WAGENINGEN UNIVERSITY AND RESEARCH

Can you feel the benefit?

Investigating the cognitive and affective aspects of consumer risk-benefit perceptions of new food technologies

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A

Master Thesis

by

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Abstract

This study investigated whether presenting consumers with different types of risk-benefit information about new food technologies influences the cognitive and affective aspects of their risk-benefit perceptions towards these technologies. The study also examines the effect of the risk-benefit perceptions on the consumer acceptance of new food technologies.

A survey was conducted among 159 consumers, using nanotechnology as the new food technology. Respondents were divided into five groups (control, risk vividness, risk probability, utilitarian benefit and hedonic benefit), each receiving different information about nanotechnology. Subsequently their cognitive and affective risk-benefit perceptions were measured, followed by their willingness to buy a product produced with nanotechnology.

Results did not find a significant effect of a specific type of risk information on their corresponding cognitive or affective risk perception. Furthermore, no significant effect of a specific type of benefit information on the corresponding cognitive or affective benefit perception was found in this study. There was evidence of an influence of cognitive and affective risk-benefit perceptions on consumer acceptance of new food technologies. This study displays the importance of affect on both risk and benefit perceptions.

Content

§1 Introduction

In recent years, new food technologies are providing an increase in the production of novel foods that enter the market (Vidigal et al., 2015). These technologies could provide numerous benefits for companies and consumers (Rollin, Kennedy, & Wills, 2011; Ronteltap, Van Trijp, Renes, & Frewer, 2007). Nowadays, consumers are exposed to a number of new food technologies including nanotechnology, genetic modification, biotechnology and food irradiation (Connor & Siegrist, 2011; Rollin et al., 2011; Siegrist, Stampfli, Kastenholz, & Keller, 2008). However, not every food innovation is instantly accepted by consumers. Where consumers are often open-minded towards traditional food innovations (foods that are passed through generations) (Vanhonacker et al., 2013), new food technologies are often met with resistance (Rollin et al., 2011; Vidigal et al., 2015). Consumers frequently show a negative response to terms such as 'irradiation' and 'genetic engineering' and these responses subsequently influence their expected liking of the product (Cardello, 2003). Understanding exactly why certain food technologies are (not) accepted by consumers is essential for the marketing of novel foods and the success of new food technologies. To understand this, we will start with consumer acceptance.

An abundance of research is dedicated to the investigation of consumer acceptance of new food technologies (Costa-Font, Gil, & Traill, 2008; Miles & Frewer, 2001; Rollin et al., 2011; Ronteltap et al., 2007; Siegrist et al., 2008). Several factors were linked to the acceptance of innovative food technologies such as knowledge, trust, and socio-demographics (Bearth & Siegrist, 2016). Apart from these, two of the most frequently found predictors of consumer acceptance of new food technologies are risk and benefit perceptions of consumers (Alhakami & Slovic, 1994; Bearth, Cousin, & Siegrist, 2014; Ronteltap et al., 2007; Siegrist, 2000; Siegrist et al., 2008). However, the relationship between risk and benefit perceptions of consumers and its formation in the consumer's mind is still under debate (Bearth & Siegrist, 2016).

Risk perception, in the psychological sense, is a person's subjective evaluation of a risk. Early research on risk perception was based on the consequentialist approach. This is the suggestion that the evaluation of a risk is solely based on a rational assessment of the possible outcomes (Loewenstein, Weber, Hsee, & Welch, 2001). Later on, Slovic and colleagues (1978) identified two main dimensions that drive risk perception; 'unknown risk' and 'dread risk' (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). In this mapping, the unknown risk axis relates the extent to which the hazard is judged to be unobservable, unknown, new, or delayed in producing harmful impacts. The dread risk axis is defined by the extent of perceived lack of control, the severity of the possible outcome and feelings of dread. (Fischhoff et al., 1978; Loewenstein et al., 2001; Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1980). The higher a hazard scores on these dimensions, the higher its perceived risk. In the emergence

of new food technologies, consumer concerns are also centred around the two dimensions of unknown and dread risk (Ronteltap et al., 2007).

Of these two dimensions identified by Slovic et. al., (1978), the dread dimension is often seen to possess an affective evaluative aspect rather than a cognitive one (Loewenstein et al., 2001). This suggests that risk perception is not solely determined by a rational assessment of the situation, but also by the involvement an emotional aspect. The approach of Slovic et. al., (1978) suggests that the affective aspect typically only plays an informational role in (risky) decision making. However, Loewenstein and colleagues (2001) and their 'risk-as-feelings' hypothesis, suggest that emotional reactions and cognitive assessments of a risk can often diverge in a person's mind. When this is the case, the affective aspect tends to guide behaviour (Loewenstein et al., 2001). This implies that there is a clear distinction between the cognitive and affective aspect of risk perception in a consumer's mind. Furthermore, these emotional reactions to, and cognitive assessments of a situation are also influenced by different factors. Emotional reactions to risks are dependent on more subjective factors compared to cognitive evaluations, such as previous experiences and the vividness with which a consequence of a risk can be imagined. On the other hand, cognitive assessments of risks are much more influenced by objective features of the risky situation, such as the probability of the outcome and assessments of outcome severity (Loewenstein et al., 2001).

Benefit perceptions of foods are related to attributes that make a product attractive to a consumer, both consciously and unconsciously. Overall, benefit perceptions of consumers have a positive influence on the acceptance of the product or technology (Costa-Font et al., 2008; Siegrist, Hartmann, & Sütterlin, 2016). Previous research has shown that risk and benefit perceptions are inversely related in a consumer's mind, such that a higher risk perception corresponds with a lower benefit perception and vice versa (Alhakami & Slovic, 1994; Bearth & Siegrist, 2016; Finucane, Alhakami, Slovic, & Johnson, 2000; Siegrist et al., 2008). This interdependency suggests that consumers do not evaluate risks and benefits separately, but rather weigh them more affectively using an evaluation method known as 'affect heuristic' (Bearth & Siegrist, 2016; Finucane et al., 2000). These are positive or negative feelings attached to images in a person's mind, used to make judgements and guide decision-making (Bearth & Siegrist, 2016). All these images are to a different degree loaded with affect and make up a person's 'affect pool', which differs per individual. This readily available pool of affective laden images may help a consumer make faster and more efficient choices when faced with complex decisions or when limited mental resources are available (Slovic, Finucane, Peters, & MacGregor, 2004). This interdependency, guided by affect, implies that benefit perceptions also hold a certain affective aspect.

The distinction between cognitive and affective perception is not as clear in benefit perception literature compared to risk perception. However, a consumer evaluates a consumption product on two dimensions; a utilitarian and a hedonic dimension, which seem to have cognitive and affective aspects. The utilitarian dimension measures the functional benefits of the product (e.g. how useful or beneficial a product is) while the hedonic dimension measures the experiential affect associated with the product (e.g. how pleasant the associated feelings are) (Batra & Ahtola, 1991). More hedonic products provide more experiential consumption, fun, pleasure, and excitement (e.g. luxury watches) while more utilitarian products are mostly instrumental and functional (e.g. microwaves) (Dhar & Wertenbroch, 2000). Both the hedonic and utilitarian benefits contribute to the overall goodness of a consumption product. A product is not necessarily (and is often not) strictly hedonic or utilitarian but rather possesses, to a different degree, hedonic or utilitarian consumption motives or benefits (Batra & Ahtola, 1991).

