new to consumers, which makes it difficult for them to grasp the phenomenon. Particularly these poorly developed schemata (images), which are not fully developed and stable, may be sensitive to the context in which the new technology is being presented and to the intensity with which the information is being processed. Essentially, the process of consumer perception and evaluation towards a product produced with a new technology depends on the selection of a set of criteria (e.g. product attributes) which are considered in the evaluation and the perception of the new technology on those specific criteria (e.g. Fishbein & Ajzen, 1975). These criteria and perceptions may either be derived from existing internal knowledge (extensive schemata or more superficial images) or they may be inferred more ad hoc, on the basis of contextual factors. Which route is being taken depends, among other things, especially on the level of motivation, ability, and opportunity (Petty & Wegener, 1999). The Elaboration Likelihood Model (e.g. Petty, Heesacker and Hughes, 1997) distinguishes between two routes of information processing which consumers can adopt, namely the central route and the peripheral route. Consumers can adopt a low effort intuitive assessment (peripheral route) or a more deliberate and elaborate cognitive processing (central route).

For new production technologies such as genomics, the understanding of how consumer perception and evaluation may differ, depending on context in which the new technology is being presented and the depth of consumer information processing, is very important in terms of optimal positioning and communication of the new technology. As discussed before, genomics combines insights of the plants' genetic material (which may elicit associations with GM) into the conventional breeding process (which may elicit associations with conventional breeding). To do justice to the true nature of genomics-enhanced breeding it would be important to differentiate it from both conventional breeding practices, but also from genetic modification.

Given that genomics-enhanced plant breeding is still an emerging technology, with no real product yet, it is reasonable to assume that most consumers are unknowledgeable about it and hence lack a stable set of evaluation criteria for its assessment. In those instances, the perception process may be highly malleable depending on the reference point that consumers (implicitly or explicitly) take. In other words, it is likely that consumers will construct their preferences on the spot, based on a limited set of criteria (e.g. stereotyping), which may either be extracted from their internal reference point or the context in which the new technology is being presented (e.g. Wilson, Lindsey & Schooler, 2000). The more familiar context of GM and that of conventional breeding are likely to form reference points from which relevant criteria and beliefs may be 'borrowed' (Mussweiler, 2007). More specifically, we argue that consumer perception and evaluation of genomics-enhanced breeding practices may differ depending on whether genomics is evaluated in a GM-relevant context, as compared to a conventional breeding context, simply because these different contexts make different beliefs salient.

The effects of different contexts are not so easy to predict since two specific processes may occur. First, the perception of the new technology (e.g. genomics) may be assimilated towards the reference point against which it is evaluated (e.g. Martins, Seta & Crelia, 1990). This will happen (e.g. Tormala & Clarckson, 2007) when consumers perceive similarity between the new technology and the reference point (e.g. genomics is seen as an instance of GM or conventional breeding). On the other hand, the perception and evaluation of the new technology may also be contrasted from the reference point taken, in which case the new technology is seen as clearly different from the reference point (Martins et al., 1990). As assimilation versus contrast effects depend critically on the perceived (dis-)similarity, positioning of the new technology is crucial, together with a priori consumer perceptions and evaluations of the reference point categories. For example, if conventional breeding is taken as the reference point for the evaluation of a genomics enabled tomato, the value which consumers place on conventional breeding, together with the displaced context effect (i.e. assimilation or contrast), influences the attitudes towards genomics. When consumers valued conventional breeding as positive (negative), genomics will also be valued positive (negative) if consumers assimilate genomics towards conventional breeding. If however consumers displace genomics away from (i.e. contrast) conventional breeding, they will value genomics as negative (positive).

A priori it is off course unknown which reference point consumers use in their evaluation of genomics based products. However, in instances where consumers lack detailed knowledge and as a consequence strong reference points, they may refer to factors provided in the environment for guidance. Experimentally, these environmental contexts can be provided to the consumers, a process known as framing (Donovan & Jalleh, 1999). For example, by providing consumers with information on the new technology (e.g. genomics), together with information on GM (vs. conventional breeding), GM (vs. conventional breeding) is made salient and it may be expected that genomics will be evaluated against the provid-

ed reference point of GM (vs. conventional breeding). Using such procedures hopefully provides insight into how consumer perception and evaluation of genomics may differ depending on the reference point that is made salient.
A second important factor, in addition to the reference point, that may affect consumers' perception and evaluation of new technologies such as genomics is *how* the information is being processed. Information may be processed more elaborately and in-depth (the central route) or more superficially and potentially intuitively (the peripheral route). Many models in consumer information processing still assume that conscious and in-depth processing of the available information (the central route) is the preferred route, especially when confronted with an important decision. This assumption has however recently been challenged (e.g. Dijksterhuis, Smith, Van Baaren, & Wigboldus, 2005). In many situations, conscious processing of information is hindered by limited cognitive resources, which in turn may lead to suboptimal weighting of the beliefs in forming an overall judgment or evaluation (Dijksterhuis et al., 2005). An extensive psychological literature exists that shows that consumer decision making is not limited to conscious processing of information (Bargh, 2002; Bargh & Chartrand, 1999; Chartrand, 2005; Dijksterhuis & Smith, 2005; Dijksterhuis, et al., 2005; Dijksterhuis & Van Olden, 2006; Frizsimons, Hutchinson, Williams, Alba, Chartrand, Huber, et al., 2002; Simonson, 2005; Wilson, Lisle, Schooler, Hodges, Klaaren, & LaFleur, 1993) and that a considerable part of human functioning is rooted in non-conscious processes that do not require conscious and effortful processing (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). The Unconscious Thought Theory, developed by Dijksterhuis and Nordgren (2006) builds on this literature in focusing on the strengths and weaknesses of conscious and unconscious thought, that is, of deliberation with or without attention (Dijksterhuis, Bos, Nordgren, & Van Baaren, 2006; Dijksterhuis & Van Olden, 2006). Conscious and unconscious modes of thought have different characteristics, and these different characteristics make each mode preferable under different circumstances (Dijksterhuis & Nordgren, 2006). The theory is based on the deliberation-without-attention hypothesis. This is a counterintuitive hypothesis about the relation between mode of thought (conscious vs. unconscious), complexity of the decision problem, and the quality of a decision (Dijksterhuis, et al., 2006). In general, this hypothesis states that decisions about simple issues can be better tackled by conscious thought, whereas decision about complex matters can be better approached with unconscious thought (Dijksterhuis & Nordgren, 2006). Applied to the situation of genomics, processing genomics information, either with or without attention might affect the consumer's perception and evaluation of the new technology. More specifically, the difference of whether consumers judge intuitively, evaluate elaborately, or evaluate more unconsciously may affect the outcome of the evaluation process of genomics as a plant breeding technology.

In sum, it is argued that consumer evaluation of a new technology such a genomics-enhanced breeding, may depend on specific reference points that consumers use and the type of information processing they engage in. To test these hypotheses in the present context, an experimental approach will be used in which reference point and type of information processing are experimentally manipulated. Genomics as a plant-breeding technology will be evaluated by consumers under situations where (1) the reference point is externally induced (either providing a GM or a conventional breeding context) and (2) the type of information processing is manipulated through the choice task. To our knowledge, this research is a first application to test the relevance of the Unconscious Thought Theory within the context of new production technology.

1.5 Aim and scope of the research

The present study is inspired by a recent new development in plant-breeding technology, namely that of genomics-enhanced plant breeding practices. We put this new technology into the context of changing consumer demands and argue that successful application of this new technology will be enhanced if it takes into account the increased consumer interest in credence qualities of food products. That is, although genomics-enhance plant breeding practices may enhance the effectiveness and efficiency in producing food products with superior experience quality (e.g. taste, convenience, etc), they will also be evaluated by consumers in terms of their performance on so-called credence attributes (e.g. naturalness). It is argued that consumer understanding and hence perception and evaluation of this new technology are still poorly developed. As a result, consumers will assess the (added) value of this new technology on the basis of rather superficially developed knowledge (i.e. images) rather than in-depth and elaborate knowledge. This can have a profound impact on consumer acceptance of this new technology.

As part of the larger CBSG research program on Genomics in Plant Sciences, the aim of this research is to explore specific aspects of consumer acceptance of tomato varieties produced with genomics-enabled plant breeding technology. Throughout this research we emphasize the importance of consumer orientation and that understanding the specific consumer needs and demands may provide important insights for the optimal positioning and communication of the new technology when it enters the market place. We build the case through four empirical chapters.
Chapter 2 (Van den Heuvel et al., 2007) highlights the importance of taking a consumer orientation in the development of new tomato varieties produced with genomics-enable technologies. We argue that previous models which defined sharp product definitions upfront have largely ignored the fact that consumers in their evaluation of new products (i.e. tomatoes) not only take sensory quality into

account, but also their associations with how the product is being produced. New technologies serve as an important extrinsic quality cue to consumers and lead to evaluation of credence attributes (e.g. naturalness, healthiness, safety etc.) of the product, which in turn may substantially affect their overall quality judgments. We develop and empirically validate an Extended Quality Guidance Model and show that credence attributes have a profound effect on consumer evaluation of tomatoes produced with genomics-enhanced technology.

Chapter 3 (Van den Heuvel et al., 2006) explores the process of inferential belief formation, on the basis of knowledge about the product's production technology, in more detail. Depending on information provided on the technology, effects may come about by either differences in perceptions of the product's performance on evaluation criteria or by the relative importance of those evaluative criteria in overall quality judgments. We show that information provided on genomics has an effect on the importance's consumers attach to how the product is produced (i.e. naturalness, safety, etc.) in their evaluations.

Given that consumers' a priori knowledge, no matter how superficial or elaborate, may affect their decision process, chapter 4 (Van den Heuvel et al., 2008) explores the construct of consumers' images with new production technologies, in more detail. It compares images associated with three different production technologies, namely genomics, conventional breeding, and genetic modification. We show that images regarding genomics as plant breeding technology are more superficial when consumers instantly judge the technology, and are more elaborated after a time of discussion.

Chapter 5 (Van den Heuvel et al., 2008) explores if consumer evaluation of genomics as a technology and the quality of tomato varieties brought forward by the technology differ depending on the reference point that consumers take and the way in which they process the information. The underlying assumption is that these factors are particularly important for emerging technologies, such as genomics, as consumer beliefs and evaluation are malleable rather than well established and stable. We show that evaluations of genomics differ through the way how consumer process information and through prior attitudes they possess regarding other technologies.

Chapter 2

Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features[2]

Abstract

The Quality Guidance Model was extended beyond sensory properties to include credence motivations like healthiness, environmental friendliness, naturalness, and safety. This Extended Quality Guidance Model was built and tested to explain consumer preferences from consumer perceptions, expert sensory judgments, and metabolite features of tomatoes. The different type of features (sensory, technical, and consumer perceptions) made it possible to explore the actionability of the features in predicting consumer preferences both in-store and upon consumption.

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2.1 Introduction

Alignment of market supply to consumer needs and preferences is crucial for marketing success and is becoming even more important under existing market conditions of intense competition and highly demanding consumers. Increasingly, consumers not only want food products to be of high (sensory) quality but also to deliver specific benefits in terms of health, safety, and environmental quality. Many markets have turned from sellers' markets into buyers' markets (Steenkamp and van Trijp, 1996a). It is therefore, a crucial question to almost every marketing oriented organization to understand what consumers value in their product category, and to effectively and efficiently translate these consumer needs into concrete product offerings.

The process of translating consumer needs into product offerings is a notoriously difficult process. Several approaches have been suggested to enhance the success rate of new products (e.g. Cooper, 1999), including the use of structured processes and methods. For example, Quality Function Deployment (QFD) has been put forward to bring the 'voice of the consumer' upfront in translating consumer needs across the supply chain. More specifically, Quality Function Deployment is a tool which translates the language of the customer into the language of the engineer (Griffin and Hauser, 1992). Others, such as Moskowitz (2000) have developed specific methodologies for the reverse engineering of consumer needs to preferred product features.

Two more integrative models exist which can be used for the translation of consumer needs towards preferred product features: the Quality Guidance Model (QGM) (Steenkamp and Van Trijp, 1996a) and the Total Food Quality Model (Grunert, et al., 1996). Whereas the Quality Guidance Model focuses on linking consumer quality judgments to physical product features, the Total Food Quality Model also considers the factors that intervene between purchase behavior and quality expectation and experience judgments. In their attempt to translate consumer judgments into technical product features, these models can be conceived of as quantitative multivariate approaches to the QFDs House of Quality (e.g. Hauser and Clausing, 1988).

In relating them to physical product features, these quality guidance models have tended to emphasize the sensory quality of foods and other benefits verifiable by the consumer. The important so-called credence attributes (Darby and Kerni, 1973), such as safety, environmental quality, and health are recognized as important food choice motivations by consumers (Steenkamp, 1989) yet have received far less attention in these models. Credence attributes differ from search (e.g. price, size) and experience (e.g. taste, convenience) attributes in that their 'true' values cannot be verified by the average consumer not even upon normal consumption of the food (Grunert, Bredahl, & Brunsø, 2004). However, despite this fact, consumers still form perceptions of product performance on these attributes through the processes of informational and inferential belief formation

(Fishbein and Ajzen, 1975). In inferential belief formation, arguably the more important belief formation process in relation to credence attributes (Steenkamp, 1989; p. 121), consumers use a priori beliefs about the relationship between a cue, an attribute, and even a benefit to make inferences about the product performance. An example would be the color of candy from which a consumer infers the presence of artificial colorings and hence the healthiness and naturalness of the product. In other words, despite the fact that they are mostly not tangible, credence attributes like healthiness, safety, naturalness, and environmental friendliness are to some extent 'visible' for the consumer (or at least consumers believe so) and therefore it is important to take them into account in the quality guidance process.
Crucial in the process of satisfying abstract consumer needs is the translation of these perceived benefits into concrete product characteristics actionable for optimizing product offerings. However, product characteristics can be described at different (interrelated) levels of abstraction, including physical-chemical features, sensory expert judgments, and analytical consumer perceptions. An important question in this research is what the most appropriate abstraction level is for optimizing consumer preferences. This is not a straightforward issue as it concerns a trade off between predictive validity for consumer perceptions on the one hand and actionability for food technological solutions on the other.
Physical-chemical characteristics and sensory product features can be considered as the more 'distal' representations of consumer choice behaviour and may be limited in accounting for consumer preference and choice (Van Trijp and Schifferstein, 1995). Consumer sensory panels have been suggested (e.g. Moskowitz, 1994) as a more proximal representation of consumer preferences and hence may be more accurate in prediction of consumer preferences than the expert sensory judgments and physical-chemical product features. In optimizing consumer preferences, physical chemical features are, to our knowledge, not linked directly to consumer preferences. Physical chemical features are mostly linked to expert or consumer sensory panels and to consumer perceptions, which are then believed to shape preferences (quality expectations and quality experiences), as in our Extended Quality Guidance Model and in the Quality Guidance Model. In addition to these models we assess the direct explanatory power of physical chemical features with regard to the consumer preferences.
In summary, the present study has two main objectives. The first objective is to extend the Quality Guidance Model to include credence attributes perceptions of consumers, encountered during their buying behaviour. We assess the extent to which credence attributes play a role in consumer preference formation, and more importantly to what extent consumers infer these credence attribute perceptions from concrete product characteristics. The second objective is to explore the explanatory power of different levels of product characteristics in an integrative account of the consumer's overall evaluation in store (quality expectation) and in the consumption situation (quality experience).

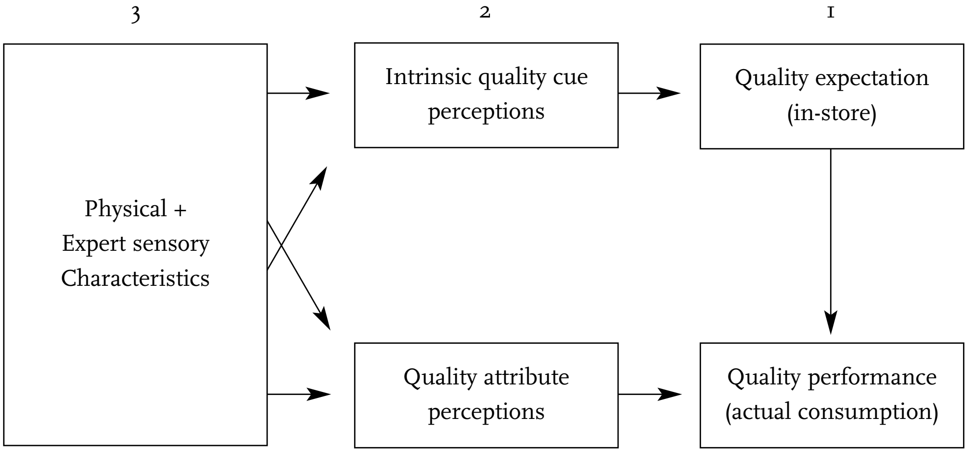
The next section explains the rationale behind the Extended Quality Guidance Model. Then, the methodology and the empirical application will be outlined. The outcomes of the integrative testing and estimation of the model will be presented in the results. Finally, the results will be discussed and recommendations will be provided.

2.2 The Extended Quality Guidance Model

Quality guidance is an integrated consumer-based quality improvement philosophy that relates perceived quality judgments to physical product characteristics. A valuable framework for conceptualizing the judgment process is the Lens model of Brunswik (1943, 1952). In this model the relationships between individual and environmental components of the judgment situations are formalized (Steenkamp, 1989). Related to the Lens model are the quality perception process and the quality guidance concept. This last concept is based on several theoretical underpinnings (Steenkamp and van Trijp, 1996a). The first underpinning is that quality is in the eye of the beholder and that quality judgments are formed at two moments in time: in-store, in shaping consumers' expectations of the benefits the product will deliver (quality expectations) and during actual consumption of the product at home or elsewhere where the consumer can (to some extent) actually verify the true quality the product is delivering (quality experience). The second underpinning is the separation of the quality judgments into quality cues and quality attributes. Quality cues are informational stimuli that are, according to the consumer, related to the quality of the product, and can be ascertained by the consumer through the senses prior to consumption (Steenkamp, 1989). Quality attributes are the functional and psychosocial benefits provided by product upon consumption (Steenkamp, 1989). Quality cues closely resemble search attributes (Steenkamp, 1990). In this research we will use the terms interchangeably. The last underpinning is linking the consumer perceptions with respect to the quality cues and quality attributes to physical product characteristics. These underpinnings together with the key concepts can be formulated into a model, as is shown in Figure 2.1.

The first part of the Quality Guidance Model (the integration phase) focuses on the quality expectations and the quality experience of consumers and how these are formed. Quality expectations represent the purchase decision consumers' face and are formed in the shop. The shop is usually a grocery shop or a supermarket. The consumers can see, feel, and smell the products and use these stimuli (cues) to assess the quality of the product. Based on these observations, quality attribute perceptions can be asserted / inferred from these 'distal' sensory cues. These processes are integrated into the QGM to extend it with credence attribute perceptions, our first objective. The main difference with the home situation is that the product cannot usually be consumed in the shop. Quality expe-

Figure 2.1: Quality Guidance Model (Steenkamp and Van Trijp, 1996a)



rience represents the quality assessment upon actual consumption in the home situation and is based on quality attribute perceptions and partly on the quality expectation. Integrated in the quality expectations and quality experiences are the intrinsic cue perceptions and attribute perceptions, shown in the second part. Quality cues have predictive validity for the product's quality performance upon consumption (Steenkamp and van Trijp, 1996a). Intrinsic cue perceptions are perceptions based on the physical part of the product. Quality attributes are the utility generating benefits provided by the product. They represent what the product is perceived as doing or providing for the consumer in relation to his wants, and form the basis for consumer preference (Steenkamp and van Trijp, 1996a). Perceptions of intrinsic quality cues and quality attributes are influenced by the product's physical characteristics, which are shown in the third part of the model (the abstraction phase). This part of the model constitutes the so-called psychophysical relationships (Steenkamp and van Trijp, 1996a), although in Quality Guidance Model the concept of psychophysics is treated more broadly than in traditional psychophysics. This linkage of physical and expert sensory data and consumer data by means of the psychophysical relationships enables us to achieve the second objective; the comparison of the predictive power of the different product features on consumer preferences.

The concept of quality guidance has been adopted in other research. An extension to the quality guidance concept was made by Poulsen, Juhl, Kristensen, Bech, and Engelund (1996). They proposed the concept of quality formation. This extension makes it possible to evaluate the relative importance of quality expectation and experience in consumer preference formation and choice. Quality guidance was also used in the research of Sijtsema, Backus, Linnemann, and Jongen (2004), who adopted it for structuring product characteristics that were objectively measurable. Previous applications of the QGM have emphasized experience attributes, but failed to include the important credence attribute perceptions. Current research states that 'credence quality can, under normal circumstances, not be evaluated by the average consumer at all, but credence quality is a question of faith and trust in the information provided' (Grunert et al., 2004). This definition emphasizes the informational belief formation process in quality perception processes. We extend this focus to also include the process of inferential belief formation (Fishbein and Ajzen, 1975) arguing that credence attribute perceptions are also to some extent inferred by consumers from the physical and sensory attribute perceptions and hence influence consumer preference, even though these credence perceptions cannot be 'objectively' verified. For that reason it is important to also include credence attributes and extend the Quality Guidance Model, accordingly. Credence attribute perceptions are inferred from intrinsic and extrinsic quality cues. The healthiness of a tomato for example cannot be verified and is thus a credence attribute. What can be verified before consumption are the search attributes or otherwise called the quality cues of the tomato, like the size, color, and shape of the tomato. Consumers may infer healthiness perceptions from the color, shape, and size of the tomato.