In sum, research dedicated to risk perception suggests a clear distinction between a cognitive and an affective evaluation influencing a consumer's risk perception and subsequently their acceptance of new food technologies. The concept of the affect heuristic suggests a relationship between risk and benefit perception, implying that a similar distinction could be made for benefit perceptions. However, to our knowledge, this distinction is not that apparent in previous research. We propose that the distinction between hedonic and utilitarian benefits could be key in this research. Therefore, the aim of this research is to investigate the cognitive and affective aspects of consumers' risk-benefit perceptions of new food technologies. Research results aim to help food marketeers better understand consumers and provide them with tools to increase consumer acceptance towards new food technologies and the products produced with them.

§2 Theoretical background

§2.1 Risk-benefit perception as consumer acceptance

Consumer acceptance has various definitions across different disciplines (Fischer & Reinders, 2016). In risk analysis literature, 'consumer acceptance' indicates that consumers do not categorically reject a certain product or technology but that consumers are willing to consider that product or technology in the future (Bredahl, 2001; Siegrist, 2000). This psychological acceptance, often measured through willingness to buy (WTB) (Siegrist, Cousin, Kastenholz, & Wiek, 2007), will also be the definition used in this research to accurately investigate consumer acceptance of future products and technologies.

Consumer acceptance of new food technologies is influenced by risk and benefit perceptions of consumers (Alhakami & Slovic, 1994; Bearth et al., 2014; Ronteltap et al., 2007; Siegrist, 2000; Siegrist et al., 2007, 2008). Out of these two perceptions, some articles suggest that benefit perception often exert more influence on consumer acceptance (Bredahl, Grunert, & Frewer, 1998; Siegrist, Cvetkovich, & Roth, 2000), while others suggest risk perception is more important (Cardello, Schutz, & Lesher, 2007). A meta-analysis dedicated to this matter revealed no explicit answer to that question (Bearth & Siegrist, 2016). In a broad sense, within this research, we assume that consumer acceptance is influenced by these two major factors as illustrated in figure 1.

Figure 1: Risk-benefit perception as predictors of consumer acceptance

The disparity between experts' and laypeople's risk-benefit perceptions of food technologies is frequently mentioned in literature (Bearth & Siegrist, 2016; Savadori et al., 2004; Slovic et al., 1980). Part of the explanation for this disparity could be that experts and laypeople use different appraisal strategies and that both groups have different resources available (Bearth & Siegrist, 2016; Savadori et al., 2004). Therefore, consumers often must make inferences based on what they remember or have observed in the past (Slovic et al., 1980). Furthermore, not the actual risks or benefits of a food technology influence consumer acceptance, but rather the consumer's perceptions of that technology (Cardello et al., 2007; Mitchell, 1999; Sjoberg, 2000), hence the term risk-benefit *perceptions*. This implies that the way outside information is translated into a consumer's perception, is of major influence on the judgement of new food technologies.

§2.2 Dual processing in the mind

Dual process theories are frequently used in consumer behaviour literature for analysing consumer information processing. The basis of the different dual-process theories suggests that there are two different types of information processing systems in a person's mind (Epstein, 1998; Evans, 2008; Kahneman & Frederick, 2002; Sloman, 1996). The general differences between the two processing systems are divided by Evans (2008) into four categories; (1) consciousness, (2) evolution, (3) functional characteristics and (4) individual differences (Evans, 2008). Of these, consciousness and functional characteristics are of most importance for this research. First, a frequently mentioned difference is that one information processing system operates in the unconscious mind, whereas the other system operates in the conscious. Second, both systems have different functional characteristics; where one system is often defined as associative, contextualized and pragmatic, the other is often seen as rule-based, abstract and logical.

Many scientists have dedicated attention to dual processing theories (Epstein, 1998; Kahneman & Frederick, 2002; Sloman, 1996), showing that it remains a complex issue (Evans, 2008). For this research, we will not get into the elaborate discussion of which dual-processing theory is correct, but rather touch upon the similarities and the relevance for our framework.

One widely accepted example of a dual process theory is Epstein's (1994) cognitive-experiential self-theory (CEST). This theory suggests that humans and animals use two different information processing systems he named experiential and rational. The former is considered a crude system that operates automatically, rapidly, effortlessly and efficiently. It presents events more concretely and unconsciously through images and feelings with the use of metaphors and narratives (Epstein, 1998). On important aspect of the experiential system is that it has an affective basis (Slovic et al., 2004). The latter system is often more deliberative and effortful and is experienced more consciously. It presents reality in abstract symbols, words, and numbers and is capable of long-term delay of gratification (Epstein, 1998). This distinction shows great similarity with the other dual processing theories (Evans, 2008) and will be the base for this research to continue upon.

As many dual process theories exist, equally many different names are used for both systems (Evans, 2008). For this research, instead of using Epstein's experiential and rational, we will use a definition adapted from this by Slovic and colleagues (2004); experiential and analytic, since there are elements of rationality in both systems (Slovic et al., 2004). The most important distinctions between both processing systems for this research are that one is fast, automatic and affect-laden (experiential) and the other is slow, effortful and more cognitive (analytic).

Another point of interest of dual-processing theory research is the activation of the two systems (Evans, 2008). We assume both systems are continually active and interacting (Epstein, 1998; Kahneman & Frederick, 2002; Slovic et al., 2004) but the relative influence of each system is driven by various factors, such as individual thinking style, mood, emotional involvement, presence of time pressure and situational context (Epstein, 1998; Finucane et al., 2000; Kahneman & Frederick, 2002). Most of the time, the analytic system runs in a low-effort mode with minor usage of its capacity and follows the suggestions of the experiential system. Only when the experiential system encounters problems, the analytic system becomes more active (Kahneman, 2003).

Since the experiential system is more effortless and efficient, it is considered the default option and it is suggested to be dominant over the analytic system (Epstein, 1998). Furthermore, since the experiential system is more affect-laden and guided from experience, it is often more compelling to guide behaviour compared to abstract logical thinking (Epstein, 1998; Slovic et al., 2004). Affect itself refers to the specific goodness or badness (1) experienced as a feeling state and (2) differentiate whether a stimulus is positive or negative (Slovic et al., 2004). These affective reactions are often the first reactions, occur automatically and are often unaware but exert a major influence on decision making and judgement (Epstein, 1998; Savadori et al., 2004). According to Epstein (1998), a person reacts to an emotionally significant event in the following matter: Automatically, the experiential system searches for related events in its memory bank and their emotional attachment. These recalled feelings then influence the person's thoughts and actions both conscious and unconscious. (Epstein, 1998).

Figure 2: Analytic and experiential evaluation as acceptance

Based on the theories above, we suggest that there is an influence of both information processing systems on the judgement and acceptance of new food technologies. We suggest that this process can be mapped as shown in figure 2. Combining this model with our previous model provides us with the main conceptual framework of this research, presented in figure 3. The support for this model will be presented next, starting with cognitive and affective risk perception.

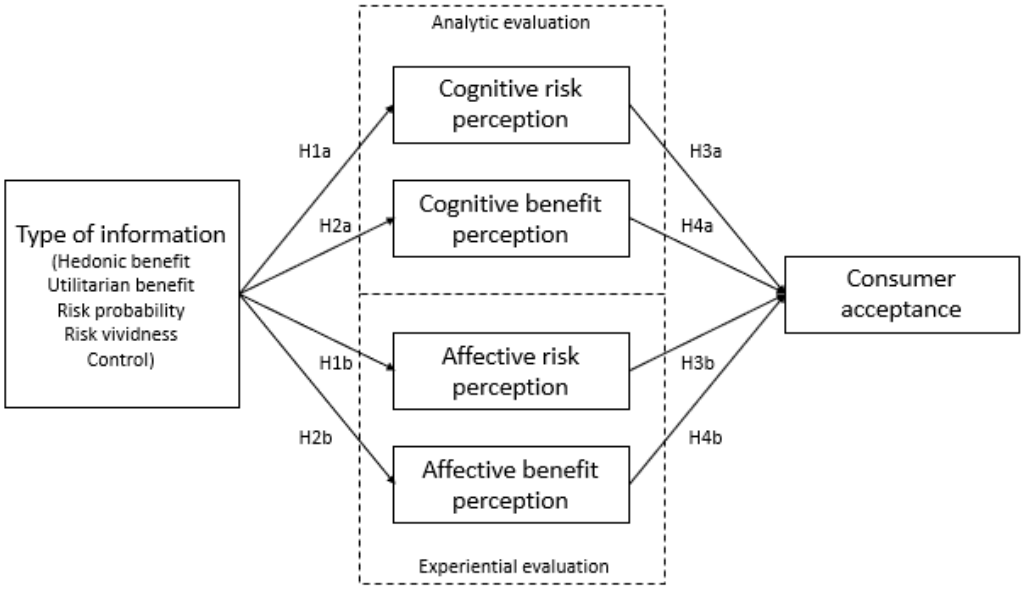

Figure 3: Conceptual framework for cognitive and affective risk-benefit perception

§2.3 Cognitive and affective risk perception

In the past, both psychologists and economics used the consequentialist approach to study the outcomes of risky situations. The consequentialist approach was, in its conventional sense, the fact that people make decisions based on a rational assessment of the different outcomes of possible alternative choices and feelings were solely an outcome of this decision situation in the form of immediate visceral reactions (e.g. fear, anxiety) called anticipatory emotions (Loewenstein et al., 2001). In contrast to these anticipatory emotions, anticipated emotions were later added to the consequentialist perspective. These anticipated emotions are emotions that are not directly experienced in the present but expected to be experienced in the future (Loewenstein et al., 2001). In these theories, the decision-making process is still implicitly cognitive although influenced by the expected emotions obtained from the expected outcome of the decision.

Another approach on risk perception in consumer behaviour literature suggests that risk perception consists of two components; a 'chance' and a 'danger' aspect (Kogan & Wallach, 1964). Similarly, Cunningham (1967) defined these concepts as 'the amount that would be lost' and 'feeling of certainty that the consequence would be unfavourable' (Cunningham, 1967). Subsequently, these two components were later translated by Slovic (1987) into the two widely accepted psychological dimensions to influence risk perception; 'dread', defined as perceived lack of control, severity of the possible outcome and feelings of dread, and 'unknown risk', defined by the degree to which a risky situation is perceived to be unknown, new, uncertain or unobservable (Loewenstein et al., 2001; Slovic, 1987; Ueland et al., 2012). This is in line with research from Yueng & Morris (2001), suggesting that,

also in food safety, consumers risk perception is a combination of the perception of exposure to a hazard and the consequences of this exposure (Yeung & Morris, 2001).

Of the two dimensions identified by Slovic, especially the dread dimension is often viewed to possess a certain affective evaluation of the situation (Loewenstein et al., 2001) and is considered to influence consumer's risk perception the most (Slovic, 1987; Yeung & Morris, 2001). All two-component definitions of risk perception seem to suggest that risk perception is not solely based on an analytic way of assessing risk, but rather that an emotional or affective component is also involved in influencing risk perception. In this approach, the affective component fulfils a more informational role in decision making. It provides the analytic system with input for decision-making and helps people evaluate different outcomes of a situation. Loewenstein and colleagues (2001) suggest a bigger role of this affective component in risky decision making with their 'risk-as-feelings' hypothesis. They suggest that cognitive evaluations and emotional reactions to a risky situation can deviate and, when they do, these emotional reactions can guide behaviour. This influence of an affective component as a person's judgement shows great similarities with the dual process theories mentioned before.

The risk-as-feelings hypothesis also suggests that people's emotional reactions to risks are influenced by several factors that do not, or weakly, influence people's cognitive evaluations of risks (Loewenstein et al., 2001). For example, Nisbett & Ross (1980) showed that, when a negative consequence is described more vividly to a person, it evoked stronger emotional reactions (Nisbett & Ross, 1980). Furthermore, studies have shown that an increase in probability of a negative consequence only affects emotional reactions when the probability increases from zero, showing that emotional reactions are more influenced by possibility rather than probability (Loewenstein et al., 2001; Monat, Averill, & Lazarus, 1972). This implies that emotional evaluations of a risk are more influenced by factors such as vividness with which a consequence can be imagined and the possibility of a negative consequence (Loewenstein et al., 2001). On the other hand, cognitive evaluations of risks are likely to be influenced by more objective features of the risks, such as probability and assessment of potential consequences (Loewenstein et al., 2001).

Based on the above, we can conclude that a single risk can be perceived differently, depending on how the risk is presented. Firstly, we propose that this can be explained by the existence of two types of risk perception we will call *cognitive* and *affective* risk perception. Here, cognitive risk perception is the analytical evaluation of a risk, focussing more on the cognitive aspects of that risk. In contrast, affective risk perception is the experiential evaluation of a risk, focussing on the affective aspect of that risk. Secondly, we propose that these two types of risk perception are influenced by different factors as mentioned above. Therefore, we hypothesise that:

H1a: Risk information related to the probability of the possible consequences will lead to a higher cognitive risk perception compared to risk information related to the vividness of possible consequences.

H1b: Risk information related to the vividness of possible consequences will lead to a higher affective risk perception compared to risk information related to the probability of the possible consequences.

§2.4 Benefit perceptions

As mentioned before, benefit perceptions are related to attributes that make a product or technology attractive to consumers and have shown to exert a positive influence on consumer acceptance. In general, information about the safety or benefits of novel food processes has shown to positively influence consumer acceptance of foods produced with these technologies (Frewer, Howard, & Shepherd, 1997). Research from Cardello (2007) suggests that better taste and better nutrition have the most positive influence in consumer acceptance of novel food products (Cardello et al., 2007).

Research suggests that consumers purchase and consume goods for two basic reasons: (1) affective, hedonic, gratification from consumption (from sensory aspects), and (2) instrumental, utilitarian reasons (functional consequences) (Batra & Ahtola, 1991). A consumption object is also evaluated on these two dimensions, hedonic and utilitarian (Batra & Ahtola, 1991; Dhar & Wertenbroch, 2000). Both dimensions of benefits make up the overall goodness of a certain product (Batra & Ahtola, 1991) and consumers are able to distinguish between goods according to their relative hedonic or utilitarian nature, based on independent components of product evaluations (Batra & Ahtola, 1991; Mano & Oliver, 1993). Although a good is not entirely hedonic or utilitarian, but rather a combination of both dimensions, consumers do classify goods as primarily hedonic or utilitarian based on which dimension is more salient (Batra & Ahtola, 1991; Dhar & Wertenbroch, 2000).