2.3 Methodology

2.3.1 Stimuli

The research project is part of a larger research program performing research on potatoes and tomatoes, run at the Centre for Biosystems Genomics (CBSG) and funded by the Dutch National Science Foundation (NWO). Within this program we are interested in the consumer's behaviour regarding tomatoes and how we can explain this behaviour better. As part of this larger study, 94 selected cultivars of tomatoes were explored in great depth, 22 of which were cherry tomatoes, 53 round tomatoes and 19 of which were beef tomatoes. In addition to consumer data, detailed information was collected to profile the cultivars in expert sensory terms as well as a large number of metabolomic parameters.

Special care was taken to ensure comparability of tomato samples of a particular cultivar. The tomatoes were picked in a specific pre-defined color stage. The picked batch was split into three sub-batches for consumer tests, expert sensory profiling, and metabolomics tests, respectively. Tomatoes selected for the consumer tests were transported to a commercial marketing research agency and preserved at room temperature over night for the consumer tests which took place the next day. The consumer tests were spread over four days. Every time the same procedure was followed. Several research groups in sensory, consumer behaviour, and plant sciences work on this same set of stimuli and jointly prepared the input to the Extended Quality Guidance Model.

2.3.2 Procedures and measures

Quality guidance builds on the integration of product-related data and consumer-related data. Product-related data involve both metabolic features of the plants and its fruits as well as expert sensory judgments which are also objective / calibrated measures. Consumer-related measures involve both overall quality assessment prior (quality expectation) and after (quality experience) consumption as well as the more subjective consumer perceptions of the tomatoes.

Consumer data

Consumer data are collected by a commercial market research agency among a sample of Dutch consumers who hold main responsibility for the food purchases in the household and eat tomatoes at least twice a month. Over 80% of the sample was female as men still are a minority in the responsibility for household food purchases. Respondents worked individually and at their own pace in attribute rating of the tomatoes and tested two to five tomatoes per one hour session. In total 939 observations about the tomatoes are gathered which averages 10 replications per cultivar.

Selection of quality cue and quality attribute perceptions were based on a literature survey and a series of 12 (two male, ten female respondents) in-depth individual interviews specific to this study. In the in-depth interviews consumer were confronted with commercial tomatoes and conducted a Repertory Grid Procedure (Kelly, 1955) to identify the cue perceptions combined with a Laddering Technique (Reynolds and Gutman, 1988) to explore the cue - attribute - quality perception links. Consumers were asked to imagine the purchase and consumption situations of tomatoes. Interviews took between 5 and 20 minutes. The identified cue and attribute perceptions were validated against the results obtained from the literature review.

The interviews and the literature review resulted in the following items for the shop situation: hardness, smoothness, and shape came out of the interviews, first impression, and red tomato (Auerswald, Peters, Bruckner, Krumbein & Kuchenbuch, 1998), color, and firmness (Johansson, Haglund, Berglund, Lea & Risvik, 1999), size (Jahns, Moller Nielsen, & Paul, 2001), smell, and equality of color (Steenkamp and van Trijp, 1996a) out of the literature review. For the home situation: seeds, fruit flesh, ripeness, and shape came out of the interviews, smell of the cut tomato, sweet taste, sour taste, firmness of chewing, and remaining skin of the tomato (Auerswald et al., 1998), taste intensity, sweetness, bitterness, acidulousness, bitter taste, and firmness (Johansson et al., 1999), size (Jahns et al., 2001), easiness to cut, juiciness, freshness, and liking taste (Steenkamp and Van Trijp 1996a) out of the literature review. Items to measure quality expectation, quality experience and the credence attributes were similarly identified from literature and the in depth interviews. Quality expectation and experience are built out of good quality (e.g. Steenkamp and Van Trijp, 1996a), willingness to buy (e.g. Grunert et al., 1996) and first and overall impression (in-depth inter-

views). Items regarding credence attributes are adapted from Bredahl, Grunert, and Fertin (1998) who show that consumers associate health-related dimensions in assessing products, Steenkamp (1989) who used naturalness, and Bernues, Olaizola, and Corcoran (2003) who used safety and environmental friendly production.
Consumer data collection was in line with the quality guidance procedures (Steenkamp and Van Trijp, 1996a) in which consumer's rate specific tomatoes on seven-point Likert type scales. Prior to administering, the questionnaire was pretested among seven respondents which indicated no need for change.

Expert sensory evaluations
Expert sensory evaluations were obtained from a trained sensory expert panel (Agrotechnology and Food Innovations in Wageningen). Eight panel members assessed the 94 cultivars in duplicate on 25 attributes using 0-100 line scales with end-poles 'very little' and 'very much'. A Quantitative Data Analysis (QDA) based method is used to generate the attributes. Tomatoes were presented to the panelists in a pre-defined order (according to a Williams Latin Square to minimize carry-over effects and to reduce fatigue). The attributes were presented as four blocks covering odor (aroma intensity, tomato, spicy, sweet, and smoky), flavor (pungent, sweet, sour, tomato, earth, unripe, spicy, and watery), mouth feel (contract, moist, mealy, solid, and though skin), and aftertaste (sweet, sour, salty, bitter, fresh, chemical, and rough) respectively.

Metabolomics data
Plant breeding and plant sciences groups also analyzed the 94 cultivars on a large number of product-specific 'technical' measures that were deemed relevant by the 'technical' plant scientists working within the total program. The measurements were performed with highly specialized equipment to reflect the state of the art in plant physiology (see Tikunov, et al., in press), non-volatile components (e.g. lycopene), derivization components (e.g. glutamate), fruit traits (e.g. weight) and phenotypic measurements (e.g. leaf area) on the plants and fruits.

2.3.3 Analyses
The aim of the Extended Quality Guidance Model is to interrelate three sets of measures (consumer, expert sensory, and physical-chemical) in an integrated way. The unit of analysis in this research is the cultivar (n=94), and in the integrated data set these are profiled in terms of average consumer ratings, expert sensory judgments, and their physical-chemical features. To assess whether pooling of the cultivar types (round, beef, and cherry) is justified we estimated the regression models for all cultivars (n=94) and for the cultivar types separately (n=53, n=19, n=22). We subsequently compared the residual sum of squares of the pooled and cultivar-specific analyses using a Chow test [F (10,79) = 1.90, n.s.], indicating that the pooling is indeed justified.

The construction and analysis of the Extended Quality Guidance Model involves a combination of several statistical techniques. Principal Component Analysis (PCA) is applied to uncover the basic constructs: the underlying blocks of measures at the consumer, sensory and metabolic level. These basic constructs with their accompanied operative measures represent the structure of the Extended Quality Guidance Model (see Figure 2.2). The reliability of the constructs will be tested by means of Cronbach's alpha, on the basis of the average inter-item correlations between its measures (Hair, Anderson, Tatham, & Black, 1995). To estimate the causal relation between the constructs, as well as the measurement model, Partial Least Squares (PLS) structural equation modeling is applied.

2.3.3.1 Principal Component Analysis

Independent Principal Component Analyses (PCA) with Varimax rotation were conducted separately for (1) quality cue perceptions in store, (2) quality expectation in store, (3) quality attribute perceptions upon consumption, (4) quality experience, as well as (5) the sensory expert judgments and the physical-chemical features. The aim was to find the key building blocks of the Extended Quality Guidance Model and these are represented in Table 1 (see appendix). Selection of components was based on the criterion of eigenvalues [3] greater than 1. Factor loadings of all items representing the identified dimensions were greater than .50 and all dimensions have a reliability above the recommended .70 (Hair et al., 1995) for the consumer data. For the physical chemical data the factor loadings of all items representing the identified dimensions were greater than .70 and all dimensions has reliability above the recommended .70. The physical-chemical measurements resulted in many items and to avoid redundancy we used only factor loadings of .70 and higher. The number of items for some constructs had to be reduced based on their Cronbach's alpha scores. The principal components are given in Table 2.1 in the appendix. This table also shows the factor loadings and Cronbach's alpha.

2.3.3.2 Partial Least Squares - Model specification

The Extended Quality Guidance Model specifies causal relationships between physical characteristics (sensory, and metabolomics data), quality cue/attribute perceptions and quality expectation/experience. The components in our model are expected to have a causal relation with the quality expectation and quality experience, as is in the Quality Guidance Model. As explained by Steenkamp and van Trijp (1996a), Partial Least Squares is the preferred statistical procedure to estimate the model comprehensively and in an integrated way, specifically when

3 The selection of the number of factors was verified with the Horn's parallel test (e.g., Zwick and Velicer, 1986). For conceptual reasons we used two factors more in the in-store perception stage and one more in actual consumption situation. For the physical-chemical data we used six factors less than recommended based on conceptual reasons and other statistical procedures mentioned like cronbach's alpha.

the number of observations (n=94) is small relative to the number of constructs in the model[4].

A PLS path model is described by a measurement model, relating the manifest variables (MVs) to their latent variable, and a structural model relating some endogenous latent variables to other latent variables (LVs) (Tenenhaus, Chatelin, & Esposito Vinzi, 2002). For carrying out the path model we use PLS-Graph 3.0 (Chin 2001), which is actually based on LVPLS 1.8 (Lohmöller, 1984). The 'objective' (i.e. expert sensory and metabolomics) variables were measured by multiple indicators that are formative of the construct in question. The reason to use formative indicators is that we believe that these measures are not affected by the same underlying construct but are measures that form or cause the creation or change in a latent variable. The consumer perception and preference constructs were measured by multiple indicators that are reflective in nature. The model we use contains a measurement (outer) part and a structural (inner) part.

2.4 Results

2.4.1 Causal relationships in the Extended Quality Guidance Model

Figure 2.2 provides a graphical representation of the estimates of the structural parameters in the Extended Quality Guidance Model. For ease of exposition, only the statistically significant ($p < 0.05$) causal relationships are depicted.

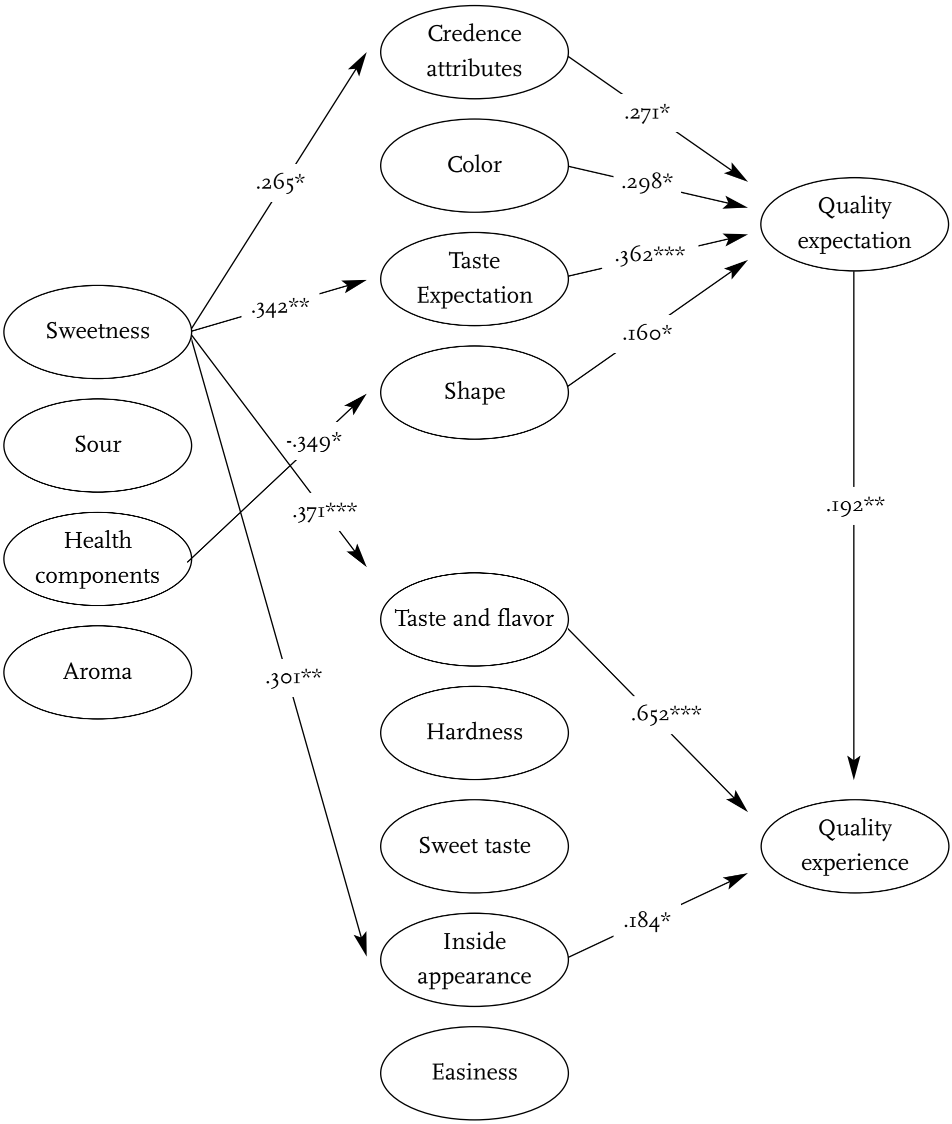
2.4.1.1 Quality expectation

The quality expectation of consumers at the point of purchase will increase with positive credence attributes items ($\beta = 0.271$; $p < 0.05$), 'shape' ($\beta = 0.160$; $p < 0.05$), 'color' ($\beta = 0.298$; $p < 0.05$), and 'taste expectation' ($\beta = 0.362$; $p < 0.001$). Together these quality dimensions account for 78 percent of the variation in the quality expectation ratings.

The Extended Quality Guidance Model also assesses the predictability of quality perceptions on the basis of the physical characteristics of the tomatoes. Fourteen percent of the variance in consumers' credence attribute items can be explained by the physical characteristics of the tomato sample. 'Sweetness' has a significant effect on the credence attribute items ($\beta = 0.265$; $p < 0.05$) and on 'taste expectation' ($\beta = 0.342$; $p < 0.01$). The physical-chemical 'health components' construct has a significantly impact on consumer perceptions of shape' ($\beta = -0.349$; $p < 0.05$). The total R^2 for 'shape' is 19 percent. 'Color' and 'taste expectation' do not have any significant relations with the physical product characteristics of the tomatoes. The total R^2 for 'color' is 19 percent, and for 'taste expectation' is 19 percent.

4 The ratio of sample size to number of free parameters should be at least 5:1 to get trustworthy parameter estimates (Bentler and Chou, 1987) for LISREL estimates and thus would require much more observations than with PLS.

Figure 2.2: Extended Quality Guidance Model



** p < 0.05; ** p < 0.01; *** p < 0.001*
To avoid a confusing tangle of arrows, the non-significant effects have been omitted.

2.4.1.2 Quality experience

Together the quality attribute dimensions and quality expectation explain 83 percent of the variance in consumers' quality experience ratings. The quality experience increases with positive quality expectations ($\beta = 0.192$; $p < 0.01$), good 'inside appearance' ($\beta = 0.184$; $p < 0.05$) and 'taste and flavor' ($\beta = 0.652$; $p <$

0.001). 'Easiness to cut', 'sweet taste', and 'hardness' do not exert a significant effect on quality experience.
Thirteen per cent of the variance in consumers' 'hardness' perception can be explained by the physical characteristics of the tomato sample. For 'sweet taste', 15 percent of the variance is explained and for 'easiness to cut' this was 7 percent. 'Sweetness' has a significant relation with 'taste and flavor' ($\beta = 0.371$; $p < 0.001$), and 'inside appearance' ($\beta = 0.301$; $p < 0.01$). The total variance explained for 'taste and flavor' is 31 percent and for 'inside appearance' 10 percent.

2.4.2 Predictive power of the product features

To explain the predictive power of alternative product and consumer features, we explored the direct effects of these features on consumer quality expectation and quality experience judgments. The physical and expert sensory features together explain 7.3 percent of the variance in quality expectation. Combined with the consumer perceptions these features explain 84.1 percent of the variance in quality expectation ($p < 0.001$). The change between the different features used in explaining the variance of quality expectation is significant ($\beta = 0.768$; $p < 0.001$). Regarding the quality experience, the physical and expert sensory features together explain 17.8 percent of the variance ($p < 0.01$). When the consumer perceptions are added, the explained variance rises to 85.3 percent ($p < 0.001$). This increase is also significant ($p < 0.001$).

2.5 Discussion

This paper provides an extension of the Quality Guidance Model (Steenkamp and van Trijp, 1996a) in an application to consumers' perceived quality regarding tomatoes. The two main objectives were to extend the QGM beyond its application to sensory quality, to also include the broader set of more cognitive consumer choice criteria in store (credence motivations) and secondly to explore the actionability of different type of product features in predicting consumer preferences both in-store and upon consumption.
The study confirms that consumers' credence motivations, particularly those related to health, environmental friendly production, safety, and naturalness are important determinants of consumer quality perception in-store. Increasingly, these 'societal' considerations are a driving factor for consumer choice and a competitive weapon in food marketing. These societal considerations can be linked with specific purchase motives like family well being, social relationships, enjoyment, and pleasure (Bredahl et al., 1998).
Although credence attributes cannot be verified by the consumer in-store, the results show that consumers do form perceptions about the healthiness of tomatoes from sheer appearance and consumers form these perceptions consistently. This suggests that consumers form attribute beliefs perceptions by means of

inferential belief formation (e.g. Fishbein and Ajzen, 1975). Apparently, cues in the product lead to consistent appearances in the eyes of consumers. These cues in turn, can be exploited in food marketing and quality communication to optimize the product for consumers.

The Extended Quality Guidance Model shows that the objective features as measured by sensory and instrumental measurements have predictive validity for credence motivation perceptions. This predictive validity is especially visible in the significant relation between objectively measured sweetness, and credence attributes. The total predictive validity of the objective features regarding credence attributes is altogether nineteen percent.

A second important finding from the research is that there is a need for better identifying the 'objective' product features that matter in consumer evaluation of tomatoes. In the translation process from consumer wishes to product characteristics there is a need to identify strong relations between product features and consumer perceptions. At the moment, sensory and instrumental features have limited predictive validity for consumer perception both in-store nor upon consumption. However, some consistent relationships were identified which can serve as criteria for optimization. For example, there is a significant relation between objective 'sweetness' and 'inside appearance'.

The Extended Quality Guidance Model showed that consumers can partly predict their quality experience based on their quality expectations. The relation between the quality expectation of the consumers and the quality experience of the consumers is significant, but the shared variance between the two constructs is only 3%. The influence of the quality expectation on the quality experience is thus very small. This finding is in line with the findings of the Quality Guidance Model of Steenkamp and van Trijp (1996a). The results indicate that consumers encounter a disconfirmation between the expectations and experiences. Therefore it may be necessary to look only at the quality expectations regarding purchase behavior because consumers make their choice for a specific product based on their expectation.

We identify a relationship between the objective features that combine into the dimension 'sweetness' and taste experience in both the shop and home situation. Objective 'sweetness' also positively affects consumer's credence motivations in the in-store situation, although this relationship is less straightforward. From a marketing and consumer communication perspective it is encouraging that objective 'sweetness' was recognized by consumers as contributing to taste expectation, so that consumers know that their positive taste expectation gets reinforced in a positive taste experience upon consumption. Hence the link between 'sweetness' as an objective dimension and in-store taste expectation should be an important marketing communication objective. Remarkable also is the negative relation between 'health components' and 'shape'. Phytofluene, an item of 'health components', is a carotenoid (family of widespread natural pigments found in plants and animals) and found naturally in tomatoes. Recent findings indicate that phytofluene acts in synergism with lycopene (a carotenoid responsible for the red color of the tomato) in prevention of degenerative diseases (LycoRed Natural Products Industries Limited, 2005). A thorough explanation for this relation with 'shape' is hard to give.

In both phases of the Extended Quality Guidance Model the amount of significant relations is not optimal. In the abstraction phase, this absence can be caused by incorrect indicators for the physical-chemical datasets. The indicators are chosen by experts in plant science. This may indicate that the plant breeders do not take the consumers' reactions into account when selecting the indicators. A second reason may be that the physical features interact. In future research we may specify this, since PLS only measures the main effects. It may also be that the beliefs on which consumers rated the tomatoes are not fully adapted to the consumer and that different consumers may use different terminology in describing tomatoes. In the present study these beliefs were generated from literature and in-depth interviews and were identical for each respondent. Alternative attribute elicitation techniques are available, which may lead to different (abstraction levels of) elicited beliefs (Steenkamp and Van Trijp, 1996b; 1997) and may even allow different consumers to rate on different sets of idiosyncratic beliefs (Steenkamp, Van Trijp, and Ten Berge, 1994). Such alternative attribute elicitation methods might be considered in future applications of this kind of research. Finally, the selection of number of factors from PCA may have played a role. For conceptual reasons and on the basis of eigenvalue criterion we selected more factors than the stricter Horn's parallel test suggested. This may also have affected the explanatory power in the abstraction phase. In the integration phase the most likely reason for the absence of more significant relations is that the tomatoes have too little variance for consumers to recognize. Accounting for inter-individual differences may improve our model as well as specifying other beliefs in our model.