Hedonic goods are associated with sensory and experiential product attributes and provide more pleasure and excitement upon consumption (Holbrook & Hirschman, 1982). Utilitarian goods are primarily instrumental and functional and consumed for expectations of positive consequences (Batra & Ahtola, 1991; Dhar & Wertenbroch, 2000). Moreover, hedonic goods are often chosen more affectively and based on sensory or aesthetic characteristics (Holbrook & Hirschman, 1982), whereas utilitarian goods are often chosen more cognitively, are more goal oriented and fulfil a more practical task (Batra & Ahtola, 1991). This shows a similar distinction in cognitive and affective evaluations as we observed in risk perception.

For a food product, the relative hedonic or utilitarian aspects are already inherent to the product itself. However, for a new food technology, we propose it is possible to change a consumer's benefit perception by providing them with more hedonic or utilitarian benefit information. Thus, similar with risk perception, one technology can be perceived differently in terms of benefits. This benefit perception will then also be more cognitive or affective, depending on the information provided. Here, affective benefit perception is a more experiential evaluation of the benefits of a product or technology, focussing more on the affective aspects. In contrast, cognitive benefit perception is a more analytical evaluation of the benefits of a product or technology, focussing more on the cognitive aspects. We propose that these types of benefit perception can be influenced by the benefit information that is presented to a consumer. Thus, we hypothesize that;

H2a: Utilitarian benefit information will lead to a higher cognitive benefit perception compared to hedonic benefit information;

H2b: Hedonic benefit information will lead to a higher affective benefit perception compared to utilitarian benefit information;

§2.5 Consumer acceptance of a food technology

As mentioned before, risk and benefit perceptions have a direct influence on consumer acceptance or WTB (Siegrist et al., 2007). Perceived benefits have a positive influence and perceived risks have a negative influence on consumer acceptance (Siegrist, 1999). Therefore, we hypothesise that:

H3a: A higher cognitive risk perception of a food technology will lead to a lower consumer acceptance towards a product produced with that food technology;

H3b: A higher affective risk perception of a food technology will lead to a more negative lower consumer acceptance towards a product produced with that food technology;

H4a: A higher cognitive benefit perception of a food technology will lead to a higher consumer acceptance towards a product produced with that food technology;

H4b: A higher affective benefit perception of a food technology will lead to a higher consumer acceptance towards a product produced with that food technology;

§3 Method

§3.1 Respondents

The data in this research was obtained using a convenience sample amongst people in the network of the researcher. Requirements for participating in the survey were; (1) the participant had to be a consumer and (2) between 18 and 99 years old. A link to an online questionnaire was shared within the researcher's network and asked to share with others. In total, 197 people clicked the link to start the survey. Out of these respondents, 38 did not finish and 159 respondents were used for the analysis.

§3.2 Design

Respondents were randomly assigned to one of five conditions (control, hedonic benefit, utilitarian benefit, risk vividness, and risk probability). Each respondent evaluated a total of two counterbalanced nano-applications, both on five aspects (affective benefit perception, cognitive benefit perception, affective risk perception, cognitive risk perception, and WTB). The design of the study is presented in table 1.

Table 1: Design of the Study

Group	N	Control	Benefit	Benefit	Risk	Risk
1	33	Control				
2	32		Hedonic			
3	27			Utilitarian		
4	31				Vividness	
5	36					Probability

§3.3 Stimuli

Stimuli were pre-tested on understandability, realism and manipulation effectiveness. Based on the pre-test and to increase the reach of potential respondents, the survey was translated into Dutch. Stimuli were related to a new food technology; nanotechnology. The stimuli were developed as examples of future applications of nanotechnology with explicit consumer risks or benefits. All respondents received the same description of nanotechnology to create an equal understanding of nanotechnology in general amongst respondents (Dutch, see appendix 1):

"Nanotechnology is a field dedicated to studying, creating and using substances between 1 and 100 nanometres in size. To give you an idea of the size, a human hair is about 80.000 to 100.000 nanometres thick. Because the particles are extremely small, they provide unique properties with a vast potential for all sorts of applications. Producers can grind larger particles into nanoparticles, or they can manipulate individual atoms or molecules into nanostructures.

Nanotechnology is already being used in various applications. Nanotechnology is now being applied in the food industry as well. When nanotechnology is used for the production or packaging of food products, we call them *nanofoods*. In nanofoods, nanoparticles can be in the actual food product or used in the packaging of these food products."

All respondents received additional information about one of two nanotechnology applications, which were randomly assigned across respondents (table 2, Dutch in appendix 2). The applications were based on two categories of nano-applications, nano-inside (i.e. in the food product as in primary production or food processing) and nano-outside (i.e. in food packaging) (Handford et al., 2014).

Four groups of respondents received additional information about either one of two benefits or one of two risks corresponding to the previously selected application. The control group received no additional information. All groups were randomly assigned and an overview of the five conditions and extra information per condition can be found in table 2 (Dutch, see appendix 2). The benefit information was either hedonic or utilitarian and the risk information was either explained vividly or statistically (probability). The information related to the risks and benefits was designed to stimulate either experiential or analytic information processing amongst respondents. For example, hedonic benefits information was presented to stimulate experiential information processing, whereas utilitarian benefit information was presented to stimulate analytical information processing.

All information provided in the introduction or extra information is based on previous research in nanotechnology (Alfadul & Elneshwy, 2010; Araújo et al., 2013; Borm et al., 2006; Han, Yu, Li, & Wang, 2011; Handford et al., 2014; Momin, Jayakumar, & Prajapati, 2013; Riviere, 2012; Silvestre, Duraccio, & Cimmino, 2011).

Table 2: Overview of five conditions

Application		Condition	Additional Text in the Questionnaire
Nano-outside		Introduction	"One application that nanotechnology can be used for is food packaging. Food packaging is considered one of the most active areas of nanotechnology in the food sector. In this application, metal or metal oxide nanoparticles (i.e. silver, gold, zinc oxide, silica, titanium dioxide and iron oxides) are used as a coating on the inside of food packaging, called active packaging."
	1.	Control	No additional text
	2.	Hedonic Benefit	"By using nanotechnology in this form of active packaging, the food product can have better flavours, better smells and better looks. Thus, making the food product tastier and more appetizing."
	3.	Utilitarian Benefit	"By using nanotechnology in this form of active packaging, a food product's expiration date can be prolonged. Thanks to this, foods can easily be stored up to four times the length of traditional containers, increasing food shelf life and reducing food waste."
	4.	Risk Probability	"When using nanotechnology in this form of active packaging, there is a small chance that the nanoparticles move from the packaging into the food product itself. This may lead to negative consequences."
	5.	Vivid Risk	"Nanoparticles can move into the food product itself. These free nanoparticles can then cross cellular barriers and potentially harmful nanoparticles can accumulate and stay in the brains and the reproductive system (testes/utero)."
Nano-Inside		Introduction	"One application that nanotechnology can be used for is food production. Simply said, in this application, nano food ingredients or nanoparticles are added to specific food products to add or remove certain aspects from that food"
	1.	Control	No additional text
	2.	Hedonic Benefit	"By adding these nanoparticles to certain food products or in food processing, it is possible to make products tastier, smell better and look better. Overall, making the food more delicious."
	3.	Utilitarian Benefit	"The addition of the nanoparticles to certain food products, allows for more effective delivery of nutrients such as protein, vitamins, minerals and antioxidants, thus making the products healthier for consumers."
	4.	Risk Probability	"There still remains large amount of uncertainty around nanoparticles added to food products. There might be negative consequences related to the use of nanoparticles. If and how this affects the human body is still not completely clear"
	5.	Risk Vividness	"Some nanoparticles lead to inflammatory reactions of the digestive tract (stomach, colon, intestine). Repeated exposure can lead to toxic responses such as kidney and liver failure, as well as several forms of cancer."