Several topics regarding the translation of consumer wishes to product characteristics still deserve further research attention. For example the insights in the credence attribute perceptions of consumers. What are the underlying processes used by consumers in acknowledging the credence attributes of products? Further, what is the influence of extrinsic cues like price and packaging on consumer preferences? In this paper, the focus regarding the formation of attribute perception beliefs was on the inferential belief formation. The informational belief formation is also important and has to be addressed in the future. For a better translation it is also important to provide a better integration of the product features with the consumer features.

2.6 Appendix

Table 2.1: Principal components Extended Quality Guidance Model

	Factor loading	*Reliability (Cronbach's alpha)*
Quality Expectation		0.95
Quality	0.96	
Willingness to buy	0.95	
First impression	0.95	
Credence attributes		0.90
Safety	0.84	
Naturalness	0.81	
Environment	0.80	
Health	0.74	
Color		0.88
Red color	0.88	
Good color	0.84	
Equality color	0.75	
Shape		0.84
Round shape	0.85	
Good shape	0.83	
Taste expectation		0.88
Fresh	0.70	
Tasteful	0.68	
Smooth	0.63	
Quality Experience		0.93
Willingness to buy	0.96	
Positive impression	0.95	
Quality	0.95	
First impression	0.79	
Taste and flavor		0.88
Ripeness	0.84	
Juiciness	0.76	
Appealing	0.70	
Liking taste	0.70	
Freshness taste	0.57	
Inside appearance		0.89
Good inside appearance	0.86	
Good inside color	0.84	
Core shape	0.82	

	Factor loading	*Reliability (Cronbach's alpha)*
Hardness		0.86
Solid	0.87	
Hard	0.84	
Hardness heart	0.83	
Solid while chewing	0.77	
Sweet Taste		
Sweet Taste	0.86	
Easiness		
Easy to cut	0.71	
Sweetness		0.85
Brix	0.95	
Spicy (taste)	0.91	
Watery	-0.84	
Sweet	0.82	
Sweet (aftertaste)	0.80	
Glucose	0.77	
Sour		0.88
Sour (aftertaste)	0.90	
Sour	0.89	
Contract	0.74	
Aroma		0.74
Smoky	0.83	
Aroma-intensity	0.70	
Health components		0.90
Rt 25.5	0.95	
Phytofluene	0.90	
Rt 20.8	0.87	
Methyl 5 hepten 2 one	0.81	

Chapter 3

Why preferences change: beliefs become more salient through provided (genomics) information[5]

Abstract

Information regarding the method of production of food products influences the decision making process of consumers. The aim of this study is investigate to what extent information about genomics biases consumer decision making. We investigate the exact source of the biasing nature by separating the effect on consumer beliefs and the salience of those beliefs. The effect of information is tested through an information condition concerning two breeding methods, namely classical breeding and breeding enabled by genomics. The results show that consumer preferences are influenced by the information on production technology. More specifically, the consumer preferences change because consumers alter the saliences of their beliefs towards the product.

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3.1 Introduction

Understanding how consumers make decisions with regard to (new) product offerings is of paramount importance, especially in the marketing process of aligning new products and services to identified consumer needs. It is however difficult to understand the decision making process of consumers since it is a multifaceted process influenced by many factors. Consumer preferences and beliefs are believed to be important determinants of this process. The general approach in understanding consumer decision making has been to model consumer preferences as a weighted sum of consumer beliefs and evaluations of these beliefs. Important approaches in modeling the consumer preferences are the Lens model (Brunswik, 1943; 1952) and most prominently the Fishbein model (Fishbein & Ajzen, 1975).

These models show that consumer preferences can be influenced in two ways: by consumer beliefs and / or by the evaluations of the beliefs. Consumer beliefs are however not autonomous, they are also subjected to influences. An important influence with regard to consumer beliefs is information. Consumers can gather information regarding the product, based on the true qualities of the product (as in tasting) or by the information that accompanies the product very closely (as the color or packaging of the product) or more distantly (as in communication about the product or its ingredients). Another source of information is information regarding the method of production. Various studies (e.g. Kihlberg, Johansson, Langsrud, & Risvik, 2005; Johansson, Haglund, Berglund, Lea, & Risvik, 1999; Smythe & Bamforth, 2002; Caporale & Monteleone, 2004) show that information on the method of production changes the consumer beliefs about the product.

Besides the influence of consumer beliefs on consumer preferences, the saliences of the beliefs also influence consumer preference. Several studies (e.g. Bettman & Sujan, 1987; Haley, 1968; Huffman & Houston, 1993; Park & Smith, 1989; Wright & Rip 1980) demonstrated that the salience of specific product benefits or decision criteria play an important role in consumer information acquisition, judgments, and choices (Ratneshwar, Warlop, Mick, & Seeger, 1997). However, the influence of these evaluations or saliences can be increased or decreased by means of priming. Research on priming effects demonstrates that judgments are sensitive to the context in which they are made (Herr, 1989), since information has the potential for multiple interpretations (Yi, 1990). Priming can make certain evaluations more salient by the provided context. For example, priming of consumers' reference points may increase the impact of these reference points on the importance of attributes in consumer judgment (Van Ittersum, Pennings, Wansink, & Van Trijp, 2005). Another cause of changing salience's can be that information makes particular qualities of the product more salient than others in the consumer decision making process. Consumer preferences can thus be influenced by the beliefs and the evaluations or saliences of the

beliefs, which on their turn, are subjected to priming and information effects.
The aim of this study is two fold: first we investigate to what extent information on the method of production biases consumer decision making. In this study we choose to focus on genomics since it is an interesting case as it is a relatively new technology (Nap, Jacobs, Gremmen, & Stiekema, 2002) and because it only mildly deviates from traditional methodologies in plant breeding (as stated by experts in this field), but at the same time may bias consumer decision making because of the associations it may evoke with genetic modification (GM). Second, we investigate the exact consequence of the information bias on consumer preferences by separating the effect on consumer beliefs and the salience of those beliefs.
The next section elaborates on the theoretical background of the study. Then, the methodology will be presented as well as the outcomes of the study. Finally, the results will be discussed and recommendations will be provided.

3.2 Theoretical background

The main assumption in this study is that information regarding the used production technology will influence the consumer decision making. To get insight in the consumer decision making process and to understand the influence of information on this process, we elaborate on several underlying features of the decision making process, especially on consumer beliefs and saliences of the beliefs. These underlying features of the decision making process can be influenced in several ways. Information has an important influence on the underlying features of the decision making process, as mentioned. We will present a number of studies describing the influence of information. The hypotheses of this study will be presented at the end of this section.
Consumer decision making has been a focal interest in consumer research, and consideration of current marketplace trends indicate that this topic will continue to be important (Bettman, Frances Luce, & Payne, 1998). The consumer decision making process involves the analysis of how people choose between alternatives. Consumers choose between alternatives based on their attitudes towards these alternatives. The Attitude model of Fishbein (Fishbein & Ajzen, 1975) is a means to understand the attitude formation of consumers. According to the theory behind this model a person's attitude toward any object is a function of his beliefs about the object and the implicit evaluative responses associated with those beliefs. This can be formulated into the following equation: $A_o = \sum b_i e_i$ where A_o is the attitude towards some object, b_i is the belief i about some object, and e_i is the evaluation of attributes i.
The consumer decision making process, and more specifically its determinants, can be influenced by information. Several studies show the influence of information (e.g. Johansson et al., 1999; Kihlberg et al., 2005; Caporale & Monteleone,

2004; Cardello 2003). Product information regarding the growth conditions, for example, influences the consumer preferences (Johansson et al., 1999). The results showed that information about ecological growth affected preference in a positive way compared to the blind preference test, but the effect was less important for well liked tomatoes than for tomatoes less well liked. Information on the manufacturing process has an influence on liking of beer (Caporale & Monteleone, 2004). The results of the study demonstrated that information is capable of modifying the liking of the product. A model was tested where liking was a function of information ('traditional', 'genetically modified', and 'organic'), beer ('best liked', 'moderately liked', and 'least liked'), and information x beer. Only information had a significant effect on liking. Information on farming systems is also capable of changing consumer liking (Kihlberg et al., 2005). Liking of bread was affected by, among other things, information on farming systems regarding the used flour. Information about organic production had a greater positive effect on liking than other types of information, especially for less well-liked products. Another study shows that information on (novel) processing techniques affected expected and actual liking (Cardello, 2003). Respondents were asked to evaluate chocolate pudding. Three to six weeks later respondents returned for a second study where they were led to believe that the product was produced with one of the 20 selected food processing techniques (there were 20 techniques selected by the researcher). The results show that the expected liking for puddings declined compared with the baseline preference of the earlier evaluations.

Information has thus an influence on the consumer beliefs. However, the saliences of the beliefs can also be influenced. In making certain criteria's more salient, producers can prime product attributes or frame them. Framing can be seen as a specific application of priming. Framing enables properties of products to be enhanced that are more likely to evoke certain beliefs and feelings of consumers, just as in priming. For producers it is often possible to frame a given decision problem in more than one way (Tversky & Kahneman, 1981), even when the representations would be regarded as equivalent (Bettman et al., 1998). The effects of this framing should become apparent by higher importance scores for the attributes on which the product is framed (Bettman & Sujan, 1987). The outcome of the decision problem can thus be different, dependent on the context. Van Kleef, Van Trijp, & Luning (2005) framed a set of health claims in either an 'enhanced function' format or a 'reduced disease risk' format. The results showed that framing was important in consumers' evaluation of the health claim, but the effect depends on the type of health benefit communicated.

In this research two breeding technologies will be framed, namely traditional breeding and genomics enabled breeding. It will be interesting to see how consumers react on the framing of traditional breeding, but especially on the genomics enabled breeding technology. We know that the attitude of consumers towards genetic issues like genetic modification has already been the subject of many research projects in Europe (e.g. Saher, Lindeman, & Hursti, 2006; Magnusson & Hursti, 2002; Miles, Ueland, & Frewer, 2005; Frewer, Howard, & Shepherd, 1996). It is well known that European consumers' attitudes toward GM in food production are negative (Grunert, Bredahl, & Scholderer, 2003). Numerous opinion polls like the Eurobarometer survey have shown that consumer do not like the idea of genetically modified organism in their foods (Grunert et al., 2003). In a recent Eurobarometer survey respondents were asked if they were very worried, fairly worried, not very worried, or not at all worried by genetically modified products in foods and drinks. Twenty-five percent of EU citizens answered 'very worried' and 37 percent answered 'fairly worried' (European Commission, 2006). One of the three countries where less than one in two declares that they are on the whole worried was the Netherlands (42%) (European Commission, 2006). Finland and Sweden (46% in both) were the other two countries (European Commission, 2006).

One of the framing conditions is, as explained, genomics enabled breeding. Genomics is defined as the science that studies the structure and function of genomes and, in particular, genes (Lexicon EncycloBio, 2006). Genomics envisions the complete study of the hereditary material of living beings (Lexicon EncycloBio, 2006). Genomic research in plant breeding can be defined as research that is generating new tools, such as functional molecular markers and informatics, as well as new knowledge about statistics and inheritance phenomena that could increase the efficiency and precision of crop improvement (Varshney, Graner, & Sorrells, 2005). Genomics thus differs from GM. Where genomics research studies the structure and function of genomes mainly to improve efficiency and effectiveness of breeding practices, GM alters the structure of the genomes by actively modifying them. Both breeding technologies will produce products that can be encountered by the consumer (in the future). It is important to know how consumers perceive products bred or produced with these technologies. The consumer attitudes towards genetic issues are rather negative, as just discussed. These attitudes are based on the perceptions of consumers towards GM (e.g. Grunert et al., 2003; Frewer 2003; Grunert et al., 2001). Since genomics is a relatively new technology there is, to our knowledge, little known about the consumer perceptions towards genomics. It is therefore interesting to see how information on this new technology will influence the consumer.

Based on the studies described above and the new emerging technology of genomics, we hypothesize that consumer's preferences will differ when they receive information about the method of production. In this study we hypothesize that consumers will have a higher preference for products produced in a traditional way. Information about a traditional way of breeding will not evoke special thoughts by consumers since it is the default option for them. This will be different with the information provided about genomics. Attitudes towards non-traditional products are sometimes quite negative (e.g. Gamble,

Muggleston, Hedderley, Parminter, & Vaughan, 2000), especially in Europe. Consumers in general have an overwhelming preference for conventional products, even though most of the benefits of genetic modification are acknowledged (Grunert, Bech-Larsen, & Bredahl, 2000). The lack of confidence in the use of genetic modification reduces the potential benefits. We believe that consumer preferences of genomics products will be low because of the negative attitudes towards non-traditional products and we believe that these attitudes will be evoked by framing genomics as method of production.
Further we hypothesize that the information provided will not change the beliefs but the saliences of those beliefs and in this way cause a change in the preferences of consumers. By framing the method of production, we make the method of production more salient for consumers, especially for the consumers in the genomics condition, as mentioned. The resulting effect will be that the evaluations of the beliefs change. Cardello (2003) assessed the influence of mentioning different product technologies on the expected liking/disliking by comparing baseline preference ratings and expected liking ratings, as described above. He found a significant change in the ratings caused by the information. We believe that information about the method of production will change the evaluations of the beliefs. Bettman and Sujan (1987) stated that framing should become apparent by higher importance scores for the attributes on which the product is framed. In our study we use the method of production as framing concept and this should become apparent in the saliences of the beliefs.

3.3 Methodology

Design and participants
The data collection started with collecting consumers' evaluations on the characteristics and overall liking of tomatoes, in a simulated store situation and a simulated home situation. Besides these evaluations we asked respondents to rate the importances of attributes in their evaluations, again regarding the store and home situation. Altogether we have obtained three sets of data; the first dataset regarding the preferences of consumers, the second concerning their beliefs and a third one regarding the self-rated importances of their beliefs. Based on these datasets we can also derive the importances of their beliefs. The importance ratings of the beliefs are the expressed saliences of the beliefs.
The conceptualization of the study was accomplished by means of a questionnaire. The questionnaire for this research covered an in-store situation as well as an actual consumption situation. The basis of the questionnaire is founded in in-depth interviews and literature. Interviews were taken from 12 persons and took between 5 till 20 minutes. Prior to administering, the questionnaire was pre-tested among seven respondents who indicated no need for change.
As stimuli in this study we used 94 selected cultivars of tomatoes. Special care

was taken to ensure the comparability of the tomatoes. The tomatoes were picked in a specific pre-defined color stage and were transported to a commercial marketing research agency to be preserved at room temperature over night for the consumer tests the next day. The consumer tests were spread over four days. Every time the same procedure was followed. The tests took place in a commercial market research agency, which had a special designed room where respondents sat in half open cubby-holes.
The consumer data were collected by asking respondents to imagine and behave as they were in a store and at home. This implied that they were first asked to observe the tomato (shop situation) and secondly to cut and taste the tomato (home situation). They were thus asked to rate their preferences and beliefs. Respondents worked individually and at their own pace and tested two to five tomatoes per session. The session ended with the self-rated importances and some demographic questions. The data was collected among a sample of Dutch consumers who hold main responsibility for the food purchases in the household and eat tomatoes at least twice a month. Over 80% of the sample was female as men still are a minority in the responsibility for household food purchases. In The Netherlands over 65 percent of the time spent on food purchase is done by women, for food preparation this is more than 62 percent (SCP, 2000, p. 33). In general, time spent by men on households activities, as food purchases, is about the same in all countries except for Japan, Norway, and Sweden (Cornelisse-Vermaat, 2005). The age of the respondents ranged from 20 till 60 years with a mean of 38.75. Their level of education ranged from elementary school till academic schooling.
Respondents participated in the research for an hour, for which they were paid 10 euros. In total 103 respondents participated of which 53 respondents received the traditional information condition and 50 respondents received the genomics information condition. Given the information condition we adopted a between subjects design for this study.

Procedure

To test the influence of information on the consumer decision making process we framed the method of production by means of an information condition. Two groups of respondents received different information regarding the method of production of tomatoes. Respondents were randomly assigned to one group and received information about the production process by means of a written introduction. The first group was informed that the method of production was traditional (breeding). Respondents were told that:

> *'You are about to evaluate tomatoes. The tomatoes in front of you are tomatoes produced by means of traditional plant breeding. Traditional plant-breeding implies that the tomato-plants are crossbred to combine the favorable characteristics of the different plants after which the best*

plants are selected and multiplied. The tomatoes of these plants are available in every store.'

The second group was the group that was informed that the method of production involved genomics. These respondents were told that:

> *'You are about to evaluate tomatoes. The tomatoes in front of you are tomatoes produced by means of modern plant breeding. Modern plant-breeding implies that the tomato-plants are crossbred to combine the favorable characteristics of the different plants after which the best plants are selected and multiplied. Modern plant breeding uses knowledge of the genetic material of the tomato. The modern science dealing with this is called genomics. The tomatoes of these plants are available in every store.'*

The information condition was the only difference between the two groups. Respondents received the same tomatoes, bred in a traditional way. Respondents were thus led to believe that they received genomics tomatoes. Despite that fact, there were no refusals to eat 'genomics' tomatoes. Tomatoes can be bred by means of genomics but these tomatoes are not available in the stores.

Measures

The respondents were asked to rate their preferences and beliefs for the items. They could answer on a seven-point Likert-type scale from totally not agree to totally agree. For the self-rated importances respondents were asked which aspects are important for them when they buy and consume tomatoes. In total they were asked to rate 26 items (see Table 4), which could be answered on a seven-point Likert-type scale running from not important to very important. The collected consumer preferences and beliefs items were submitted to Principal Component Analysis (PCA) to uncover the basic constructs in the store and home situation, separately. Given the division between the in-store situation and at home situation, we conducted per situation two PCA's; one regarding the beliefs of consumers and one regarding their preferences. The principal components were selected based on the criterion of eigenvalues greater than 1 and had factor loadings of more than .50 and all dimensions have a reliability above the recommended .70 (Hair, Anderson, Tatham, & Black, 1995).

The conducted PCA's on the items revealed four belief constructs (credence attributes (α = .90), color (α = .88), shape (α = .84), and taste expectation (α = .88)) and one preference construct (quality expectation (α = .95)) regarding the in-store situation. In the at home situation the PCA revealed five belief constructs (taste and flavor (α = .88), hardness (α = .86), sweet taste (one item), easiness (one-item), and inside appearance (α = .89)) and also one preference construct (quality experience (α = .93)). The items belonging to each construct, for both the in-store as at home situation are integrated in Table 3.3.

Data analysis
After calculating the PCA's we performed three analyses. First, an Analysis of Variance (ANOVA) was performed on the preferences and beliefs with the information condition as an independent variable. Second, to assess the saliences of the beliefs we conducted an OLS regression with the information condition as interaction effect. The following equation was tested: preference = $b_1B_1 + b_2I_2 + b_3B_1I_2$, where B_1 are the belief constructs like e.g. color, I_2 is the information condition, thus 'traditional' and 'genomics', and the interaction term between those two variables. The resulting betas are the derived saliences of belief. Third, an AVOVA was performed to test the difference between the self rated importances for the information conditions. Besides these analyses we calculated the correlations between the individual items of the principal component and the component itself. More importantly we tested if these correlations differ significantly from each other between the different information conditions. To be able to test this we had to use Fisher's Z transformation (Hays, 1973).

3.4 Results

To test if consumers had different responses, depending on the framed condition regarding the method of production, we performed an ANOVA. The results show that the principal component 'sweet taste' was the only factor where the consumer beliefs of the two groups was significant different based on the information condition [$F(1, 888) = 13.92$, $p < 0.001$]. The tomatoes were believed to be sweeter in the genomics condition than in the traditional condition. In general we see that there are small differences between the two conditions. The tendency is that the quality beliefs of consumer regarding tomatoes are better for the traditional produced tomatoes. The same result occurs regarding the consumer preferences, where the traditional produced tomatoes are valued higher. Consumers have a preference for the traditional method of production regarding tomatoes. The results of the ANOVA regarding the principal components are presented in Tables 3.1 and 3.2.

The results of the OLS regression, thus the derived saliences of the beliefs, are presented in Table 3.3. This table gives the main effects of the constructs and the information condition, and the interaction effect between the two variables regarding the preferences of consumers. All main effects between the preferences and beliefs were significant, implying that the beliefs of consumers influence their preferences. Further we see that the relative priority of an attribute or the salience of the belief is altered by the information on the method of production. Credence attributes become more salient in the consumer evaluation when the information condition covers genomics variant ($\beta = -0.038$; $p < 0.05$). The interaction effect in the regressions regarding sweet taste ($\beta = -0.081$; $p < 0.05$)

3.1: Product information differences of in store-constructs

	Information condition			
	Traditional	*Genomics*	*F value*	*Sig.*
Constuct	Mean values			
Beliefs				
Credence attributes	4.94	4.92	0.05	0.83
Color	4.72	4.79	0.51	0.47
Taste expectation	5.11	4.92	3.37	0.07
Shape	4.73	4.82	0.81	0.37
Prefences				
Quality expectation	4.70	4.62	0.50	0.48

** p < 0,05; ** p < 0.01; *** p < 0.001*

Table 3.2: Product information differences of actual consumption- constructs

	Information condition			
	Traditional	*Genomics*	*F value*	*Sig.*
Construct	Mean values			
Beliefs				
Taste and Flavor	4.77	4.64	2.48	0.12
Hardness	4.80	4.79	0.02	0.89
Sweet taste	3.61	4.02	13.93	0.00***
Inside Appearance	5.10	4.94	2.62	0.11
Easiness	2.14	2.15	0.01	0.94
Preferences				
Quality experience	4.50	4.32	2.77	0.10

**p < 0.05; ** p < 0.01; *** p < 0.001*

was also significant, implicating that the information about genomics influences the preferences not only by altering the beliefs but also by making the beliefs more salient.

Table 3.3 further provides all the correlation coefficients between the individual items and the constructs. By means of Fisher's Z we were able to test the hypothesis that two populations show equal correlations. The results show that, in general, the correlations in the genomics information condition are higher than in the traditional condition. This is supported by the items 'naturalness', 'tasteful look', 'freshness', and 'intact surface' where the correlations in the genomics condition are significant higher (.05 level, two-tailed) than for the traditional condition. This implies that the information condition changes the correlations between the items and the construct and in this case strengthens the correlation between the items and the construct in the genomics information condition. This can explicitly be seen in the construct of taste expectation.
The influence of information on the self rated importances of consumers was also tested. In the buying situation, thus in the store, we see that consumers find color [F (1, 101) = 5.00, $p < 0.05$] significantly more important in the traditional information conditions than in the genomics condition. In the consumption situation, thus at home, consumers find again color [F (1,101) = 7.32, $p < 0.01$] and also smell [F (1,101) = 5.88, $p < 0.05$] significantly more important in the traditional information conditions. Table 3.4 presents all the results.

3.5 Discussion

The differences in consumer beliefs between the traditional and genomics information condition were generally small. The tendency is that the quality beliefs of consumers regarding tomatoes are better for the traditional produced tomatoes. Since the differences are small there were not many significant relations present. However, the information provided to the respondents alters the beliefs of respondents regarding the sweetness of the taste significantly. One possible explanation may be that consumers have the idea that, when tomatoes are not produced traditionally, producers can alter the tomatoes and make them sweeter than traditional bred tomatoes. Another explanation may be that given the amount of tests always some relations will be significant, and in this case thus sweetness, since we can not think of any other explanations for this result.
The consumer preferences also showed a higher preference for traditional produced tomatoes. There was however no significant difference between the two conditions. The fact that consumer have a higher preference for traditional tomatoes was in line with our expectations, since attitudes towards non-traditional products are sometimes quite negative. Although genomics only mildly deviates from traditional production it is still a non-traditional production method, in the eyes of consumers. Genomics may thus bias consumer decision making also because of the associations it may evoke with genetic modification. These lines of reasoning by consumers may result in higher preferences for the traditional production method.

Table 3.3: Derived saliences and correlations with regard to product information conditions

Situation	Constructs	Derived Salience (Beliefs)	Derived Salience (Information)	Derived Salience (Interaction effect)
In store Beliefs	Credence attributes	.83***	.02	-.04*
		$F (3, 886) = 680.32, p < 0.001, R^2 = .70$		
	Color	.69***	.04	-.00
		$F (3, 886) = 265.49, p < 0.001, R^2 = .47$		
	Taste Expectation	.85****	-.03	-.02
		$F (3, 886) = 777.43, p < 0.001, R^2 = .72$		
	Shape	.54***	.04	-.04
		$F (3, 886) = 119.20, p < 0.001, R^2 = .29$		
Preferences	Quality Expectation			

The decision making process is among other things characterized by the consumer preferences and consumer beliefs. The relation between consumer preferences and consumer beliefs on their turn is characterized by the saliences of the beliefs. In this study we see that information on the production method does to some extent influence the beliefs of consumers but more importantly influences the saliences of those beliefs. For example, credence attributes become more salient when consumers received the genomics information condition. This result is in line with the findings of Cardello (2003). He found a significant

Items	Traditional	Genomics	Fisher's Z
		Correlation coefficient	Correlation coefficient
Healthy	.87**	.94**	-1.95
Naturalness	.35**	.73**	-2.81**
Safety	.76**	.83**	-0.97
Environment	.56**	.76**	-1.77
Red color	.76**	.63**	1.26
Good color	.88**	.80**	1.43
Evenly color	.61**	.66**	-0.45
Tasteful look	.89**	.95**	-2.32*
Fresh	.77**	.93**	-3.25**
Intact	.60**	.81**	-2.16*
Round shape	.35**	.49**	-0.85
Good shape	.59**	.69**	-0.89
First impression	.95**	.96**	-0.39
Willing to buy	.94**	.95**	-0.63
Quality	.94**	.96**	-0.95

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

decline in expected liking/disliking ratings for the used technology names compared with the baseline preference ratings. Our study shows that mentioning the method of production changes consumer preferences. This can be explained by the changing saliences. The information regarding the method of production changes the saliences and this leads to changing consumer preferences.
The changes in the consumer preferences are however small and not significant. Other studies regarding the influence of information did lead to significant changes of the consumer preferences. Since the sample size of our sub-samples

Table 3.3 (continued): Derived saliences and correlations with regard to product information

Situation	Constructs	Derived Salience (Beliefs)	Derived Salience (Information)	Derived Salience (Interaction effect)
Actual consumption Beliefs	Taste and Flavor	.87***	.01	.00
		$F(3, 886) = 926.65$, $p < 0.001$ $R^2 = .76$		
	Hardness	.25***	.05	-.05
		$F(3, 886) = 21.06$, $p < 0.001$ $R^2 = .07$		
	Inside appearance	.73***	.05	.00
		$F(3, 886) = 333.71$, $p < 0.001$ $R^2 = .53$		
	Sweet taste	.38***	.10**	-.08*
		$F(3, 886) = 49.13$, $p < 0.001$ $R^2 = .14$		
	Easiness	-.09*	.06	.03
		$F(3, 886) = 3.12$, $p < 0.05$ $R^2 = .01$		
Preferences	Quality experience			

conditions.

Items	Traditional	Genomics Correlation coefficient	Fisher's Z Correlation coefficient
Fresh taste	.58**	.71**	-1.14
Juiciness	.41**	.58**	-1.12
Ripeness	.53**	.64**	-0.82
Appealing	.92*	.93**	-0.30
Nice look	.88**	.86**	0.38
Solid	.29**	.54**	-1.55
Hard	.03	.13	-0.51
Solid while chewing	.31**	.36**	-0.27
Hardness core	.09	.28**	-1.01
Inside look	.65**	.72**	-0.72
Inside color	.57**	.67**	-0.74
Nice core shape	.48**	.65**	-1.24
Sweet taste	.27**	.36**	-0.49
Easy to cut	-.05	-.27*	1.10
First impression	.66**	.77**	-1.14
Willingness to buy	.95**	.94*	0.44
Quality	.94**	.94**	0.20
Overall positive impression	.95**	.94*	0.45

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.4: ANOVA self rated attribute importances

Situation	Items	Traditional Self-rated	Genomics Self-rated	F.	P-value
In store	Healthy	6.32	6.32	.00	1.00
	Naturalness	5.81	5.66	.55	.46
	Safety	6.00	5.76	1.11	.30
	Environment	5.25	4.80	2.69	.10
	Evenly color	5.04	5.02	.00	.95
	Color	5.79	5.38	5.00	.03*
	Damages	5.49	5.72	.71	.40
	Fresh	6.19	6.40	1.45	.23
	Firmness	4.70	5.18	3.04	.08
	Smooth	4.83	4.72	.14	.71
	Smell	5.28	5.04	.64	.43
	Ripeness	6.08	6.08	.00	.98
	Shape	4.02	4.32	1.00	.32
	Size	3.79	3.98	.34	.56
Actual consumption	Smell	5.77	5.14	5.88	.02*
	Juiciness	5.96	5.72	1.56	.22
	Ripeness	6.17	6.08	.35	.55
	Shape	3.77	4.08	1.00	.32
	Solid	5.49	5.44	.07	.79
	Core shape	3.66	3.64	.00	.95
	Fruit flesh	5.66	5.68	.01	.92
	Hard	5.32	5.16	.49	.48
	Hardness core	4.89	4.66	.53	.47
	Inside color	5.64	5.02	7.32	.01**
	Amount of seeds	4.21	4.12	.07	.79
	Taste	6.70	6.56	1.32	.25

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

are about as large as the studies of Cardello (2003), Kihlberg et al. (2005), and Caporale and Monteleone (2004) we believe that the lack of significant effects can be found in the introduction given to the respondents and not in the sample size. In our introduction, genomics is closely positioned to traditional breeding, while in other studies (e.g. Caporale and Monteleone, 2004) terms like biotechnology were used to set apart the specific technology from traditional breeding. Another explanation for the non significant effects in the consumer preferences between the two information conditions can be that genomics is a relative new concept and that it may not have reached the vocabulary of the public yet (Nap et al., 2000).

One limitation of this research is that it is conducted in one country only, namely The Netherlands. It is known from the Eurobarometer that Dutch consumer are quite receptive to genetic based product propositions as GM. Other countries such as Greece and Italy are much more reluctant. Previous research also identified greater resistance to biotechnology in Europe than in the USA (Hoban, 1997). This may affect the generalizability of the findings which may depend on attitudes towards genetic based technologies. This state of comparative analysis is an important issue for future research.

Through this research we know that information regarding the production technology influences the saliences of beliefs and thereby the consumer preferences. This can be caused by changing consumer images regarding those production technologies. Future research can try to explore the images consumers have about these non-traditional production technologies. Certainly, because these images can play an important role in the acceptance and preferences of products. To stimulate and improve the consumer acceptance for these non-traditional production technologies, an appropriate communication strategy has to be developed which can influence the images of consumer.

Chapter 4

Consumers' images regarding genomics as a tomato breeding technology: 'maybe it can provide a more tasty tomato'[6]

Abstract

Methods of production are becoming more important to consumers in their decisions about whether or not to buy or consume a certain product. This decision making process is influenced, among other things, by the images consumers have with regard to the product and its method of production. In this research, consumer images regarding plant breeding technologies were ascertained by means of focus group discussions. Thirty-five respondents, divided into four homogenous groups, were given descriptions of three plant breeding techniques and challenged to provide and discuss their images of these technologies. The discussions resulted in images about genetic modification, genomics, and conventional breeding. It was interesting to see that elaboration of the descriptions changed the consumers' images, especially regarding the positioning of genomics in relation to the other two technologies. Whereas initially consumers' images placed genomics close to genetic modification, further discussion and clarification resulted in a re-positioning of genomics closer to conventional breeding.

6 This chapter is published as Van den Heuvel, T., Renes, R.J., Gremmen, B., Van Woerkum, C., & Van Trijp, H. (2008). Consumers' images regarding genomics as a tomato breeding technology: 'maybe it can provide a more tasty tomato'. *Euphytica* 159: 207-216.

4.1 Introduction

In addition to the sensory qualities of a tomato and of course the price, the method of production is becoming an increasingly important factor in consumer decision making (Deliza, Rosenthal, & Silva, 2003; Grunert, Bredahl, & Scholderer, 2003), and the acceptability of the production method can be a major determinant of consumer preference (Verbeke & Viaene, 1999). In contrast to the sensory qualities of a tomato, which can easily be experienced, properties such as the acceptability of the production method are more difficult for consumers to assess. To make such an assessment, consumers require insights into the production process itself and its implications. Most consumers lack the knowledge and often the motivation that would be required for such detailed and in-depth assessment. This inability, however, does not necessarily mean that consumers would refrain from making a judgment on the tomato's performance on credence qualities. Rather, they would tend to base their judgment on much more intuitive and peripheral assessments than on deliberate and elaborated ones.

The distinction between intuitive and deliberate assessment of information by consumers has important implications for many aspects of consumers' decision making, such as advertising effectiveness (Scholten, 1996), trust (Yang, Hung, Sung, Farn, 2006), and image formation (Poiesz, 1989). This research focuses on the image formation of consumers regarding the production method and especially on the outcome of intuitive assessments of the production method.

Since some methods of production are new to consumers, information is not always available, not easily understood, and not well contextualized yet, and quite often generates ambivalent feelings in consumers (Wagner & Kronberger, 2001). Different sources of information often make contradictory statements, and this adds to the feeling of uncertainty (Jonas & Beckmann, 1998). In such situations, consumers often use images, because images are first impressions, often intuitive, and can be seen as spontaneous categorizations or simplification strategies (Hong, Kim, Jang, & Lee, 2006) in consumers' decision making.

These first intuitive assessments are especially relevant in the case of new technologies; after all, a first impression can only be made once. In this study, we focus on the new food technology of genomics that has yet to make its appearance in the market place. Nowadays, most plant scientists do not consider genomics to be a breeding practice, but rather a toolbox which may be used, for example, to improve selection in either conventional breeding or breeding by way of genetic modification (GM). Since about 2000, most professional tomato breeding has been using genomics techniques, mainly molecular markers. As a consequence, conventional breeding (without genomic tools) is becoming extinct. This study follows the lead of Varshney, Graner, and Sorrells (2005) and considers genomics as a future breeding practice. This new technology can potentially evoke ambivalence, mainly because of the different perceptions that

are at stake. On the one hand it can be seen as close to conventional plant breeding, but on the other it may elicit associations with GM.
The position of genomics, as perceived by consumers, in this continuum between conventional breeding and GM will be elemental for its success. A position close to GM, for example, may be less favorable because of the negative attitudes of most consumers toward GM in food production (Grunert et al, 2003). On the other hand, it may be favorable because GM products may solve environmental problems or result in lower food prices (Grunert et al, 2003). To explore consumers' images regarding genomics and its positioning relative to GM and conventional breeding, focus groups interviews are used where respondents are given the opportunity to give their first impressions and interact with each other, with regard to these breeding practices. The purpose is to asses whether consumers have comparable images regarding genomics on the one hand and GM or conventional breeding on the other.
In the next section, we present information on genomics as this production technology is our primary focus. This is followed by some theoretical background, after which the methodology of the study is presented as well as the results. The results and limitations of this study are then discussed.

4.2 Plant breeding practices

The focus on genomics, GM, and conventional breeding is interesting since these breeding practices can be compared with each other. This comparison is even more interesting since genomics has associations with both GM and conventional breeding. In this section, the technologies, as defined in the literature, are presented, starting with conventional breeding and followed by genomics and GM. The definitions used in this research to inform the consumers are also presented.
In the past four decades, conventional breeding has contributed significantly to the improvement of vegetable yields, quality, post-harvest life, and resistance to biotic and abiotic stresses (Dalal, Dani, & Kumar, 2006). Conventional breeding implies that selected plants are crossed and progenies selected that combine the favorable characteristics of the different plants. Major activities of the conventional breeding approach include screening of germplasm for new traits and creating new crosses to recombine sources of variation in new genotypes (Ishitani, Rao, Wenzl, Beebe, & Tohme, 2004).
In this research, conventional breeding was specified and presented to consumers as *'breeding based on the appearance of different plants. The breeder looks for plants with certain characteristics such as 'many fruits' or 'round tomatoes'. Subsequently he crossbreeds the plants. The genes of these plants will be mixed. The new plant will have the characteristics of both parents. The characteristics of this new plant cannot be determined in advance. Afterwards, when the plant is grown, it can be deter-*

mined if the plant has many tomatoes and round tomatoes, and then the selection of the plants can begin'.

Genomics envisions the complete study of the hereditary material of living beings (Lexicon EncycloBio, 2007). Genomics research studies the structure and function of genomes to improve the efficiency and effectiveness of breeding practices, whereas GM alters the structure of the genomes by actively modifying them (Lexicon EncycloBio, 2007). Genomic research in plant breeding can be defined as research that is generating new tools, such as functional molecular markers and informatics, as well as new knowledge about statistics and inheritance phenomena that could increase the efficiency and precision of crop improvement (Varshney et al, 2005). Genomics will provide large quantities of data on plants grown as primary material (Pridmore et al, 2000). These data can be used in three ways: firstly, as a powerful tool to identify and characterize plants of commercial interest and as an important aid to rapidly advance breeding programs (Pridmore et al, 2000); secondly, to monitor the response of plants or micro-organism to their environment and as a tool to adapt the growth conditions more closely to their needs (Pridmore et al, 2000); thirdly, for the modification of plants or micro-organism to produce new varieties with improved farming, health, nutrition or processing characteristics by the exploitation of the information by the use of biotechnology (Pridmore et al, 2000).

Genomics was specified as *'breeding based on the DNA of different plants. The breeder looks for plants with certain characteristics such as 'many fruits' or 'round tomatoes'. He determines which genes are responsible for these characteristics. The breeder then will crossbreed the plants with the desired characteristics. This is faster than with conventional breeding. The new plant will have the characteristics of both parents. During a test, it will be determined which specific characteristics are present in the plant. Because of this, the best plants can be selected faster'.*

Genetic modification of food involves deliberate modification of the genetic material of plants or animals (Uzogara, 2000). Many foods consumed today are either genetically modified whole foods, or contain ingredients derived from gene modification technology (Uzogara, 2000). New food products made from genetically modified crops started appearing in U.S. supermarkets in 1996 (Huffman, Rousu, Shogren, & Tegene, 2007). The rapid adoption of genetically modified food crops with improved agronomic characteristics in the US, Argentina, and Canada stands in strong contrast to the situation in the EU (Kuiper, König, Kleter, Hammes, & Knudsen, 2004).

Genetic modification is specified as *'breeding based on the DNA of different plants. With genetic modification, one characteristic will be cut out of the DNA. This characteristic will be added without changing the other characteristics. Only the desired gene will be transferred instead of crossbreeding two plants. To be sure that the new gene will provide the plant with the desired characteristic, several generations of plants will be grown'.*

The focus on genomics, GM, and conventional breeding is interesting since these breeding practices can be compared on two determinants in plant breeding. The first determinant is the degree of human manipulation of DNA, and the second determinant is the degree of focus with regard to the plants. The breeding technologies and their place on the axis are visualized in Table 4.1.

Table 4.1: Plant breeding technologies

Plant breeding technologies		Plant focus		
		Phenotype		Genotype
Human manipulation of DNA	None	Conventional breeding	←→	Genomics
				↕
	Much			GM

The first axis on which the plant breeding technologies can be categorized is the degree of human manipulation of the DNA. Traditionally, plants have been crossed by humans to develop better plants with better yield, but this human manipulation cannot be categorized as direct human manipulation of the DNA. Nowadays, it is possible to actively sort the DNA of plants and manipulate the plants in this way. The second axis indicates the degree of focus regarding the plants, where the endpoints are phenotype and genotype. Traditionally, plant physiologists have studied the relationship between crop performance (the phenotype) and the environment, but nowadays crop performance can also be increased by modifying the crop genome (the genotype) through plant breeding and molecular biology (Edmeades, McMaster, White, & Campos, 2004).
As can be seen from Table 1, conventional breeding involves no direct human manipulation of the DNA and it is applied at the phenotype level. Genomics is placed to the right of conventional breeding since DNA is not manipulated, but parent and progeny plants are selected based on the presence of characteristics that can be identified by using DNA techniques. GM is placed on the lower right-hand side of the table since the modification involves direct human modification of the DNA and it takes place at the genotype level.

4.3 Theoretical background

Biotechnology and consumers

Biotechnology has been the object of considerable debate in most European countries in the past decade (Pardo, Midden, & Miller, 2002). The application of modern biotechnology to food has raised concern amongst the European public (Barling et al, 1999). The public perception of biotechnology applications has been characterized generally as negative (Pardo et al, 2002; Marris, Wynne, Simmons & Weldon, 2001; European Commission, 2006; Moses, 1999). This negative perception of biotechnology and its applications is not based on objective knowledge, as the knowledge of the public about biotechnology is very limited (Pardo et al, 2002; Gaskell, Bauer, Durant, & Allum, 1999; Hamstra & Smink 1996). Nonetheless, this lack of knowledge and understanding does not appear to prevent attitude formation regarding perceived risks and benefits associated with biotechnology (Frewer, Shepherd, & Sparks, 1994). The attitudes formed towards biotechnology are rather negative as mentioned, especially in Europe. This is in contrast to the United States of America where the general public are seemingly untroubled by biotechnology (Gaskell et al, 1999; Lusk & Rozan, 2005; Hoban 1997; Durant, Bauer, & Gaskell 1999).

One explanation for the negative attitude towards biotechnology could be people's preference for natural entities over those produced with human intervention (Rozin et al, 2004), but even for products involving human intervention like genetically modified food, a GM product that is perceived as more natural is more likely to be accepted than a GM product that is perceived as less natural (Tenbült, De Vries, Dreezens, & Martijn, 2005). The extent to which GM affects the perceived naturalness of a product partly depends on the kind of product (Tenbült et al, 2005) and on what the concept of 'natural' means to consumers (Rozin, 2005).

The image concept

In their decision making, consumers use images, which are created within their minds, as models of the outside world (Hastie & Pennington, 1995). Images, as they are discussed in the literature, range from holistic, general impressions to very elaborate evaluations of products, brands, stores or companies (Poiesz, 1989). The image concept as it is employed by Poiesz is defined as a general impression of the relative position of the object among its perceived neighbors. Although images are composed of many dimensions, the general image may have more to do with intangible (intuitive) aspects than with concrete aspects (Solomon, Bamossy, & Askegaard 2002). The image concept can be seen as a low elaboration approach since the impressions are general and holistic and no deliberate assessment is necessary.