§3.4 Measures

To our knowledge, there is no scale available that measures cognitive and affective risk (benefit) perceptions separately. However, Schenk et al., (2008) suggest that the attitude towards GM technology can be measured on two subscales; 'benefits' and 'rejection factors', showing a resemblance with benefits and risks. This suggests that risk (benefit) perceptions show similarities with attitudes, which is also a precedent of intention or acceptance (Ronteltap et al., 2007). In the multicomponent view of attitudes, often a distinction between cognitive and affective attitude is made (Ajzen, 1989) and several scales are designed to measure these constructs (Crites Jr, Fabrigar, & Petty, 1994; Desmet, 2005). This research adapted these existing cognitive and affective attitude scales in relation to risks and benefits in order to measure cognitive and affective risk (benefit) perceptions as accurately as possible. Unfortunately, the adaptation of the scales and making them logically related to risk and benefit perceptions, made it impossible to use the original semantic differential scale developed by Crites. Instead, we used a unipolar scale with only one word from Crites' original word pairs. The one that relates best to risk or benefit perception. Therefore, all measures about cognitive (affective) risk (benefit) perceptions were on a 7-point scale ranging from 1 = 'not at all' to 7 = 'very much'. All survey questions can be found in appendix 3.

For *cognitive risk perception,* two times four cognitive items related to risk perception were measured. These are inherently negative (unsafe, harmful, unhealthy, disadvantageous)(Crites Jr et al., 1994). Respondents were asked to indicate to what degree they think each of the words applies to the nano-application that was described. The eight items were averaged to create the cognitive risk perception scale ($M = 4.02$, $SD = 1.35$) with a Cronbach's α of 0.93 ($n = 8$).

Cognitive benefit perception was also measured twice on a four-item cognitive measurement scale. In contrast to the cognitive risk perceptions, cognitive benefit perception was measured using only positive cognitive items related to the benefits of the nano-application (useful, beneficial, valuable, wholesome) (Crites Jr et al., 1994). Respondents were asked to indicate to what degree they think each of the words applies to the nano-application that was described. The items were averaged to create the cognitive benefit perception scale ($M = 4.21$, $SD = 1.26$) with a Cronbach's α of 0.91 ($n = 8$).

Affective risk perception was measured using a four-item affective measurement scale. Affective feelings were measured by measuring emotions (Desmet, 2005). Only negative emotions related to risks were used for measuring affective risk perception (worried, disgusted, unpleasant surprise, disappointment) (Desmet, 2005; Slovic, 1987). Respondents were asked to indicate to what degree they experienced each of the emotions when reading about the nano-application. The items were averaged to create the affective risk scale ($M = 3.43$, $SD = 1.35$) with a Cronbach's α of 0.90 ($n = 8$).

Affective benefit perception was also measured on a four-item affective measurement scale, measuring emotions. For affective benefit perception, only positive emotions were used (pleasant surprise, acceptable, joy, fascination) (Desmet, 2005). Respondents were asked to indicate to what degree they experienced each of the emotions when reading about the benefits of the nano-application. The items were averaged to create the affective benefit perception scale (M = 3.53, SD = 1.26) with a Cronbach's α of 0.91 (n = 8).

Consumer acceptance towards the food technology was measured by assessing a consumer's willingness to buy (WTB) a product made with that technology (Siegrist et al., 2007, 2008). Respondents were asked to indicate their willingness to buy a product that is produced using nanotechnology on a 7-point Likert scale ranging from 1 (Certainly not) to 7 (Certainly).

Four items were used as a *manipulation check*. Respondents were asked if they thought the information presented to them was about (1) the chance that nanotechnology will bring negative consequences, (2) the explanation of the negative consequences of nanotechnology, (3) the functional benefits of nanotechnology or (4) the pleasure-enhancing benefits of nanotechnology. Answers were on a 7-point Likert scale (1 = Completely disagree, 7 = Completely agree).

As a *control variable*, respondents were asked how familiar they were with nanotechnology before entering the survey, on a 5-point Likert scale (1 = Not familiar at all, 5 = Very familiar). A small explanation of each answer possibility was added to make sure each respondent had the same understanding of 'familiarity'. Respondents were also asked to indicate their age (in numbers between 18-99), gender (Male/Female/Other or Prefer not to say) and level of education.

§3.5 Procedure

The survey was pre-tested on understandability and realism. Manipulations were shortened and translated to Dutch to increase understandability and to isolate the manipulation.

Respondents started the online questionnaire in their own time at home, on their computer or mobile device, starting with the description of nanotechnology. They were asked to carefully read every piece of information before continuing to the next page. Respondents received additional information on one of the two nano-applications and, depending on the assigned level, respondents received additional information about a specific risk or benefit.

After reading the additional information, the four constructs were measured, separated into two questions. In one question the four cognitive risk perception items and the four cognitive benefit perception items were measured. Another question then measured the affective risk and benefit perceptions. Both the questions and the answer possibilities were randomized to eliminate order bias

and to avoid four positive, followed by four negative words. Subsequently, respondents' WTB was measured.

Next, a counterbalanced second nano-application was introduced as a repeat measure to control for intensity of the risk or benefit and personal differences. To minimalize range effect, respondents remained in the previously assigned level and all constructs were measured again.

Lastly, respondents were asked to fill out the control variables (familiarity with nanotechnology, gender, age, and education) and a manipulation check. They were then de-briefed, explaining that the scenarios in the questionnaire were fictional (although based on actual research) and thanked for their participation, before submitting the questionnaire.

§4 Results

§4.1 Descriptive statistics

Gender was fairly equally split across respondents (N = 159) with almost half male (45%, n = 72) and almost half female (54% n = 86) respondents. Respondents were between 18 and 70 years old with an average age of 29 (SD = 12.09). The largest part of respondents indicated to have a bachelor (39%, n = 62) or master's degree (48%, n = 76). Other respondents filled out middle school (n = 11), doctorate (n = 5) or other (n = 3) as their highest achieved degree. On average, respondents indicated to be 'not familiar' with nanotechnology before entering the survey (M = 2.33, SD = 0.93). Most of the respondents indicated 'not familiar at all' (18%, n = 28), 'not familiar' (43%, n = 69) and 'a little bit familiar' (29%, n = 46). Only a small portion indicated to be 'familiar' (8%, n = 13) or 'very familiar' (2%, n = 3) with nanotechnology.

§4.2 Randomization and manipulation check

A randomization check was used to check if age, education, and familiarity with nanotechnology were randomly distributed across groups. A one-way ANOVA showed no significant differences of gender between different groups $F(4, 153) = 0.93$, $p = .444$. There was also no significant difference between groups for education $F(4, 152) = 1.57$, $p = .186$ and familiarity $F(4, 154) = 0.48$, $p = .750$. This indicates that level of education, gender, and familiarity with nanotechnology were indeed randomly assigned across different groups.