These holistic impressions can well be used when consumers are confronted with new breeding practices. Because of the newness of these practices, consumers have little information available for a deliberate assessment, but will form images about them. The elaboration level will be low because of this lack of information and the most appropriate form of images to be used, then, is holistic impressions. In this article, the image concept is defined as an iconic representation of the relative position of an object (breeding practice) among its perceived neighbors (other breeding practices).

4.4 Material and method

Subjects

In this study we used the focus group methodology, because this provides the opportunity to witness the first impressions of consumers and to explore the dynamics of these images through interaction (communication). Four consumer focus group interviews were conducted with a total of 35 participants. All respondents were recruited based on the criterion of being responsible for food shopping, even when they worked outside the home. In the majority of households these are women, because it is still only a minority of men who are responsible for household food purchases. We therefore chose to recruit only women. The study took place in May 2006 in Utrecht, a city in the middle of the Netherlands, and all respondents lived in or near the city.

The four focus groups were homogenous as to age (old / young) and level of education (high / low). In Table 4.2, the four homogenous focus groups are described. The more highly educated group consists of respondents with academic, higher vocational education, or equivalent schooling. The less educated group consists of respondents with elementary, lower, and middle vocational education, or equivalent schooling. Young respondents ranged in age from 18 to 48 years and old respondents from 49 to 79 years. The categorization of the groups is mainly based on the research of Bäckström, Pirttilä-Backman, and Tuorila (2003).

Table 4.2: Homogenous focus groups

Homogenous focus groups	
A	Young and less educated
B	Old and highly educated
C	Old and less educated
D	Young and highly educated

Stimulus material

Three breeding technology descriptions were used during the interviews. The descriptions introduced the breeding practices, if not already known, to the respondents and were used in the discussion. Each description included a visual and textual explanation of the breeding practice. An example of a description can be found in the appendix (Figure 4.1). The three visual explanations together formed a poster (see appendix, Figure 4.2) which was used in the discussion.

The descriptions were formulated with the help of an expert. The expert is the director of a network comprised of Dutch scientists in the field of plant genomics and the major Dutch companies in plant genomics, breeding, cultivation, and processing.

Conduct of the interviews

The focus group sessions followed an interview guide that had been prepared with the moderator. The interview guide was built upon several themes starting with an introduction round, a free association task, a discussion about the three breeding practices, and a closure.

During the introduction round, it was pointed out to participants that there were no right or wrong answers to the questions and that they should express their honest thoughts, opinions, and beliefs. The participants were seated around a table to allow interaction, eye contact, and free flow of discussion. Each session lasted approximately 90 minutes under similar conditions. Coffee and tea were available to the participants.

Data treatment

The interviews were analyzed for themes by means of thematic coding. Thematic coding enables one to look at groups that are derived from the research question and are thus defined a priori (Flick, 2002). The underlying assumption is that, in different social groups, differing views can be found (Flick, 2002). During each interview, one or two researchers and a reporter wrote down the participants' opinions and impressions. Issues were regarded as important enough for inclusion in the summary when they were mentioned in at least two of the four interview sessions (Brug, Lechner, & De Vries, 1995).

4.5 Results

Group discussion

Naturalness is the first image of the plant breeding practices to be presented. Naturalness can be seen as a dichotomous theme. Whereas conventional breeding was seen as natural: *'With conventional [breeding], I had that it is a natural selection (D6)'*, genomics and GM were seen as artificial and unnatural: *'[genomics] does not even come close to conventional breeding ... there is nothing natural about it (A2)'*; *'I find it [GM] very unnatural, because they use a gene out of something else that has nothing to do with a tomato (D3)'*. However, respondents saw a difference between the unnaturalness of these last two breeding practices. Genomics was perceived to be more natural than GM: *'[genomics] is a bit more natural [than GM] (C4)'*.

It was interesting to find that in the young and more highly educated group genomics was not seen as unnatural as in the other groups. Genomics was perceived as less natural than conventional breeding, but it was considered rather natural: *'[genomics] is still natural (D1)'*. This was clarified even further when the moderator asked about the differences between genomics and GM: *'the difference between genomics and GM is natural versus unnatural (D1)'*.

The second theme regarding the images of plant breeding practices is the *efficien-*

cy of the different practices. A distinction was made between conventional breeding and genomics with regard to efficiency: *'you are in this way [genomics] able to work effectively, when you only use conventional breeding, a lot of things will be lost, but, in this way, you are able to just hold onto the good ones (D7)'*. In the genomics description it was stated that genomics is faster than conventional breeding. Respondents used that statement to conclude that genomics is more efficient than conventional breeding.

The third theme that emerged from the discussions is oriented towards the possible *consequences* of the new plant breeding practices. Respondents were not concerned about conventional breeding. Possible consequences regarding the breeding practices were not mentioned in the descriptions. Prior knowledge could, however, have had an influence, especially with regard to GM: *'[GM] sometimes you read something about it (B7)'*.

The fourth and last theme is *sensory* appeal. Respondents indicated that the taste of the tomato is one of its most important characteristics: *'I am only interested in the taste (B9)'*. This characteristic especially emerged during the discussions even though nothing relating to sensory appeal was mentioned in the descriptions presented to them. The discussion led to some differences regarding this theme with respect to the different breeding practices. Respondents believed that tomatoes bred by means of conventional breeding methods would be the tastiest: *'I have the idea that it [the taste] is best with conventional breeding (B8)'*. This did not mean, however, that other breeding practices could not produce tasty tomatoes. More highly educated respondents linked taste to genomics-enabled breeding and did this in a positive way. They believed that tomatoes bred by means of genomics would be tasty: *'If, by genomics, you could get a little bit more taste again, that must be technically possible (B9)'*.

Dynamics in the group discussion

In the discussions, the respondents were challenged to elaborate on their first associations and images regarding genomics and the other breeding practices. The interaction between respondents resulted in a change of images. In the groups with older respondents (irrespective of educational level), respondents changed their images regarding genomics after some elaboration, thereby placing it from close to GM to close to conventional breeding: *'[genomics] is closer to conventional breeding. I only just believed that the two adapted methods [GM and genomics] were closer to each other (B4)'*. The groups with younger respondents (again irrespective of educational level) did not make much change in their initial associations regarding the positioning of genomics. The less educated young group placed genomics close to GM and the more highly educated young group placed it close to conventional breeding. So, eventually, after some elaboration, three out of the four groups believed that genomics is closer to conventional breeding than to genetic modification: *'[genomics] is very close to the conventional method (B5)'*; *'[genomics] it is actually conventional breeding with more insight (D8)'*.

Overall judgment of the breeding practices

In a general sense, respondents preferred conventional breeding above genomics, and both practices above GM: *'Most of us opt for conventional [breeding] (A8)'*. Conventional breeding is preferred because it is seen as a natural breeding practice, has a good sensory appeal, and respondents are not concerned about this breeding practice. Conventional breeding is an accepted breeding practice. Genomics is also acceptable to consumers, but they have more concerns regarding this practice and do not perceive it to be as natural as conventional breeding. Respondents realized, however, that conventional breeding was old-fashioned and slow, implying that genomics may be the solution for conventional breeding and will, in the future, become the preferred technology. The only group where the majority of the respondents had a preference for genomics as plant breeding technology was the young and more highly educated group: *'[genomics] has a head start on conventional [breeding] (D1)'*. GM on the other hand is not acceptable. The non-acceptability of GM was mainly based on the statement that GM takes and uses specific genes to incorporate into plants but that these are not necessarily genes from tomato plants; they could just as easily be bacteria.

4.6 Discussion

Consumers' images regarding the tomato breeding practices are built on four themes: naturalness, efficiency, consequence, and sensory appeal. Specific themes can be coupled to specific plant breeding practices. For example, conventional breeding was seen as natural. Genomics and GM were seen as unnatural; however, respondents saw a difference between the unnaturalness of these two breeding practices, with GM as the most unnatural. In the descriptions the participants received, nothing was mentioned about the naturalness of the breeding practices; however, the pictures used in these descriptions could have triggered responses with regard to naturalness. Actual pictures of tomato plants were used in the description of conventional breeding, but not in the descriptions of genomics and GM. For the latter descriptions, DNA-strands were used to explain the breeding practices. In comparing the different plant breeding practices, with the given difference in descriptions of plants versus DNA-strands, respondents may perceive the naturalness of the plant breeding practices in a different way.

The result that probably stands out the most is the fact that more highly educated respondents linked taste to genomics-enabled breeding and did this in a positive way. They believed that tomatoes bred by means of genomics would be tasty. A possible explanation for this could be their level of education. The level of education affects the content of argumentation of respondents (Bäckström et al, 2003) and increases their capacity to think. This may lead to a better understanding of the functioning of genomics and the resulting effect it can have on taste.

It was interesting to see that respondents, in the first instance and thus before the further elaboration, perceived genomics and GM as almost the same. Eventually, thus after some elaboration, genomics was not regarded as equivalent to GM by three of the four homogenous groups. The main reason for believing that genomics is closer to conventional breeding is that it is still breeding with tomatoes, thus within the same species. This reason triggered respondents to perceive that genomics is close to conventional breeding and not comparable with GM.

The preference for conventional breeding over genomics and GM may be explained by the preferences consumers have for natural entities above entities produced with human intervention as pointed out by Rozin et al (2004). Consumers perceive conventional breeding as most natural, followed by genomics and then GM, and this may explain the preference for conventional breeding above genomics and GM. The preference for natural entities may also explain why consumers do not accept GM. The extensive human intervention within this breeding practice may decrease the acceptance of GM.

Previous survey studies (Frewer, 1992) have indicated that consumer awareness of biotechnology is low. Although the public debate about GM has been substantial (e.g. Pardo et al, 2002), in this study it became clear that respondents' awareness of biotechnology applications might still be low. Respondents were amazed at the fact that tomatoes could be bred in different ways, using different breeding practices. They knew nothing of the existence of these different breeding possibilities.

The low awareness of biotechnology and its applications triggers the question of how much consumers actually understand about these technologies. The results of this study suggest that such knowledge is limited. Most respondents could not, for example, make a clear distinction between the breeding of tomatoes and the production of tomatoes. Respondents saw these two processes as one.

In spite of limited awareness and understanding of biotechnology and its applications, one daring and preliminary conclusion of this study may be that there has been a slight shift in the public's adverse perception of biotechnology and some of its applications. Biotechnology has always been characterized as negative (e.g. Marris et al, 2001; European Commission, 2006), but this study indicates that at least some respondents, namely, those that are younger and more highly educated, see genomics as positive and as the solution and only possibility for the future. However, the negative perception of GM is maintained.

The question remains as to how it is possible that the images changed in this discussion. By way of the focus group discussions, respondents were asked to diligently consider the descriptions and poster provided. The interaction and the deliberations caused a shift in respondents' elaboration. Instead of their images being formed by intuitive assessment, consumers formed deliberate images about the plant breeding practices. This change will probably not occur in the real life situation because consumers are often not motivated or able to elaborate on the images.

This may change, however, when products produced with genomics or GM cause more concerns to consumers. These concerns may be triggered by the media and NGOs acting as providers of information when products bred by GM or genomics appear on the shelves. In this way, consumers may become involved, and consequently will be more motivated to pursue the issue and thereby make use of more information sources and discuss this topic in their own social groups. The question still remains as to whether the introduction of a GM tomato and certainly a tomato bred by genomics will cause such a public debate. It is difficult to say what the dynamics of the process will be after the introduction of tomatoes bred using a technique other than conventional breeding.

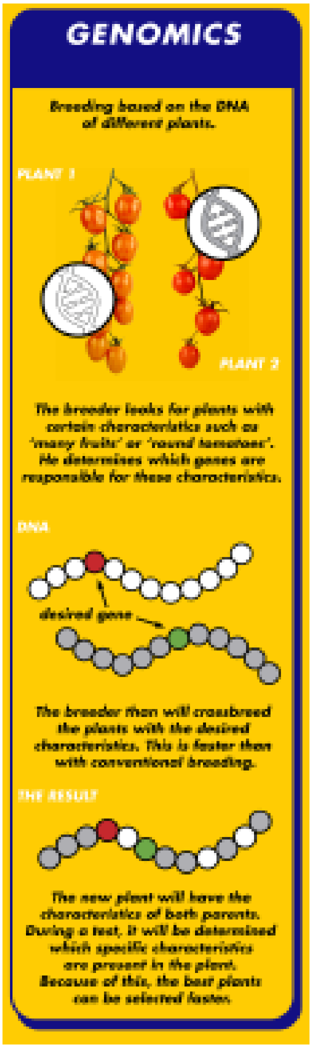
Limitations

It is important to keep in mind that the respondents received input for the group discussion. We have to take into account that this input, in this case the descriptions and the poster, may influence consumers' images. The pictures portrayed may be the most important influence. The picture regarding genomics, where a DNA-strand was used to explain the breeding of a tomato, could have had a more than normal influence. The reason for this assumption is that respondents immediately associated DNA, genes, etc, with GM. By showing the DNA-strand in the genomics picture, we may have positioned genomics close to GM. In spite of our attempts to present the respondents with descriptions that were as neutral as possible, afterwards it seemed that it would have been better if all three examples had been identical, as in reality. Nonetheless, most respondents were able to distinguish genomics from GM after they were presented with the opportunity to elaborate on the plant breeding practices.

To prevent a learning effect, resulting in a disproportionately large number of associations for the last received description, we systematically changed the order of the descriptions. The randomization had, however, an order effect with regard to the breeding practices, especially with regard to the degree of human manipulation of the DNA. Respondents who received a GM description before a genomics description were not always, in the first instance, able to make a clear distinction about how much human manipulation of the DNA was involved. Those specific respondents believed that genomics needed more human manipulation of the DNA than GM.

4.7 Appendix

Figure 4.1: Breeding technology description: genomics.



Genomics can be used as a selection-instrument in the breeding of new crops.

A breeder gets, by means of genomics, insights into all the characteristics of the plant by looking at the genes of the plant.

Hereby he is able to select only those plants with the desired characteristics.

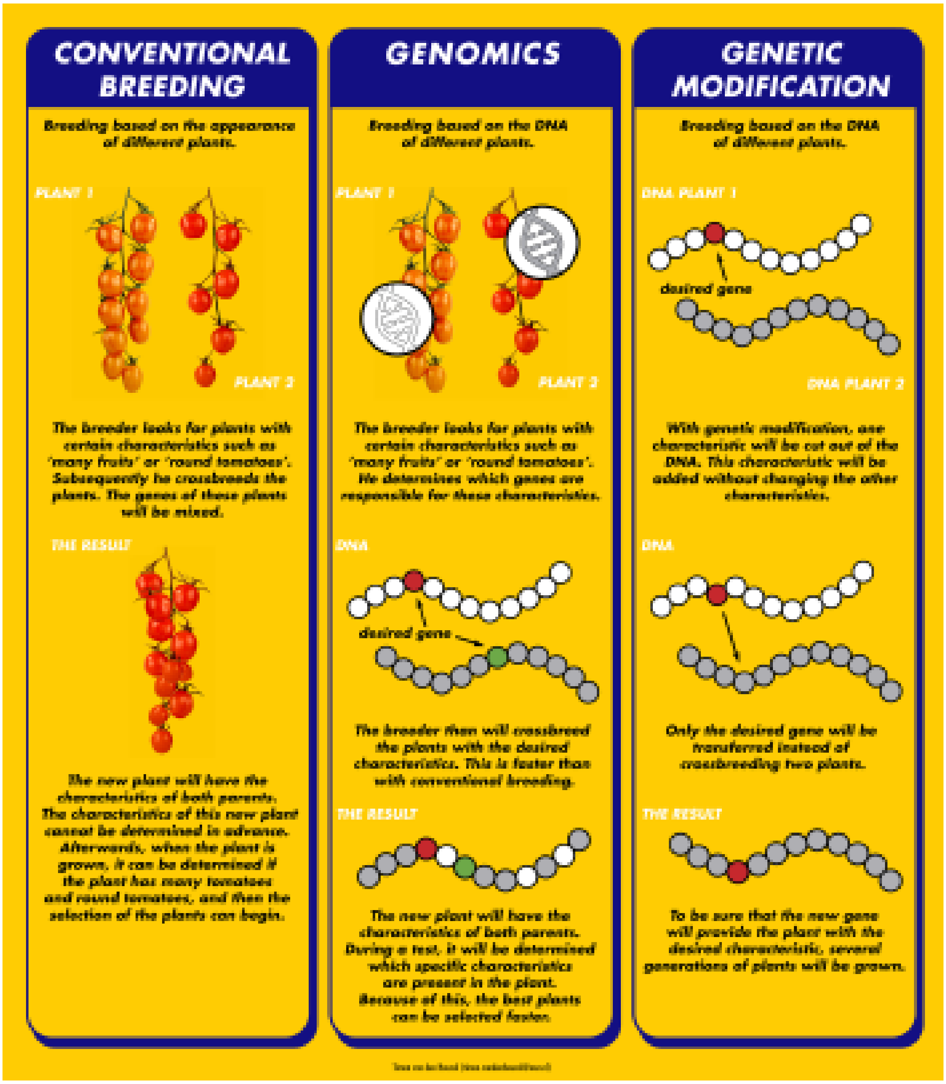
After the crossing it is possible, by means of test, to verify whether the new plant has the desired characteristics.

If the breeder wants a tomato plant which produces many tomatoes and round tomatoes, he is able to look into existing plants to see if these plants possess these characteristics.

By means of genomics, he can cross in one sequence the plant possessing the genes which cause the plant to produce many fruits with the plant with the genes which produce round tomatoes.

Because of this crossing he knows for certain that he will get a tomato plant with many and round tomatoes.

Figure 4.2: Poster breeding technologies



Chapter 5

Consumer judgment regarding genomics: exploring the influence of initial categorization and different modes of thought[7]

Abstract

The influence of initial categorization and modes of thought on consumer judgment towards an ambivalent technology as genomics is investigated. Based on the Categorization theory and the Unconscious Thought Theory, initial categorization and mode of thought were induced as experimental conditions in the study. Analysis of Covariance, with attitude towards technology and specific genomics products as dependent variables, showed that the unconscious mode led to lower utilitarian and hedonic consumer attitudes towards genomics. The study further showed that the attitudes towards genomics as a breeding technology are influenced, while the product attitudes are not susceptible towards influences. In conclusion, the results suggest that consumer judgment regarding genomics is influenced by mode of thought, while initial categorization has no influence regarding the judgment.

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5.1 Introduction

New developments in science and technology have the potential to contribute to various domains of man's quality and comfort of life (Li & Perkins, 2007; Ronteltap, Van Trijp, Renes, & Frewer, 2007), but only in those cases where the developments are accepted and actually adopted by consumers. Early insight into the factors that drive consumer acceptance of new technologies, and the innovations arising from them, is important as it informs the further development of science and technology and its communication (Van Kleef, Van Trijp, & Luning, 2005). However, early assessment of consumer acceptance is not without its problems as, at initial stages of science and technology development, there are still many unknowns, both for the consumer and the scientific and policy communities as to how the new technology will be positioned and communicated and how much impact it will have on the consumers' life.

Consumer acceptance of new technologies is largely founded in consumers' interpretation processes and value assessments (Ronteltap et al., 2007). Upon (first) confrontation with new products, services or technologies, consumers perceive ('what is it?'), interpret ('what inference can I make from it?'), and evaluate ('how much do I like it?') these new developments against the background knowledge already stored in their memory. This psychological process is known as categorization (Rosch 1975; Rosch & Mervis 1975). New information that is perceived as sufficient for cueing a meaningful mental category is categorized immediately upon encountering (Fiske & Neuberg, 1990). For example, a yellow, crescent moon-shaped object with a skin will immediately be categorized by most people as a banana. In those instances, initial categorization provides the consumer with a direct reference point from which to interpret and evaluate since the elicited category schemes inform the consumer about the relevant attributes, their links and the products' relationships to other categories (Stayman, Alden, & Smith, 1992).

However, for many new developments that carry a certain level of ambivalence, initial categorization is not necessarily unambiguous and as straightforward as suggested in the banana example. New technologies, or the innovations arising from them, may have a mental overlap with several different categories in a consumer's memory (Ozanne, Brucks, & Grewal, 1992; Gregan-Paxton, Hoeffler, & Zhao, 2005). As a consequence, consumer perception, interpretation, and evaluation may differ depending on which reference category it is evaluated against. For example, upon first encounter with a PDA phone it may either be categorized as a (highly advanced) phone or as a (much less advanced) minicomputer. Both interpretation and evaluation will differ depending on which mental category is initially triggered from memory and which background knowledge is being activated since the elicited category scheme, i.e. reference point, defines the importance of the attributes of the new product in consumer judgment (Van Ittersum, Pennings, Wansink, & Van Trijp, 2004; Sujan & Bettman, 1989).