A manipulation check was used to check if respondents thought the presented information was about the vividness of a risk, the probability of a risk, a hedonic benefit or a utilitarian benefit. Results from a one-way ANOVA shows all four manipulation check answer categories were significantly different across groups (probability risk $F(4, 153) = 30.71$, $p = .000$; vivid risk $F(4,153) = 32.61$, $p = .000$; utilitarian benefit $F(4, 153) = 10.99$, $p = .000$; hedonic benefit $F(4, 153) = 12.93$, $p = .000$). Post hoc tests (Bonferroni) were used to check how the five groups scored differently on the manipulation check questions (table 3).

For the risk probability manipulation check, the *probability risk group* scored significantly higher (M = 4.75, SD = 1.61) compared to all other groups ($p = .000$) except the *vivid risk group* (M = 5.61, SD = 1.36, $p = .212$). For the vivid risk manipulation check, as expected, the *vivid risk group* scored significantly higher (M = 5.90, SD = 0.98) compared to all other groups ($p < .001$). For the utilitarian benefit manipulation check, the *utilitarian benefit group* scored significantly higher (M = 5.56, SD = 1.12) compared to the *vivid risk group* ($p = ,000$) and the *probability risk group* ($p = .003$). It scored higher, although not significant, compared to the *control group* (M = 4,52, Sd = 1.50, $p = .378$) and the *hedonic benefit group* (M = 5.32, SD = 1.40, $p = 1.000$). For the hedonic benefit manipulation check, the *hedonic*

benefit group scored significantly higher (M = 4.61, SD = 1.69) compared to all other groups (p < .002) except the *utilitarian benefit group* (M = 4.26, SD = 1.63, *p* = 1.000).

The results from the one-way ANOVA show that the manipulation was partially successful. Respondents did indicate a difference in manipulation between risk and benefit information for all groups. For three out of four manipulation checks, the highest mean was within the group corresponding with that manipulation. However, this mean was mostly not significantly different.

Table 3
Manipulation check (mean and standard deviation) (N = 159)

Group[1]	Manipulation check measure M(SD)			
	Vividness of Risk	Probability of Risk	Utilitarian Benefit	Hedonic Benefit
1. Control (n=33)	2.91 [a] (1.38)	2.76 [a] (1.52)	4.52 [bc] (1.50)	3.15 [ab] (1.50)
2. UB (n=27)	2.93 [a] (1.51)	2.85 [a] (1.54)	5.56 [c] (1.12)	4.26 [bc] (1.63)
3. HB (n=32)	2.10 [a] (1.49)	2.10 [a] (1.51)	5.32 [c] (1.40)	4.61 [c] (1.69)
4. RP (n=36)	4.42 [b] (1.84)	4.75 [b] (1.61)	4.11 [ab] (1.95)	2.86 [a] (1.61)
5. RV (n=31)	5.90 [c] (0.98)	5.61 [b] (1.36)	3.26 [a] (1.48)	2.19 [a] (1.25)

Note: Mean values sharing the same letters (a-c) indicate no significant differences (p > 0.05) among assigned groups.
[1] UB = Utilitarian benefit, HB = Hedonic Benefit, RP = Risk Probability, RV = Risk Vivid.

§4.3 Correlations and covariates

To check whether it was relevant to integrate covariates into the analyses, correlations between the control variables, the mediator variables and the dependent variables were calculated. The control variables used were; age, gender, familiarity and education. Mediating variables were the perception variables and the dependent variable used was consumer acceptance. No relevant correlations higher than *r* = 0.163 were found and none of these variables were used as covariances in further analysis. No significant main effect of familiarity on consumer acceptance was found (F(4, 154) = 1.707, *p* = 0.151).

§4.4 MANOVA

A MANOVA was used to check for general differences between groups and the mediating variables. Box's test of equality was significant (*p* = .045), showing that the observed covariance matrices of the dependent variables were not equal across groups. Levene's test for equality of variances is not significant for all groups except 'affective risk perception', *p* = .033. Wilk's Λ shows a significant difference between groups and a combination of the perception variables, Λ = 0.628, F(16, 461.95) = 4.746, *p* = .000, η^2 = .110. Univariate tests show that these groups differ on all perception variables with a relevant effect (affective risk perception, F(4, 154) = 14.564, *p* = .000, η^2 = .274; cognitive risk perception, F(4,154) = 14.232, *p* = .000, η^2 = .270; cognitive benefit perception, F(4, 154) = 13.631, *p* = ,000, η^2 = .261; affective benefit perception F(4, 154) = 12.790, *p* = .000, η^2 = .205). This implies that there are significant differences between experimental groups on the different perception variables.

§4.5 Hypothesis testing

Results from a *one-way* ANOVA (table 4) showed a significant main effect of the different groups on the cognitive risk perception of respondents, F(4, 154) = 14.23, *p* = .000. Contrast analysis results (table 5) showed that the cognitive risk perception for the *probability risk group* was unexpectedly, significantly lower (M = 4.35, SD = 1.04) compared to the cognitive risk perception of the *vivid risk group* (M = 5.27, SD = 1.03), t(154) = -3.19, *p* = 0.002. However, it was significantly higher compared to the cognitive risk perception of the *control group* (M = 3.55, SD = 1.18), t(154) = -2.80, *p* = 0.006. These results give no support for *H1a*.

Results from another *one-way* ANOVA (table 4) showed a significant main effect of the different groups on the affective risk perception of respondents, Brown-Forsythe (4, 137.53) = 14.394, *p* = .000. Brown-Forsythe was used since the assumption of equal variances was violated (Levene's test statistic = 2.696 *p* = .033). Contrast analysis results (table 5) showed, as expected, that the affective risk perception for the *vivid risk group* was higher (M = 4.68, SD = 0.89) compared to the affective risk perception of the *probability risk group* (M = 3.71, SD = 1.02), t(64.97) = -4.131, *p* = .000 and the affective risk perception of the *control group* (M = 2.84, SD = 1.28), t(57.33) = -6.72, *p* = .000, providing initial support for *H1b*.

However, we are also interested in the difference between cognitive and affective risk perceptions across groups. This difference indicates the relative, rather than the absolute, influence of the groups on the cognitive and affective risk perception of respondents. Results from a one-way ANOVA show no significant main effect of the groups on the difference between the cognitive and affective risk perceptions, F(4, 154) = 0.564, *p* = .689. This implies that the difference between cognitive and affective risk perceptions is equal across groups. Therefore, we cannot claim that one risk group scored significantly higher on a type of risk perception compared to another risk group, thus providing no support for *H1a* and *H1b*. Figure 4 shows a visual representation of the differences in risk perception.

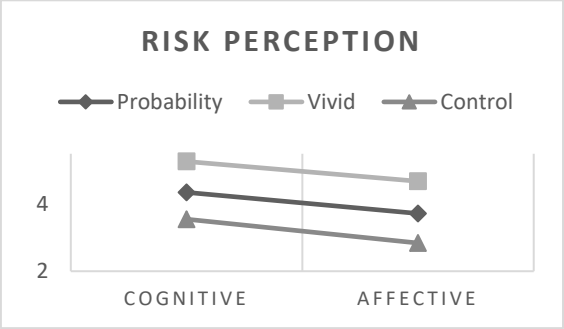

Figure 4: Cognitive and affective risk perception

Moving on to hypotheses H2a and H2b, results from a *one-way* ANOVA (table 4) showed a significant main effect of the different levels on the cognitive benefit perceptions of respondents, F(4, 154) =

13.63, *p* = .000. Contrast analysis results (table 5) showed that cognitive benefit perception for *utilitarian benefit group* was, as expected, significantly higher (M = 5.10, SD = 1.10) compared to the cognitive benefit perception of the *hedonic benefit group* (M = 4.47, SD = 1.15), t(154) = -2.20, *p* = .029, providing initial support for *H2a*. However, it was not significantly higher compared to the *control group* (M = 4.58, SD = 1.10), t(154) = -1.825, *p* = .070.

Furthermore, a significant main effect of the different levels on affective benefit perception was also found, F(4, 154) = 9.91, *p* = .000 (table 4). Contrast analysis results (table 5) showed affective benefit perception for the *hedonic benefit group* was lower (M = 3.99, SD = 1.34), but not significantly, compared to the *utilitarian benefit group* (M = 4.28, SD = 1.29), t(154) = -1.01, *p* = .311, implying no support for *H2b*. The recorded affective benefit perception of the *hedonic benefit group,* was higher compared to that of the *control group* (M = 3.61, SD = 1.06), t(154) = -1.31, *p* = .190, although also not significantly.

If we look at the difference between the cognitive and affective benefit perception across groups, we see a different image compared to that of the risk perception differences (figure 5). However, similar to the risk perception differences, a one-way ANOVA showed no significant main effect of the groups on the difference between the cognitive and affective benefit perceptions, F(4, 154) = 1.648, *p* = .165. This implies that the difference between cognitive and affective benefit perceptions is equal across groups. Therefore, similar to risk perception results, we cannot claim that one benefit group scored significantly higher on a type of benefit perception compared to another benefit group, thus providing no support for *H2a* and *H2b.*

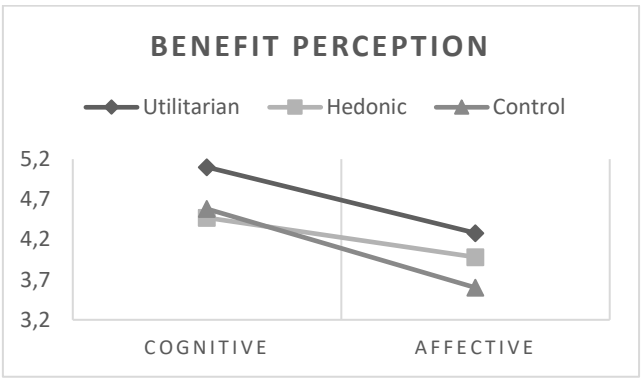

Figure 5: Cognitive and affective benefit perception

Table 4

Mean and standard deviation of perception variables across different groups (N = 159)

Group[1]	Measure, Mean (Standard deviation)			
	Affective risk perception[2]	Cognitive risk perception[3]	Affective benefit perception[3]	Cognitive benefit perception[3]
1. Control (n=33)	2.84 (1.28)	3.55 (1.18)	3.60 (1.06)	4.58 (1.10)
2. UB (n=27)	2.74 (1.29)	3.37 (1.38)	4.28 (1.29)	5.10 (1.10)
3. HB (n=32)	3.09 (1.33)	3.50 (1.32)	3.98 (1.34)	4.47 (1.15)
4. RP (n=36)	3.72 (1.02)	4.34 (1.04)	3.31 (0.99)	3.89 (1.02)
5. RV (n=31)	4.68 (0.89)	5.27 (1.03)	2.59 (1.00)	3.17 (1.10)

[1] UB = Utilitarian benefit, HB = Hedonic Benefit, RP = Risk Probability, RV = Risk Vivid.

[2] Brown-Forsythe (p = .000) was used (Levene's = 2.696, p = 0.033)

[3] Analysis of Variance $p < .05$

Table 5

Contrast analysis of perception variables across different groups (N = 159)

Contrast[1]	Mean Difference (p-value)			
	Affective risk perception	Cognitive risk perception	Affective benefit perception	Cognitive benefit perception
Control – RV	-1.84 (p = .000)	-1.73 (p = .000)		
Control – RP	-0.88 (p = .003)	-0.80 (p = .006)		
RP – RV	-0.96 (p = .000)	-0.93 (p = .002)		
Control – HB			-0.37 (p = .190)	0.11 (p = .684)
Control – UB			-0.67 (p = .024)	-0.52 (p = .070)
HB – UB			-0.30 (p = .311)	-0.63 (p = .029)

[1] UB = Utilitarian benefit, HB = Hedonic Benefit, RP = Risk Probability, RV = Risk Vivid.

Results from a regression analysis (table 6) were used to determine the influence of the perception variables on consumer acceptance (WTB). A significant model, $F(4, 154) = 69.77$, p = .000 with a relevant fit was found (R^2 = .57). Out of the four perception variables, only three showed to be a significant predictor of consumer acceptance. Cognitive risk perception showed a not significant negative effect on consumer acceptance (β = -.102, n.s.), implying the rejection of *H3a*. However, if we examine the correlations matrix in table 7, we see that there is a high correlation between consumer acceptance and all four perception variables. This suggests that all perception variables have an influence on consumer acceptance. We suggest that this does not show in the regression results due to multicollinearity. Furthermore, as expected, affective risk perception has a significant negative influence on consumer acceptance (β = -.380, p = .002), supporting H3b. Cognitive benefit perception (β = .350, p = .007) and affective benefit perception (β = .307, p = .006) both showed a significant positive influence on consumer acceptance, supporting *H4a* and *H4b*.

Table 6
Main effect of perception variables on consumer acceptance

Model[2]	Unstandardized Coefficients			
	β	Std. Error	*p*-value[1]	VIF
(Constant)	3.233	0.799		
Affective Risk Perception	-0.380	0.119	.002	3.230
Cognitive Risk Perception	-0.102	0.123	.411	3.553
Cognitive Benefit Perception	0.350	0.128	.007	3.223
Affective Benefit Perception	0.307	0.109	.006	2.343

[1] Regression Analysis
[2] R^2 = .58

Table 7
Correlations matrix (N=159)

Measure	M	SD	1	2	3	4
1. Affective risk perception	3.43	1.35	-			
2. Cognitive risk perception	4.02	1.37	0.817 ***	-		
3. Cognitive benefit perception	4.21	1.26	-0.692 ***	-0.719 ***	-	
4. Affective benefit perception	3.53	1.26	-0.550 ***	-0.610 ***	0.750 ***	-
5. WTB	4.08	1.71	-0.670 ***	-0.650 ***	0.694 ***	0.634 ***

*** *p* = .000

In figure 6, an overview of the different hypotheses and effect sizes is presented.