New technologies and product innovations, by definition do not fit perfectly in an existing mental category and hence consumer acceptance may be sensitive to flexibility in initial categorization (Gregan-Paxton, et al., 2005). In the present study, we specifically focus on the new technology of plant genomics. Plant genomics is a new plant breeding technology that uses plant genetic information (structure and function of genomes) to improve the efficiency and effectiveness of breeding practices (Lexicon EncycloBio, 2007). Although it makes use of plant genetic information, changes in the plant genetic constitution are only achieved through conventional breeding, which clearly separates this technology from GM. Given the high sensitivity of GM issues in many markets (Pardo, Midden, & Miller, 2002), consumers may either categorize plant genomics in relation to conventional breeding practices (a technologically advanced version of it) or alternatively as an application area of genetic modification. Each of these categorizations may activate a different reference point and hence generate a quite different affective response to plant genomics.

A second, but related, complicating factor in the early assessment of consumer response to new technologies originates from how consumer judgments are elicited. Consumers adopt a variety of information processing approaches which may range from low effort intuitive assessment based on initial categorization, to more deliberate and elaborate cognitive processing of the attribute perceptions of the new technology (Petty, Heesacker, Hughes, 1997). Consumer judgments may differ on how much cognitive effort is being invested as initial 'gut feel' responses ('it feels right') may differ from the more analytical and rational assessment once the information is elaborated upon and further processed (Petty et al., 1997). Intuitive responses and extensive elaboration differ in terms of the time taken for thought and the amount of focused attention in information processing. It is unclear which of the two judgments is more relevant and valid as in real life consumers are also likely to invest much less information processing capacity than they do when participating in consumer research. Dijksterhuis and Nordgren (2006) have recently argued for two different modes of elaboration and thought, the conscious and the unconscious. The key difference between the two modes lies in whether thought is focused on the object that is being judged (conscious), or whether the thought occurs at the background while doing other tasks (unconscious). They show that conscious and unconscious thought processes may lead to different outcomes and different quality of decision making (Dijksterhuis and Nordgren, 2006). Specifically, decisions about simple issues can be better tackled by conscious thought, whereas decisions about complex matters can be better approached with unconscious thought (Dijksterhuis and Nordgren, 2006).

The aim of the present study is to integrate these two line of reasoning (reference point and mode of thought) in the consumer evaluation of a new technology that is potentially ambivalent. For plant genomics, as the technology of interest, we explore how judgments are affected by initial categorization (with conventional breeding and GM as reference points) and by information processing (immediate versus conscious and unconscious thought). The next section elaborates on the theoretical background of the study. Then, the methodology will be presented as well as the outcomes of the study. These outcomes will be discussed in the last section of this paper.

5.2 Theoretical Framework

Initial categorization

In interpreting genomics, as a new technology, consumers have to make sense of the new information they are confronted with. In this process, consumers typically refer to existing knowledge already contained in existing categories in memory to learn about the new instance (Yamachuchi & Markman, 1998). A first step in this learning process is the search for perceived similarities and resemblances (Rosch, 1975; Schoormans & Robben, 1997). If the new instance (in this case genomics) is perceived as sufficiently similar in structure (e.g. the attributes of the product) with an existing category in memory, the new instance is seen as a representative of that mental category. Information contained in the salient category will then be used in the perception (what is it?), the interpretation (what inference can I make from it?) and evaluation (how much do I like it?) of the new instance (e.g. Sujan & Bettman, 1989; Meyers-Levy & Tybout, 1989). In the case of genomics as a plant breeding technology, if consumer find sufficient overlap with conventional breeding they will map the knowledge contained in their conventional breeding category onto the genomics case and use that knowledge in their attribute interpretations, inferences, and overall evaluations of the genomics technology (Gregan-Paxton, Hibbard, Brunel, & Azar, 2002).

This initial categorization process is a flexible process which largely depends on the specific category that is made salient upon confrontation with the new instance. For example, if the genomics technology provides higher perceived overlap with the GM category in memory, then the inferences and evaluations contained in the GM category will be mapped onto perceptions of the genomics technology, which may lead to a different interpretation and evaluation of the new technology. This, of course, dependents on the initial attitude towards GM, as a plant breeding technology.

For really new products the situation is slightly more complex (Gregan-Paxton et al., 2002; Moreau, Markman, & Lehmann, 2001; Gregan-Paxton et al., 2005) as, by definition, consumers will find very limited structural overlap between the new instance and the existing knowledge in memory. In those instances, consumers will seek for higher order analogies (rather than structural overlap in attributes) to go through a process (1) accessing an analogical category, (2) mapping information and knowledge from one or more existing categories ('the base') onto the new instance ('the target'), and (3) generate inferences pertaining to the target (Genter, 1989; Gregan-Paxton et al., 2002; Moreau, Lehmann, & Markman, 2001). Also, in the case of really new products or technologies, the selection of the (initial) base is crucial and may be aided by either highlighting specific analogies or making particular base categories (temporarily) more salient. The selection of the base is crucial because there is often a positive relation between the value of the target and the value placed on the base (Meyers-Levy & Sternthal, 1993). This phenomenon is called assimilation (Martin, Seta, & Crelia, 1990).

In the present study, we explore how guiding consumers towards a particular base category (either GM-based or conventional breeding technology) affects consumers interpretation and evaluation of genomics as a breeding technology. We expect that this will provide useful information for the future positioning and communication of the genomics-based breeding technology. The direction of the effect is expected to be dependent on consumers' a priori attitudes towards GM, which will also be taken into account in this study.

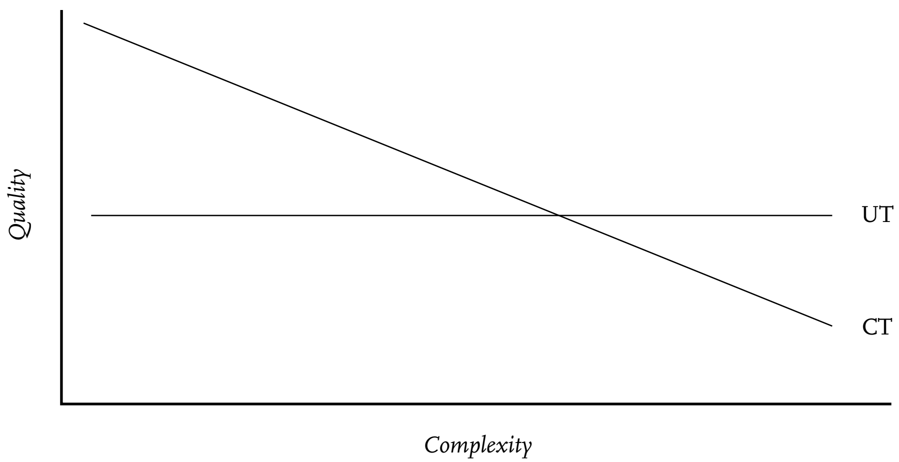
Modes of thought

Dijksterhuis and Nordgren (2006) have recently presented the Unconscious-Thought Theory which distinguishes between two different modes of thought depending on the focus of conscious attention during the deliberation processes. Conscious thought is defined as an object relevant or task-relevant cognitive or affective thought processes that occurs while the object or task is the focus of one's conscious attention (Dijksterhuis & Nordgren, 2006). Unconscious thought refers to object relevant or task-relevant cognitive or affective thought processes that occur while conscious attention is directed elsewhere (Dijksterhuis & Nordgren, 2006). In other words, in unconscious thought, the deliberation processes continue but more in a background mode as the conscious attention is directed to some other object, issue or task. Dijksterhuis, Bos, Nordgren, & Van Baaren (2006) refer to this as deliberation-without-attention.

In a series of studies, Dijksterhuis and colleagues have shown that conscious and unconscious thought (i.e. deliberation with and without attention) may lead to different outcomes. They attribute this to two important characteristics of conscious thought (Dijksterhuis et al., 2006), namely that conscious thought (1) is rule-based and very precise, but (2) suffers from low capacity, which may be problematic in more complex judgments and decisions which are more cognitively taxing. This forms the heart of the deliberation-without-attention hypothesis on the relation between mode of thought (conscious vs. unconscious) and the complexity and quality of choices, where complexity was defined as is the amount of information that is involved in the thought process (Dijksterhuis et al., 2006). With sufficient cognitive capacity (in relatively simple decisions) conscious thought will lead to better and more satisfying consumer judgments and decisions than unconscious thought, because it is rule based and precise. However, in more complex decision making contexts, judgments and decisions based on conscious thought are deteriorated due to limitations in cognitive capacity. In those instances, unconscious thought is likely to lead to better judgments and decisions (see Figure 5.1).

Several studies have supported the deliberation-without-attention hypothesis. Participants subjected to the conscious mode generally made the proper choice under simple conditions, while in the complex situation they performed poorly (Dijksterhuis et al., 2006). In that study respondents could choose between four hypothetical cars which were experimentally varied with regard to positive or negative attributes, resulting in one car with the most positive attributes, one with the most negative attributes, and two middle options. They also administered the same design with respect to consumer attitudes. In both experiments there was an objective benchmark in descriptions, namely the most positive or most negative description, i.e. car. The outcome showed that conscious thinkers were better able to differentiate between the quality of objects (cars, and also apartments (see Dijksterhuis, 2004)) under simple conditions, whereas unconscious thinkers were better able to do this under complex situations (Dijksterhuis et al., 2006).

Figure 5.1: The relation between the quality and complexity of a decision, as predicted by Unconscious Thought Theory (Dijksterhuis & Nordgren, 2006).



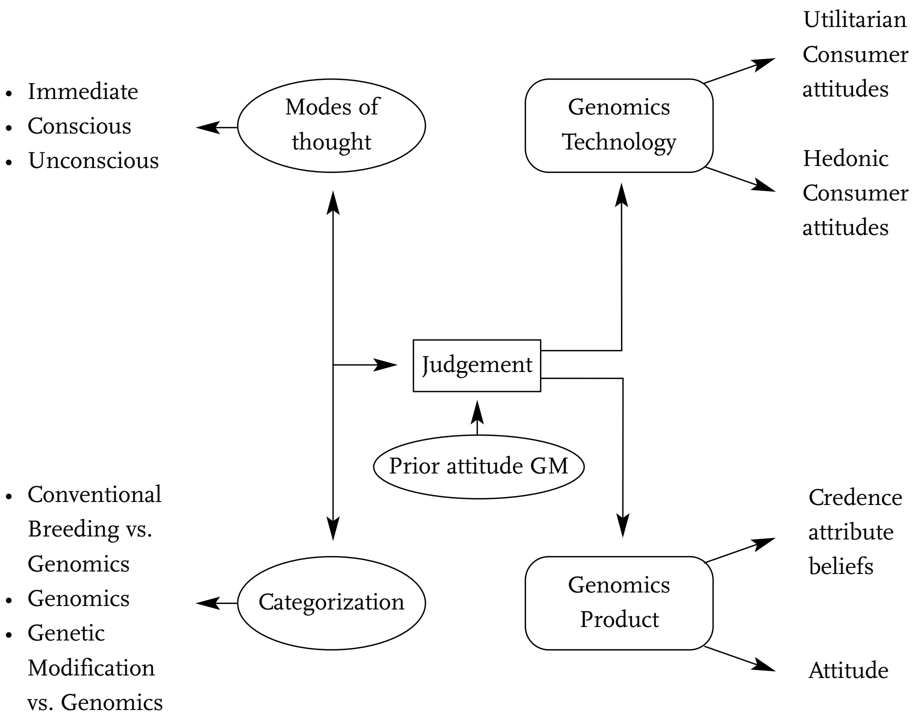
With consumer evaluation of new technologies, such as genomics, there is no objective benchmark for the quality of the consumer judgment. As a first exploratory application of conscious versus unconscious thought, we investigate how consumer judgments for the technology of plant genomics and the new products arising from it (genomics tomatoes) may differ with different thought modes and compare this to immediate, intuitive judgment that consumers give.

Prior attitudes
The consumer attitudes towards genomics may be affected by existing attitudes of consumers towards other technologies. It is, for example, well known that European consumers' attitudes towards GM in food production are negative (Grunert, Bredahl, & Scholderer, 2003). Numerous opinion polls like the Eurobarometer survey (European Commission, 2006) have shown that consumer do not like the idea of genetically modified organism in their foods (Grunert et al., 2003). These attitudes towards GM might have an influence in the current judgment making process towards genomics and will therefore be taken into consideration.

5.3 Methodology

In this study mode of thought and initial categorization were the independent variables of interest to explain consumer responses to plant genomics (see Figure 5.2), while prior attitudes toward GM was included as a covariate. The independent variables were experimentally induced in a computerized 3 x 3 between subjects design to explore their effects on consumer judgments towards the genomics technology and the products arising from it.

Figure 5.2: Outline of the study.



Procedure
Participants were individually seated in front of a computer and after administering a few standard demographic questions, the computer assigned respondents to one of the nine conditions. Respondents were asked to look at different information posters. The posters were adapted from a previous study (Van den Heuvel, Renes, Gremmen, Van Woerkum, & Van Trijp, 2008) and can be found in the appendix (Figure 5.3). After presentation of the posters respondents were subjected to one of the modes of thought. In total this experiment lasted about 15 till 20 minutes.

Independent measures
Initial categorization was manipulated at three levels: no reference point, genetic modification as reference point or conventional breeding as reference point. In the 'conventional breeding as reference point' condition respondents received a poster which presented information on conventional breeding to read for 50 seconds after which they received a poster on plant genomics, also to read for 50 seconds. In the 'GM as reference point' condition, respondents received a poster on GM to read for 50 seconds, followed by the poster regarding plant genomics to read for 50 seconds. In the 'no reference point' condition, respondents only received a poster regarding plant genomics to read for 50 seconds. In this last condition respondents only saw information to read for 50 seconds, while in the other two conditions respondents saw information for 2 times 50 seconds.
Mode of thought was manipulated in line with the research of Dijksterhuis and Van Olden (2006). The modes of thought were manipulated at three levels: no thought (i.e. immediate judgment), conscious thought, and unconscious thought. In the immediate condition, consumers were asked for an immediate judgment on questionnaire items after exposure to the information (i.e. posters), thus very much restricting their time to think about and reflect on the presented information. In the conscious thought condition respondents were given 180 seconds to think about the presented posters and write down any thought, before they were asked to answer the questionnaire items. In the unconscious thought condition respondents received, after exposure to the information, a (distracting) task for 180 seconds in which they had to solve some word puzzles before they answered the questionnaire items.

Prior attitude towards GM
Differences in consumer judgment based on different categorization conditions may be affected by prior attitudes towards GM. To partial out this effect, we included a covariate in the study design. As a covariate, prior attitude toward GM was measured through a single item: 'My attitude towards genetic modification is....', which could be rated on a 7-point semantic differential scale (negative-positive). By asking respondents about their GM attitude prior to their genomics attitude, their judgment process towards genomics might be biased and disturb the

manipulation. For this reason, the prior attitude towards GM was measured after providing product- and technology attitude ratings, in order not to influence the manipulation of the study.

Dependent measures

The dependent measures (see Figure 5.2) relate to Attitude towards the genomics technology and Attitude towards the genomics product (in this case tomato) with their relevant sub-dimensions.

Technology attitudes

Following Batra and Ahtola (1991) the utilitarian and hedonic components of attitude towards genomics as technology were measured through a set of nine point (range -4 to +4) semantic differential scales: 'please indicate what is most applicable for you with regard to genomics as breeding practice'. The *utilitarian* dimensions was measured through four (useless-useful, worthless-valuable, harmful-beneficial, foolish-wise) items ($\alpha = .87$). The *hedonic* dimension was also measured through four items (unpleasant-pleasant, awful-nice, disagreeable-agreeable, sad-happy), also with excellent internal reliability ($\alpha = .91$).

Product attitudes

The affective component of the genomics product attitude was measured as a *general product attitude* towards tomatoes produced with genomics technology. Adapted from Toncar and Munch (2001) respondents rated three nine point (-4 till 4) semantic differential scales 'please indicate what is most applicable for you with regard to a genomics tomato' with end poles labeled negative-positive, bad-good, unpleasant-pleasant ($\alpha = .81$).
The analytical component of product attitude was measured through a set of four specific *consumer beliefs* towards genomics tomatoes identified in previous research (Van den Heuvel, Van Trijp, Van Woerkum, Renes, & Gremmen, 2007). Principal Component Analysis (Varimax rotation) was used to uncover the construct, namely credence attributes (unsafe - safe, unnatural - natural, environment unfriendly - environmental-friendly, unhealthy - healthy, $\alpha = .80$). All the credence belief attributes are measured on a nine-point semantic differentials scale running from -4 till 4.

Subjects

The experiment was administered to students from the Wageningen University (N = 240) in May 2007. The age of the respondents ranged from 17 to 28 years with a mean of 21.03 (sd. = 2.20). Of the 240 respondents, 161 (67 percent) were women and 79 (33 percent) were men. They received 4 euros for their participation in the experiment.

Data analysis

The data was analyzed with analysis of covariance with modes of thought (UTT-condition) and initial categorization (IC-condition) and their interaction (UTT*IC) as factors and prior attitude towards GM as covariate.

5.4 Results

Technology attitudes

The results (see Table 5.1) show that judgments on attitude towards genomics technology are insensitive to initial categorization. This holds both for the utilitarian and hedonic attitudes, and also the interaction with mode of thought is not significant. Both the utilitarian (F (2,237) = 3.30, $p < .05$, $\eta^2 = .03$) and hedonic (F (2,237) = 4.04, $p < .05$, $\eta^2 = .03$) consumer attitudes towards genomics technology are affected by mode of thought. The main effects are compared and Table 2 shows the estimated marginal means (LSD) for the different modes of thought (UTT-conditions) with regard to the technology attitudes. These results show that the unconscious thought condition led to significantly lower judgments on utilitarian and hedonic consumer attitudes compared to both the immediate and conscious thought judgments. The prior attitude towards GM influences the technology attitudes towards genomics. There is a positive relation between the prior attitudes of GM and the technology attitudes towards genomics implying that respondents who are positive (negative) towards GM are positive (negative) towards genomics [8].

Product attitudes

Product attitudes are unaffected by mode of thought, initial categorization, and the interaction between both independent variables. This holds both for general attitudes towards genomics tomatoes and for the perceptions on credence attributes. Again, the attitude towards genomics products are strongly affect by prior attitudes towards GM. Prior attitudes of GM relate positively to product attitudes towards genomics, implying that respondents who are positive (negative) towards GM are positive (negative) towards genomics.

8 In a more exploratory analysis we also explored whether prior attitudes exert an effect in interaction with the independent variables. However, no strong consistent pattern emerged from these analyses, although there are indications that ratings of those with strong negative prior attitudes toward GM would particularly benefit from the provision of conventional breeding as reference point.

Table 5.1: ANCOVA for all attitudes and product beliefs.

	ANCOVA		F	Sig.	R-square
Technology attitudes					
	Utilitarian consumer attitudes				.37
		UTT	3.300	.039	
		IC	1.851	.159	
		Attitude GM	120.496	.000	
		UTT*IC	1.643	.164	
	Hedonic consumer attitudes				.39
		UTT	4.036	.019	
		IC	1.079	.341	
		Attitude GM	136.436	.000	
		UTT*IC	.661	.620	
Products attitudes					
Beliefs	Credence attributes				.32
		UTT	1.789	.169	
		IC	1.241	.291	
		Attitude GM	96.338	.000	
		UTT*IC	1.755	.139	
Attitudes	General attitude				.26
		UTT	1.504	.224	
		IC	.053	.948	
		Attitude GM	72.970	.000	
		UTT*IC	1.297	.272	

Table 5.2: Estimated marginal means for UTT-conditions of the technology attitudes (SD between parentheses).
Vertical means not sharing common subscripts are significantly different at the .05 level.

		Constructs	
		Utilitarian consumer attitudes	Hedonic consumer attitudes
Condition	Immediate	1.79 (2.01) [a]	.79 (1.97) [a]
	Conscious	1.74 (2.03) [a]	.78 (1.98) [a]
	Unconscious	1.35 (2.04) [b]	.34 (2.00) [b]

5.5 Discussion

Genomics is a new and potentially controversial breeding technology. This makes an early insight into the consumer perception and acceptance very necessary, but rather difficult at the same time. In this study we explored, based on previous research, two dimensions that might bias their judgment regarding genomics.
First, we anticipated that consumer judgment would be affected by initial categorization. This was founded in the assimilation theory which states that the judgment of consumers regarding a target stimulus shifts toward the context (Tormala & Clarkson, 2007), implying that consumers assimilate perceptions of the new technology towards their expectations of the reference point. For genomics this would imply that the consumer judgment would be more positive when it is compared (and assimilated) with conventional breeding, which is in general perceived as very positive (Van den Heuvel et al., in press). In case of GM as an implicit reference point, the consumer judgment would be more negative, also because of the negative prior attitudes that exist towards this specific breeding practice (Grunert et al., 2003). However, we did not find any significant effect of initial categorization on consumer attitudes towards genomics.
A second dimension that was expected to affect consumer judgment is mode of thought. To our best knowledge, this is the first study that introduces two modes of thought into the food acceptance literature. Like Dijksterhuis and colleagues, we find that judgment on attitude towards technology is sensitive to mode of thought. Specifically, we find that unconscious thought results in lower evaluations compared to both immediate judgment and conscious thought.
The same experimental design as in the research of Dijksterhuis and colleagues

was used with regard to the modes of thought. The only difference is however that they had an objective benchmark in their research. The use of this benchmark showed that unconscious thought has higher predictive power in complex situations. This might suggest that conscious thought, with respect to genomics, leads to overestimation of the attitudes. This could be regarded as support to the theorizing by Wilson and colleagues who suggest that conscious thinkers have strong but suboptimal preferences (Wilson et al., 1993), implying that the consumer preferences are clearly evaluated more positively in conscious thought (Dijksterhuis and Van Olden, 2006). The findings of Dijksterhuis and Van Olden (2006) also endorse this hypothesis with regard to attitudes.

However, only the attitude judgment towards the technology is sensitive to the mode of thoughts, while the product attitudes are not sensitive to it. This might be explained by the strength of the activated associations. The provided poster might only activate associations concerning the technology, since the poster only provides information regarding the technologies and not regarding the products. The strength of the associations might not be strong enough to activate secondary associations with respect to the products attitudes.

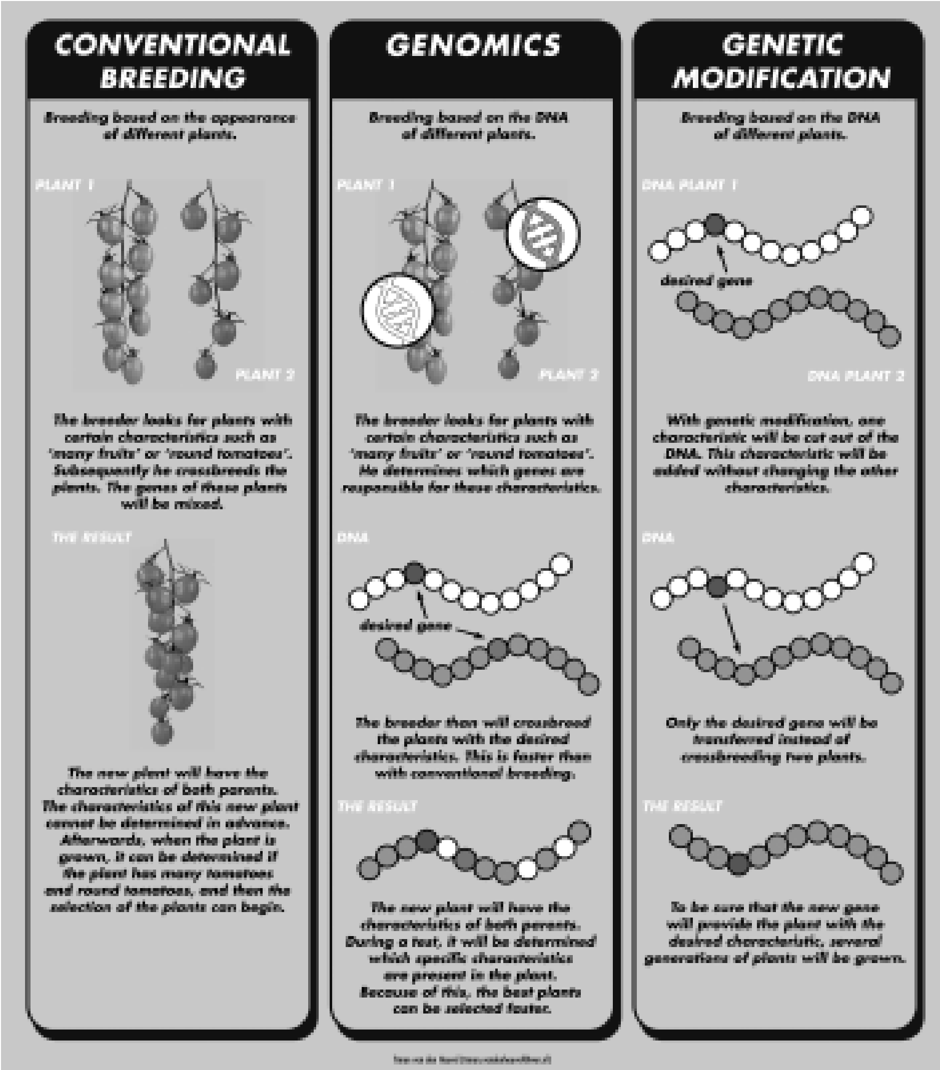
Besides the influence of categorization and mode of thought, it was anticipated that prior attitudes towards GM would also influence consumer judgment. The results indeed show that prior attitudes towards GM influenced consumer judgment. Negative prior attitudes affected the attitudes towards genomics as technology and genomics products in a negative way, while positive prior attitude affected the genomics attitudes in a positive way. The effect of these prior attitudes is so strong that it might have overshadowed the effect of initial categorization.

In sum, as a first exploratory study, these results might be an opening for applications of conscious and unconscious thought to other areas of food and technology acceptance, and consumer decision making regarding food. A deeper understanding of the role of different modes of thought in attitude formation is also necessary in order to find out if conscious thought indeed lead to overestimation of the attitudes and therefore possibly to incorrect attitudes. Further, this study might also be applied to less complex technologies or products to see the role of the different modes in those circumstances.

As a first exploratory study, this study has however its limitations. First of all, the assumption of assimilation between the genomics and the provided reference points might not be the only context effect applicable and influencing the attitude judgment. Another important context effect that has not been taken into account is the contrast effect, which refers to situations in which consumer judgment shifts away from the context, instead of towards the context, as with assimilation (Martin et al., 1990). In the current study, it is possible that half of the respondents assimilated towards the reference point, while the other half contrasted the reference point, leading to no overall effect regarding initial categorization. Another limitation is the difference in exposure time. Two of the three conditions (conventional breeding and GM as reference point) provided respondents with information for 100 seconds (reference point plus genomics), while in the 'no-reference point' condition respondents only received information about genomics for 50 seconds. Another point is that GM can be considered as a rather polarized issue implying that consumers do not moderate their opinion after reading mixed information (Munro & Ditto, 1997) and have an outspoken opinion about it. This might especially be the case in the current sample where students have a particular background and knowledge about the subject, since they are students of a university with an agricultural background. In spite of these limitations we hope that this research cleared a way for further applications of these theories, with regard to positioning and communicating new technologies, in the consumer acceptance literature regarding food.

5.6 Appendix

Figure 5.3: Information posters regarding conventional breeding, genomics, and genetic modification



Chapter 6

General discussion

6.1 Summary and conclusions

The recent genomics revolution has an impact on many areas of life and business, including that of plant breeding practices. In 2003 the Centre for BioSystems Genomics was founded, financed from both public and private money, to establish a thorough and focused plant genomics and bioinformatics research program to cater to this recent development. In the past five years research has been dedicated to the study of genes, gene expression and gene functioning at the level of the organism (CBSG, 2006). This biosystems genomics encompasses the complex interaction at all levels of biological information: DNA, mRNA, proteins, metabolites and how these informational networks co-operate together. The underlying genetic diversity that is uncovered is key to address the complex traits of disease resistance and product quality at the level of whole plants, looking from the beginning to the end of the product chain. The knowledge generated within the centre is used in dedicated breeding programs to improve the sustainable production of crops and their derived products for food and non-food applications. The ability to combine elements of gene technology into the conventional breeding process provides a major impetus for the effectiveness and efficiency in plant breeding practices. Whereas traditionally this was done on the basis of phenotype information with a substantive level of uncertainty, this uncertainty can now be reduced as phenotype information is complemented with information on genetics and gene-expression through the application of omics techniques. As a consequence, a better understanding of the relationship between the genotypic and phenotypic level will allow plant breeders to develop new varieties with more focus (*what to deliver*) and greater efficiency (*time to get there*).

The greater efficiency and effectiveness is however only an advantage if there is a clear target towards which one is working. Hence, the identification of suboptimally satisfied and even latent customer and consumer needs that can be fulfilled through genomics-enhanced plant breeding practices, is a crucial step when the purpose is to truly reap the benefits of this new technological opportunity. In the marketing literature this process is known as consumer oriented new product development. Consumer oriented new product development aims at identifying consumer needs upfront and then systematically translating them into explicit design targets for product improvement. Traditionally consumer and customer orientation in plant breeding practices has focused on usage (e.g. convenience and keep ability) and consumption (e.g. taste) benefits. However, consumers are increasingly sensitive to not only what the product delivers to them in terms of consumption and usage benefits, but also to how the product has been brought about and what it brings within the broader context of life (e.g. naturalness). These benefits are different from the traditional usage and consumption benefits in that they cannot be verified by the consumer, not even after normal consumption. They are so called credence benefits, and include considerations such as the product's naturalness, environmental friendliness, healthiness, and safety. The increased consumer interest for credence attributes may complicate the consumer orientation process in genomics-based new product development. This is because the application of genetic understanding may arouse concern and resistance with consumers, because of associations with other gene-related technologies such as genetic modification. These 'new' credence-type consumer motivations have largely been ignored in aligning new product development to consumer needs, and although consumers cannot assess these motivations from personal experience, they still form perceptions about them in relation the product's performance. These perceptions may either be based in informational belief formation (accepting information from relevant others) or in inferential belief formation, in which consumers may follow their own rules of thumb from existing knowledge (schemata and images) in combination with inferred product characteristics (Fishbein and Ajzen, 1975).
In order to better understand how consumers interpret tomatoes produced with genomics-enhanced plant breeding and how this may impact on their overall evaluation, the aim of this thesis is to articulate the consumer behavior perspective in the development of new tomato varieties based on plant genomics. The analysis is organized around four research questions which are addressed within four empirical chapters.

First of all, based on the notion that credence motivations are increasingly important in consumer evaluation processes, next to consumption and usage benefits of the products, we argue in this thesis that these 'new' considerations should be taken into account in models for consumer oriented new product development. This led to the first research question guiding the present research.

Research question 1

'How can credence attributes more explicitly be incorporated into models that relate the voice of consumers to new product development'

Acknowledging that credence motivations play an increasingly important role in consumers' quality perception and evaluation, we addressed the issue that existing models, which align new product development targets to consumer needs, have a too narrow focus by only providing guidance for the optimization of sensory quality of food products. To do justice to the importance of credence motivations, we elaborated on the Quality Guidance Model (Steenkamp & Van Trijp, 1996) to include consumers' credence attribute perceptions. The research was conducted among 94 cultivars obtained from the CBSG genomics program, which were evaluated by consumers (prior and after tasting), profiled by expert sensory panelists, and profiled on phenotype measures. Taking consumer evaluations and quality perceptions as the starting point of the analysis, we showed that:

1. consumers 'spontaneously' differentiate the cultivars on the basis of their perceptions on credence attributes, such as perceived healthiness, naturalness, safety, and environmental friendliness,
2. these perceptions on credence attributes are perceived as a unity rather then that they are perceived as separate dimensions of the product,
3. these credence attribute perceptions play a dominant role in determining overall quality evaluations at the moment of purchase,
4. sensory expert ratings and physical product measures are relatively poor predictors of consumer quality judgments,
5. these sensory expert ratings and physical product measures have a modest predictive validity for the credence attributes,
6. the in-store consumer evaluations have little influence on the consumer evaluations at home.

The results confirm the importance of incorporating credence attribute perceptions in models for consumer oriented new product development as the credence attribute perceptions constitute a dominant factor in consumer acceptance of tomatoes. Also, the proposed elaboration of the Quality Guidance Model provides strong support for the process of inferential belief formation (Fishbein and Ajzen, 1975; Steenkamp, 1990). Consumers spontaneously infer differences in quality attribute perceptions of the cultivars, even without receiving any information on the production technology. Based on the sheer appearance of the tomatoes, they consistently differentiate them on the basis of credence attribute perceptions. This knowledge is important because it provides insight into how consumers form their beliefs about products. The fact that inferential belief formation is an elementary part in forming their beliefs, next to other processes, should be considered in the whole process of product development. In line with this, the aligning process shows that the intrinsic product cues are a relevant source for inference making, for both the experience and the credence attribute perceptions of consumers. Based on visible product features, consumers take their new requirements into account in the product evaluation. This outcome supports our assumption that credence attribute perceptions are indeed a linked to the consumer needs and therefore important to take into consideration while aligning the product with the consumer needs.

The finding that credence attribute perceptions affect consumers' quality perception and evaluation processes suggests that providing information with respect to these 'new' requirements might have further impact on the consumer belief formation and evaluation processes. This may hold for both experience attribute perceptions as well as the credence attribute perceptions. Especially information regarding how products are brought about might change the beliefs of consumers. To further explore these effects of positioning of breeding technologies, the second research question is formulated as:

Research question 2
'How are consumers' credence attribute perceptions affected by the positioning of breeding technologies, such as plant genomics'

Without any information, and purely based on the intrinsic quality cues (Study 1), consumers inferred beliefs about how the product would perform on credence attributes such as perceived healthiness, naturalness, safety, and environmental friendliness. This raises the question what would happen if more knowledge would be available, for example about the applied production technology. In the study relating to research question 2, two groups of consumers evaluated identical tomato cultivars, but they were differently informed about the production methodology through which the tomato varieties were brought about. One group was informed that the cultivars were produced with conventional plant breeding practices whereas the other group was led to believe that these cultivars were produced with the help of genomics-enhanced plant breeding practices. In this research we compared to what extent providing information of production technology affects product preferences and whether this is due to changes in perception an/or in relative importance of specific product perceptions. The results from the study show that, compared to the situation where consumers were informed about conventional breeding:

1. information about genomics-enhanced plant breeding did not affect the consumer preferences differently,
2. information about genomics-enhanced plant breeding increased consumer perceptions regarding sweet taste of the tomatoes,
3. information about genomics-enhanced plant breeding increased the salience of the credence attribute perceptions and sweet taste perceptions in the product evaluation.

The results of this study show that the effect of providing consumers with information on the production technology of tomatoes, in this case genomics-enhanced plant breeding, had a very limited effect on consumer perception and preference formation. This finding was unexpected as it was anticipated that providing information on genomics would change consumer perceptions regarding the credence attributes of the tomato cultivars. However, only an unexpected effect was found on the perception of sweetness of the tomato cultivars. As there is no substantive interpretation for this effect, it is most likely due to statistical chance. Regarding credence attribute perceptions, the study does reveal that information on genomics as a production technology makes the credence attribute perceptions more salient to consumers and of greater relative importance in their quality evaluations. However, this effect is also modest and does not affect their overall quality judgments in a statistically significant way. Interestingly information on genomics as a product technology also enhances the relative importance of perceived sweetness of the tomato cultivars.
Overall, this study again confirms that genomics-enhance plant breeding practices affect consumer perception and decision making, although only mildly. This effect is most likely to occur in relation to the credence types requirements. Hence it is important to also consider these credence attribute perceptions, both in relation to product optimization and communication regarding genomics as a plant breeding technology.

Apparently, consumers infer credence motivations with regard to how the product is brought about from intrinsic product cues (study 1), and information provided on the applied production methodology affects the consumer perceptions and particularly the salience of credence attribute perceptions (study 2). This effect can only happen if consumers have stored knowledge available in their memory about what production technologies are about and how they affect the specific characteristics of products brought forward from these production technologies. Such stored knowledge in consumer memory may be quite elaborate (schemata) or much more peripheral (images). In study 3 we were particularly interested in the images that consumers hold about plant breeding technologies and how these affect consumer interpretation and evaluation of tomatoes brought forward by these plant breeding technologies. This led to:

Research question 3
'What are the specific images consumers hold regarding (new) technologies, such as plant genomics'?

The formation of beliefs regarding a product is largely based on perceived knowledge that is already contained in the consumer's memory and hence available to build inferences from. One form of stored knowledge are images. Given that these images are not always well-defined, and thus susceptible to influences, it is important to understand the construction of images and the dynamics therein. To explore the construction of images in more detail, study 3 took a more qualitative approach in unraveling consumer images regarding three different plant breeding practices. In four focus group discussions among 35 participants, images and image construction processes were investigated in more detail. For this purpose, the participants in the qualitative focus groups were confronted with brief descriptions of the essentials of (a) conventional plant breeding practices, (b) genetic modification as a plant breeding practice and (c) genomics-enhanced plant breeding practice. They then individually expressed their associations towards these plant breeding practices. This was followed by a group discussion, which offered respondents the possibility to interact and discuss about their associations and images. The focus group was concluded with an overall judgment about the technologies. Analyzing these focus group discussions with regard to plant breeding practice images reveal that:

1. in terms of images, consumers clearly differentiate between the three plant breeding practices and particularly so on the basis of four themes, namely: naturalness, consequences of the technology, efficiency of the technology, and sensory appeal,
2. consumers initially follow peripheral images, which tend to be superficial, but after discussion, images at a higher level of elaboration come to the forefront,
3. at the more superficial level consumers have almost identical images of GM and genomics, but after discussion, the further elaborated images of GM and genomics become more differentiated,
4. after discussion, the more elaborated image of genomics-enhanced plant breeding differentiates from conventional breeding in being less natural and with less sensory appeal, but being much more efficient. The genomics image differs from the GM image primarily in terms of less negative consequences and more natural compared with GM,
5. even after discussion, the negative perceptions towards genetic modification as plant breeding technology are still maintained, because most importantly consumers see GM as (1) unnatural and (2) as a breeding practice which can have major consequences for their health,
6. in terms of overall appreciation of the product technologies, there is a clear hierarchy in the elaborated images towards the product technologies, in the sense that consumers prefer conventional plant breeding practices over genomics-enhanced plant breeding and both of these technologies over genetic modification applications in plant breeding.

Despite the fact that consumers may be relatively unfamiliar with plant breeding practices, the results show that consumers still construct differentiated images about them. This can happen because consumers have stored knowledge, no matter how superficial, about what a plant breeding practices is about and use this knowledge in constructing a specific image. These images can be based on knowledge that is peripheral, resulting in superficial images, and on more elaborated knowledge, resulting in images of a higher level of elaboration, as is confirmed in this study. Regarding consumer images of genomics-enhanced plant breeding, the results show that sharing of information can lead to a more positive image of this technology, differentiating it more clearly from GM as a plant breeding. Especially in the group of younger and higher educated participants these more differentiated and positive images regarding genomics emerged. This is important knowledge for the communication and positioning of genomics-enhance plant breeding practices. Without more specific information, consumers tend to associate it with GM, which may be undesirable given the negative image of GM. Providing further detailed information may move the image of genomics to a more realistic position, more clearly differentiated from both conventional breeding and GM as a plant breeding practice.

Study 3 suggested that consumer images for new production technologies such as genomics-enhanced plant breeding are malleable and may change under the process of thinking and further elaboration. In other words, in their perception of genomics, consumers may 'borrow' associations from the images they have of both conventional breeding practice and of the genetic modification approach. Further interaction, discussion, and elaboration changed their initial perceptions. To further explore these consumer decision making processes, study 4 was designed to answer the research question:

Research question 4
'How is consumer perception and evaluation of (new) technologies, such as plant genomics, affected by the level and depth of information processing'.

Study 4 assumed that consumer perception and evaluation of tomatoes produced with genomics-enhanced plant breeding depends, on the one hand, on the reference point that consumers take into account in evaluating the technology and, on the other hand, on the depth of their information processing. To systematically explore these two factors, an experiment was designed in which 240 students were randomly assigned to one of nine experimental conditions which differed in the reference point (GM, conventional breeding, and no pre-defined reference point) being provided and the depth of information processing being allowed (immediate judgment, judgment after conscious thought, and judgment after unconscious thought). Respondents judged and evaluated both the products (i.e. tomatoes) brought forward by genomics-enhanced plant breeding and the production technology itself. Together these manipulations in the processing of information regarding genomics led to the following results:

1. that both consumer evaluations of genomics as a plant breeding practice and genomics-enabled products are unaffected by the reference point presented as context,

2. that unconscious processing of information leads to less positive evaluations of genomics as a production technology,
3. that consumer evaluations of products enabled by genomics are unaffected by the different (immediate, conscious and unconscious thought) ways of information processing,
4. that a priori attitudes towards GM are taken into account in the information processing and strongly affect the consumer attitude toward genomics.

Although this is, to our knowledge, a first application to test the relevance of the Unconscious Thought Theory within the context of new production technologies, the results contrast with that of previous studies, where consumers (in complex situations) made better choices after engaging in unconscious thought (Dijksterhuis, 2004; Dijksterhuis et al., 2006; Dijksterhuis & Van Olden, 2006). One key difference with these previous studies is that those focused on decision quality of a task with an objectively superior outcome, whereas the present study focuses on personal judgment of which such objectively superior outcome is not a priori defined. In other words, our study is about value assessment rather than decision quality. Another contrasting and unexpected result of the present study was that consumer evaluation of genomics as a plant breeding technology was insensitive to the reference point (GM versus conventional breeding) provided as context. This is unexpected as previous research suggests that information is always processed in comparison with a context (Mussweiler, 2007) and hence should differ by context.

6.2 Managerial implications

New breeding technologies such as genomics can bring producers greater efficiency and effectiveness in their production, and satisfy consumer needs to a greater extent through the provision of superior products. However, in order to achieve these important goals it is elementary that plant breeding companies comprehend, in detail, what consumer needs and specific product demands are. Essentially, consumer needs and product demands provide producers with design targets to which their products should conform to, so the identified consumer needs provide actionable guidelines to their new product development process. Also, the fulfillment of the identified consumer needs will improve consumer satisfaction with the products. Consumer research plays an important role in the uncovering of consumer needs and the translation into specific design parameters. Such research requires that consumer perceptions and preferences, typically obtained through questionnaire research, are linked to more objective measures of the product, as obtained through sensory paneling and from the objective features of the product. Study 1 of this thesis takes exactly such an approach and shows that consumer perceptions are better indicators of the consumer preferences than the sensory expert panel ratings and objective product characteristics are. This in itself already shows the importance of taking a consumer perspective, rather than a product perspective, in product optimization. This is also strongly suggested by the Quality Guidance Model that formed the basis of the first chapter of this research. A crucial contribution of this thesis is that it shows that product quality optimization should not only concern the sensory properties of food products, but also include the credence attribute perceptions of consumers. It was shown that these credence motivations constitute a substantial part of the consumer perceptions, and hence provide an important target when the purpose is to find the optimal product specification from a consumer preference point of view. The model developed within this thesis provides a clear and actionable guidance in this process. Particularly in the 'sensitive' area of foods, future quality guidance models should take credence motivations, such as those relating to how products are being produced and what 'unverifiable' benefits they produce in terms of healthiness, naturalness, environmental friendliness, and safety, explicitly into account.

A second key issue of managerial importance is the preferred level of communication to the consumer regarding the application of genomics as a breeding practice. Information on how the product is being produced may have a substantial impact on how consumers evaluate the genomics-based products. This thesis revealed that providing information on the applied production technology may impact the consumer's product evaluation process, as it may elicit specific images about the production technology. The question is whether such information should explicitly be shared with consumers or not. There are dangers involved in both positions. First, explicitly communicating the information may arouse specific associations with genetic modification, which would be inappropriate in the context of genomics as breeding practice as it is clearly different from GM. Also, consumers have better means than ever to obtain information about the technology, which may result in using sources that present a biased version of it now various stakeholder groups in society get a vested interest in communicating about this new technology. On the other hand: sooner or later the use of genomics in creating new varieties will become public, and these stakeholders may frame the technology according to their perspective. Given the fact that - as our research shows - the link between genomics and biotechnology is in the mind of the people, messages that emphasize this link are recognized easily. This suggests that it is crucial to take a proactive stance in the communication of plant genomics to ensure that consumers' images are in line with the true nature of plant genomics. The crucial challenge is develop a clear and transparent communication strategy to communicate to consumers how genomics as a breeding practice is both similar and different from traditional breeding practices. Such information is more likely to resonate with consumers if it is made personally relevant to them, such that they will pay attention to and actively process the information rather than discount it. In the present study we communicated the defining features of plant genomics through a set of posters, together with additional information. However, this is a relatively 'cold' way of communicating the information. Several communication means and channels can be exploited to further bring the issue of plant genomics alive to consumers, like You-Tube videos or well-organized debates on television. Especially interesting are attempts to stimulate discussions between consumers. Our research clearly suggests that such discussion, on the base of relatively simple informational material, can lead to more elaboration and a more favorable view on genomics, where participants move in their perceptions of genomics from a stance closer to biotechnology to a stance more linked to conventional breeding. These discussions can be organized as well in internet-forums, initiated by trustworthy sources, like universities or national food centers.

6.3 Limitations and future research

The empirical studies in this thesis have a number of limitations, which are discussed in chapter 2, 3, 4, and 5. This section will reflect on the most important limitations of the total approach. In addition, this section provides recommendations on promising directions for future research to further advance the understanding of the consumer behavior perspective in the development of new tomato varieties based on plant genomics.

In consumer oriented new product development, the consumer needs are linked to the product characteristics. In the case of developing new tomato varieties, this implies that the consumer needs are linked to the product, its phenotype, and even to the genetic structure of plants. The present research took the phenotype of the product as its target variables for product optimization. Future research should further extend this approach to include the product genotype, in order to provide even more specific guidance for genomics-enabled plant breeding practices. However, this is far from a trivial challenge. Traditional statistical approaches, which are largely data driven, fall short in this respect because of a problem of 'scale': the number of genes potentially involved in one particular phenotypic feature (e.g. shape) is huge. A limiting condition in the translation of genotype information to plant characteristics is that the number of products involved in the analysis serves as unit of analysis. Traditional statistics techniques are inadequate of handling a situation where the number of independent variables (the genes) is much larger than the number of units of analyses (products). Innovative approaches, beyond purely data driven, should be explored to solve this problem. One possibility would be to make better use of a priori knowledge that is available in the supply chain, in order to restrict the solution space in this reverse engineering. In other words: seeking patterns on the basis of a priori knowledge complemented with data, rather than using purely data driven approaches. Bayesian statistics (e.g. Congdon, 2001) provide such a promising direction to overcome this problem. In Bayesian statistics a priori knowledge is elicited and implemented into the product optimization process. As such, Bayesian analysis holds the potential to not only improve the quality of the research guidance process, but also to serve as a knowledge elicitation and integration tool across the total supply chain. Also, Bayesian statistics can deal relatively easily with uncertainty (Corney, 2002), so that even emerging knowledge can be incorporated and verified within the Quality Guidance Model. Overall, we recommend that the increasingly popular Bayesian approach, in plant genomics and marketing (e.g. Rossi & Allenby, 2003), to be exploited to quality guidance models for product optimization in genomics-enabled plant breeding.

The focus of the present study has been on general consumer perceptions and demands for tomato quality. An implicit assumption in this research has been that quality perception and evaluation processes of tomato are static entities. Future research might further loosen this assumption by recognizing that consumer quality demands, from what a high quality tomato should deliver, may differ between usage situations of the tomato. For example, consumers may expect different qualities of a tomato when it is intended for use in a salad, as compared to a tomato used in a freshly made tomato sauce. This will hold at the level of final consumers but certainly at the level of professional customers such as industrial pasta sauce producers and fresh salad producers. Future research is recommended to take this diversity in consumer demand, depending on the consumption situation, into account. Such research should again combine research into consumers' quality expectations with specific quality guidance approaches. The present Quality Guidance Model can easily be adapted to cater for this diversity in consumer demand.

As argued before, information may be a crucial factor in consumer acceptance of genomics enabled tomato products. The present research has taken a fairly formalized approach in the provision of information to consumers on what genomics is and how it is different from 'competing' plant breeding practices such as conventional breeding and genetic modification. The information provided in the posters was extensively pre-discussed with plant genomics experts in order to provide a well balanced and nuanced perspective on what genomics is and is not. In real market situations however it is unlikely that the communication on genomics, as a plant breeding technology will be that nuanced and with the same level of homogeneity in voice. Rather it is much more likely that different stakeholder groups and media will provide a much wider diversity of perspective to reflect their (prejudiced) position on the issue. In those instances, consumers are confronted with partially contradictory information rather than a unified view. Future research is warranted to investigate how consumers handle such contradictory information and how that affects their perception and evaluation of genomics as a plant breeding technology and the product brought about by that technology.

The present study has explored how different modes of information processing may affect the evaluation of genomics as a plant breeding practice. To our knowledge, this was the first (exploratory) study to investigate the effect of conscious versus unconscious processing on consumer evaluation. In the present study we find very limited support for the Unconscious Thought Theory, but still believe that this is a promising avenue for further research. With genomics as an emerging technology, we were not able to explore the quality of the decision process, and how this may differ between levels of processing, to its full extent. As such, we could not confront consumers with an objectively superior outcome, as in the main stream research of the Unconscious Thought Theory. Rather we focused on the perception and evaluation process per se. Our research seems to suggest that the methodology developed for a decision task cannot be easily translated to the perceptual task, as in this study. A different situation with regard to the application of this methodology will occur when genomics-enabled products become available. These products can then be used in a decisional task, which could lead to a validation of the Unconscious Thought Theory in the context of new production technologies.

Overall, the studies in this thesis contributed to a better understanding of the consumer perspective in the development of new varieties based on genomics. Bottom line, the studies emphasized the importance of credence attribute perceptions in the quality guidance process, and the necessity of an information strategy to communicate to consumers the true nature of genomics as a plant breeding technology. We also suggested several areas of future research to further explore these two issues. This research will get an extra impetus once the first genomics-enabled new food products enter the market place. Only then will it be possible to truly validate the effects that this thesis has begun to explore. In other words, also for genomics enabled tomatoes, the saying holds that the proof of the genomics tomato is in the eating.

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Samenvatting (summary)

Innovatieve technologische ontwikkelingen in de plantenveredeling, zoals de opkomst van genomics, zorgen voor veel veranderingen in de markt. Het succes van deze ontwikkelingen is niet alleen af te meten aan de verbeterde efficiëntie en effectiviteit van het productieproces, maar ook aan hoe goed ze aansluiten bij de percepties van consumenten en hun winkelgedrag. Het is dus van belang om de wensen van de consument in een vroeg stadium mee te nemen in de ontwikkeling en toepassing van deze innovatieve technieken in de plantenveredeling. Het onderzoek in dit proefschrift is gericht op het verkrijgen van een beter inzicht in het consumentenperspectief met betrekking tot de ontwikkeling van nieuwe tomatenrassen die gebaseerd zijn op planten genomics.

In het eerste hoofdstuk is de theoretische basis gelegd voor de vier empirische studies. Als eerste zijn de 'quality guidance' modellen behandeld, die de consumenten als startpunt nemen in de ontwikkeling van nieuwe producten. Vervolgens is er in dit hoofdstuk ingegaan op de rol van informatie over de productietechnologie op de perceptie en acceptatie van consumenten met betrekking tot de technologie en de producten die erdoor worden voortgebracht.

In hoofdstuk twee (Van den Heuvel, Van Trijp, Van Woerkum, Renes & Gremmen, 2007) is het belang van een consumentenperspectief in de ontwikkeling van nieuwe tomatenrassen benadrukt. Dit hoofdstuk is met name gericht op de niet-verifieerbare aspecten die door consumenten worden meegenomen in hun evaluatie van het product. Aspecten als gezondheid, veiligheid, milieuvriendelijkheid en natuurlijkheid worden niet door producenten meegenomen in de gangbare modellen die de consumentenwensen vertalen naar de producteigenschappen. Producenten leggen vaak de nadruk op de sensorische eigenschappen van de producten en laten de niet-verifieerbare aspecten vaak achterwege. Deze niet-verifieerbare aspecten van het product kunnen door consumenten naar boven gehaald worden in de evaluatie van het product, doordat consumenten de technologie waarmee het product is geproduceerd als een belangrijk extrinsieke kwaliteitsindicator zien. Het evalueren van deze niet-verifieerbare aspecten kan het algemeen oordeel over het product beïnvloeden. Dit onderzoek laat zien dat dit het geval is voor de genoemde niet-verifieerbare aspecten met betrekking tot de evaluatie van tomaten. Hiermee toont dit onderzoek aan dat het van belang is om deze aspecten mee te nemen als maatstaf in de productontwikkeling wanneer het doel is om producten te produceren die de voorkeur hebben van consumenten.

In hoofdstuk drie (Van den Heuvel, Van Trijp, Gremmen, Renes & Van Woerkum, 2006) is onderzocht of én in hoeverre consumenten gebruik maken van bestaande kennis en geleverde informatie om bepaalde gevolgtrekkingen te maken ten aanzien van het product. De studie laat zien dat het effect van informatieverstrekking ten aanzien van de technologie genomics weinig effect heeft op de percepties en voorkeuren van de consumenten. Wel laat deze studie zien

dat informatie over genomics het belang van de niet-verifieerbare aspecten vergroot in de evaluatie van tomaten.
In hoofdstuk vier (Van den Heuvel, Renes, Gremmen, Van Woerkum & Van Trijp, 2008) is nagegaan of consumenten bestaande kennis, zowel oppervlakkige als uitgebreide, gebruiken in het maken van beslissingen voor een bepaald product. Specifiek is er in deze studie gekeken naar de associaties en beelden die consumenten hebben met betrekking tot verschillende (nieuwe) productietechnologieën. De studie toont aan dat consumenten duidelijke onderscheidende beelden hebben aangaande genomics, genetische modificatie en klassieke verdeling, ondanks de relatieve onbekendheid van deze technologieën. De beelden omtrent genomics zijn meer oppervlakkig wanneer consumenten onmiddellijk hun beelden kenbaar moeten maken, terwijl de beelden meer uitgebreid zijn wanneer consumenten over de technologie kunnen nadenken en discussiëren. Het uitwisselen van informatie in een discussie leidt ertoe dat de beelden van genomics positiever worden en dat deze beelden onderscheiden worden van die van genetische modificatie.
In het laatste empirische hoofdstuk van dit proefschrift (hoofdstuk vijf (Van den Heuvel, Renes, Van Trijp, Gremmen & Van Woerkum, 2008)) is aandacht besteed aan de wijze waarop consumenten informatie over productietechnologieën verwerken. Ten eerste is verkend of de evaluatie van genomics, zowel de technologie als de producten die er door voortkomen, varieert als er een andere context, bijvoorbeeld informatie over andere technologieën, is aangeboden. Ten tweede is gekeken of verschillende manieren van nadenken, bewust en onbewust, invloed hebben op de evaluaties. Dit onderzoek laat zien dat de evaluatie van genomics beïnvloed wordt door enerzijds de manier van nadenken en anderzijds door de bestaande attitude die consumenten hebben ten aanzien van genetische modificatie. In deze studie is aangetoond dat bewust nadenken leidt tot positievere attitudes betreffende genomics in vergelijking met onbewust nadenken.
In hoofdstuk zes zijn de gevonden resultaten uit de voorgaande hoofdstukken samengevat. Eveneens zijn in dit afsluitende hoofdstuk de implicaties en de beperkingen van dit proefschrift weergegeven. Dit proefschrift laat zien dat het voor producenten van belang is om de wensen van de consument als leidraad te nemen in hun productontwikkeling. Voor producenten is het ook van belang om hierin ook de niet-verifieerbare aspecten voortaan mee te nemen. Verder laat dit proefschrift zien dat het van belang is om een proactieve houding aan te nemen in de communicatie over planten genomics, om er zeker van te zijn dat de beelden die consumenten hebben, overeenkomen met de ware aard van planten genomics. Eén van de aanbevelingen voor toekomstig onderzoek is om gebruik te maken van Bayesiaanse methoden. Een beperking in de huidige vertaling van genetische informatie naar planteigenschappen is dat het aantal planten in de analyse beperkt is en daarmee ook de eenheid van analyse. Traditionele statische technieken ondervinden problemen als het aantal onafhankelijke variabelen

(d.w.z. de hoeveelheid genetische informatie) veel groter is dan de eenheid van analyse (aantal planten). Bayesiaanse methoden kunnen dan een oplossing zijn omdat ze in staat zijn om patronen te ontdekken in de bestaande kennis van de keten en dit te combineren met nieuwe data. Verder is het aan te raden om meer rekening te houden met de verschillende gebruiksmogelijkheden van tomaten. Verschillende gebruiksmogelijkheden, zoals het gebruik van tomaten voor soep of voor salades, roepen verschillende kwaliteitsverwachtingen en wensen op bij consumenten. Het is aan te raden om dit in de toekomst mee te nemen in de productontwikkelingsmodellen die de consumentenwens als startpunt hebben. Een verdere uitdieping van hoe consumenten informatie verwerken, ook als er meerdere en eventueel tegenstrijdige bronnen zijn, behoort ook tot de aanbevelingen om zodoende meer inzicht te krijgen in het consumentenperspectief, als axioma voor de ontwikkeling van nieuwe tomatenrassen.

List of Publications

Scientific publications

Van den Heuvel, T., Renes, R.-J., Gremmen, B., Van Woerkum, & Van Trijp, H. (2008). Consumers' images regarding genomics as a tomato breeding technology: 'maybe it can provide a more tasty tomato'. In: *Euphytica* 159: 207-216.

Van den Heuvel, T., Van Trijp, H., Van Woerkum, C., Renes, R.-J., & Gremmen, B. (2007). Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features. In: *Food Quality and Preference* 18: 296-304.

Van den Heuvel, T., Van Trijp, H., Gremmen, B., Renes, R.J., & Van Woerkum, C. (2006). Why preferences change: Beliefs become more salient through provided (genomics) information. In: *Appetite* 47: 343-351.

Van den Heuvel, T., Renes, R.J., Van Trijp, J.C.M., Van Woerkum, C.M.J., & Gremmen, H.G.J. (2007). De Rol van Niet-verifieerbare Attributen in de Voorkeuren van Consumenten. In: *Jaarboek Sociale Psychologie 2006*. (Eds.) Van Laar, C., Ruiter, R., Karremans, J., Van Rijswijk, W., & Van Harreveld, F. Groningen: ASPO Pers, pp. 175-186.

Conference proceedings

Van den Heuvel, T., Renes, R.-J., Van Trijp, H., Gremmen, B., & Van Woerkum, C. (2008). Consumer judgment regarding genomics: exploring the influence of initial categorization and different modes of thought. In: *Etmaal van de Communicatiewetenschap 2008*. Vrije Universiteit, 7-8 February 2008. Amsterdam, the Netherlands.

Van den Heuvel, T., Van Trijp, H., Van Woerkum, C., Renes, R.-J., & Gremmen, B. (2005). The role of credence attributes in linking product offering to consumer needs. In: *Economics and Social Science Research in Food, Agriculture, Environment and Development*. PhD workshop organized by EAAE and Mansholt Graduate School, 22-23 September 2005. Wageningen, the Netherlands.

Other conference presentations

Van den Heuvel, T., Van Trijp, H., Van Woerkum, C., Renes, R.-J., & Gremmen, B. (2006). *Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features*. 4th International MAPP Workshop on Consumer Behaviour and Food Marketing: Food Innovations and New Product Development, 29-30 May 2006, Middelfart, Denmark.

Van den Heuvel, T., Renes, R.-J., Van Trijp, H., Gremmen, B., & Van Woerkum, C. (2006). *How elaboration on technologies changes consumers' images*. 2nd CORSAGE Winter Symposium, Genomics in Society, from intentions to implementations, 24 November 2006, Wageningen, the Netherlands.

Van den Heuvel, T., Renes, R.-J., Van Trijp, H., Van Woerkum, C., & Gremmen,

B. (2006). *De rol van niet-verifieerbare attributen in de voorkeuren van consumenten*. ASPO conference, 14-15 december 2006, Leiden, The Netherlands.

Other publications

Renes, R.-J., Van den Heuvel, T., Van Trijp, H., Gremmen, B., & Van Woerkum, C. (2008). Oordelen over genomics: de invloed van initiële categorisatie en (on)bewust denken. (abstract). In: *Etmaal van de Communicatiewetenschap 2008*. Vrije Universiteit, 7-8 February 2008. Amsterdam, the Netherlands.

Van den Heuvel, T., Renes, R.-J., Van Trijp, H., Gremmen, B., & Van Woerkum, C. (2006). *How elaboration on technologies changes consumers' images*. (poster presentation). Small Group Meeting in Consumer Psychology: Unconscious and Controlled Processes, 13-14 November 2006. Enschede, the Netherlands.

Jongenburger, B., Dekker, M., Van den Heuvel, T., & Van Boekel, M.A.J.S. (2005). Bayesian Belief Networks as a tool for Consumer Oriented Food Product Design. (abstract) In: *Book of abstracts of Lerende Oplossingen*. Nijmegen: Stichting Neurale Netwerken - SNN Adaptive Intelligence, pp. 25-26.

Curriculum Vitae

Timon van den Heuvel was born in Voorthuizen, the Netherlands, on October 6, 1980. He finished his secondary education (V.W.O.) at the Johannes Fontanus College in Barneveld in 1999, after which he started to study Economics of Agriculture and Environment at the Wageningen University. He obtained a Master of Science degree in 2003 after completing one master thesis on 'multiple public accounting' for his specialization Policy and Administration and another master thesis on 'the social influence on innovation' for his specialization Agricultural Business Economics. He began his doctoral dissertation research at Wageningen University in 2003. The results of this research are described in this thesis.

Training and supervision plan

N	*Name of the course*	*Department/Institute*	*Year*	*Credits**
	I. General part			
1	Research Methodology: designing and conducting a PhD research project	Mansholt Graduate School of Social Sciences (MG3S)	2003	2
2	Scientific Writing	CENTA	2004	1.2
3	Ethics for life scientists	MGS	2003	2
4	Techniques for writing and presenting a scientific paper	Wageningen Graduate Schools (WGS)	2003	1
	II. Mansholt-specific part			
5	Mansholt Introduction course		2004	1
6	Mansholt Multidisciplinary Seminar	EAAE / MGS / European PhD day	2005	1
7	Food Innovation and New Product Development 4th International MAPP Workshop on Consumer Behaviour and Food Marketing	MAPP	2006	1
8	ASPO conference, Leiden	ASPO		1
9	Internal research seminars Marketing and Consumer Behavior group	MCB	2003-2005	1
	III. Discipline-specific part			
10	Food perception & food preference	VLAG	2003	1
11	Quantitative research methods in business	UM / TUe	2004-2005	9
12	Advanced econometrics	MG3S	2005	4
13	Computerised Data Collection with Authorware	MG3S	2003	0.5
14	Afstudeervak organiseren en begeleiden	OWU	2006	0.6
15	Capita selecta voedings- en gezondheidscommunicatie	COM	2004	2
	IV. Teaching and supervising activities (optional)			
16	MCB Sensory perception and Consumer Preference (MCB30806)	MCB	2004-2008	1
17	Supervision report foreign excursion Mercurius (YSS 5032 / 21303)		2004-2005	1
18	MSc Student Jing Zhang	MCB	2005	1
19	MSc Student Bart Jongenburger	PDQ	2005	1
			TOTAL (Min 20)	32.3