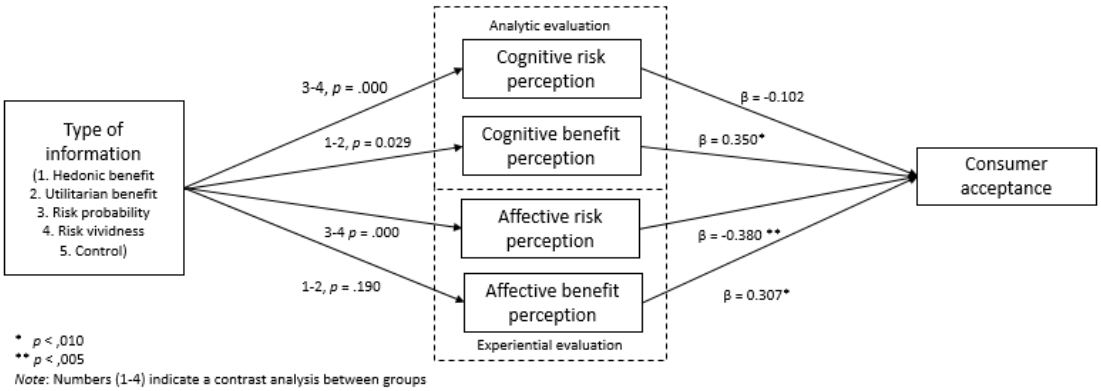

Figure 6: Overview of hypotheses and effect size

§4.6 Overall effect and mediation analysis

Results of a one-way ANOVA show a direct main effect of the different groups on consumer acceptance, F(4, 154) = 7.134, p = .000, η2 = .158. Most relevant post hoc (Bonferroni) test results show similarities with previous results (table 8). Results show that the willingness to buy a product produced with nanotechnology was significantly lower in the risk vividness group (M = 3.06, SD = 1.53) compared to the control group (M = 4.76, SD = 1.28, p = .000), the utilitarian benefit group (M = 4.74, SD = 1.81, p = .001) and the hedonic benefit group (M = 4.41, SD = 1.68, p = .010). The willingness to buy was highest in the control and utilitarian benefit group, which were both significantly higher compared to

the risk probability (M = 3.56, SD = 1.65, p < .05) and the risk vividness group (p < .05). As can be expected, we observe differences in willingness to buy between the respondents that received information about the risks and respondents who received information about the benefits of nanotechnology in food production.

However, these differences between groups in consumer acceptance can be explained by the perception variables. The regression model of the perception variable on consumer acceptance explains 58% of the variance (R2 = .58). Adding the different groups to the regression model does not significantly improve the fit of the model (R2 change = .016, p = .215). This suggests that all variance that is explained by the groups is mediated by the perception variables, implying no separate main effect of the assigned group on consumer acceptance.

Table 8

Direct main effect of group allocation on consumer acceptance (N = 159)

Group	Measure	
	n	Mean (Standard Deviation)
1. Control	33	4.76^{c} (1.28)
3. Utilitarian Benefit	27	4.74^{c} (1.81)
3. Hedonic Benefit	32	4.41^{bc} (1.68)
4. Risk Probability	36	3.56^{ab} (1.65)
5. Risk Vividness	31	3.06^{a} (1.53)

Note: Mean values sharing the same letters (a-c) indicate no significant differences (p > 0.05) among assigned groups.

§5 Discussion

§5.1 Conclusion

Previous research has shown that risk and benefit perceptions remain a complicated issue and are subjected to much research. The present study attempted to provide insights into the cognitive and affective aspects of a consumer's risk-benefit perceptions of new food technologies. The results show that the information that is provided to consumers about a new food technology does influence their risk-benefit perceptions of that technology. However, we were not able to show the relationship between vividly presenting risks and a higher affective risk perception. Similarly, the relationship between statistically presenting risks and cognitive risk perceptions was not found, although both relationships are previously established in research (Loewenstein et al., 2001). For benefit perceptions, we were also not able to show the relationship between presenting consumers with hedonic (utilitarian) benefits and affective (cognitive) benefit perceptions. That might indicate why this relationship was not established in previous research yet. We did observe that both cognitive and affective benefit perceptions towards a new food technology increase the willingness to buy a product produced with that technology. When a consumer is confronted with both risks and benefits of a new food technology, the affective aspect of the risk perception is more dominant in determining consumer acceptance towards a product produced with that technology. This once again demonstrates that providing consumers with information does influence a consumer's acceptance of that new food technology, as previous research has suggested (Siegrist & Keller, 2011; Siegrist et al., 2008).

§5.2 The relation between type of information and perception

That we were unable to find the previously mentioned relationships between type of information and cognitive (affective) perceptions does not mean that they are non-existent. The discrepancies with the theory might be caused by one of two reasons. Firstly, the creation of the scales. We know that the scales for measuring cognitive and affective risk-benefit perceptions were not tested before this study. The translation from Crites' (1993) semantic differential scales to a unipolar scale may have interfered with the validity of the scale. Furthermore, these scales were originally designed to measure cognitive and affective attitude. While attitude is a longer lasting evaluative aspect of an attitude object (Ajzen, 1989) and perception is often regarded as the organisation and interpretation of sensory stimuli, research does imply that perceptions are influenced by attitudes (Kenyon & Sen, 2015). Moreover, when in a survey setup, asking respondents to self-report on their perceptions, we cannot ignore the overlap between perceptions and attitudes. Therefore, in our opinion, the decision to use cognitive and affective attitude towards risks and benefits, to measure cognitive and affective risk-benefit perceptions remains our best option yet. However, there remains room for improvement and is a point of attention for future researchers on this topic. A second reason for the discrepancies with the theory

is that the manipulation might not have been explicit enough for all groups. Only presenting respondents with different information about nanotechnology might not trigger the different types of information processing that we were hoping for. This might also be an explanation for the high numbers of cognitive perceptions in the study. Previous research established that informational tasks such as reading, trigger more analytic information processing (Epstein, 1998). This can then be translated by respondents into higher cognitive perceptions for both the benefits and the risks.

When a similar distinction between cognitive and affective risk-benefit perceptions is being researched in the future, the manipulation should not consist of solely written information. Adding images to the manipulation might trigger more affective information processing (Keller, Siegrist, & Gutscher, 2006; Shiv & Fedorikhin, 1999), translated into a better distinction between cognitive and affective perceptions. Researchers can also try to put respondents in a certain state before submitting them to a survey. By appealing more to the feelings of a respondent, as when showing them emotional images or videos, respondents might be inclined to use their experiential information processing system more (Keller et al., 2006). Similarly, by depleting a respondent's working memory or submitting them to time pressure, respondents switch from analytic to experiential information processing (Evans, 2008; Shiv & Fedorikhin, 1999). Thus, by forcing respondents to use a certain type of information processing system more, their cognitive and affective perception of the risks and benefits of a situation might also change.

§5.3 Vivid risk information and risk perception

We found that presenting risks vividly to consumers leads to the highest overall risk perception. This is not unexpected. Previous research has established the importance of affect in risk perception (Slovic et al., 2004). Loewenstein and colleagues teach us that vivid risks evoke more emotional reactions amongst consumers (Loewenstein et al., 2001). These emotional reactions can often drive risk-related behaviour and in turn increase people's perception of these risks (Loewenstein et al., 2001; Slovic, 1987). However, we were still not able to show the relative influence of the type of risk information on cognitive or affective risk perception. This might also be the result of the previously mentioned limitations of the manipulation or the measurement scales. Furthermore, the parallel lines in figure 4 suggest that there is a possibility that the perception measurement scales were unable to distinctly measure between the cognitive and affective aspects of risk perception.

§5.4 The affect heuristic

Although we only provided respondents with information about the risks or benefits of a new food technology, we still found high correlations between the risk and benefit perceptions. This interdependency is in line with previous research (Alhakami & Slovic, 1994; Siegrist et al., 2008) and we propose this might be explained by the affect heuristic. This suggests that people rely on affect

when judging the risks and benefits of specific situations (Finucane et al., 2000; Slovic, Finucane, Peters, & MacGregor, 2007). Furthermore, the affect heuristic suggests that when people are confronted with information about the risks (or benefits) of a situation, they make inferences about the benefits (or risks) (Slovic & Peters, 2006). Since we asked respondents to indicate their risk and benefit perceptions in one survey, while only providing information on one of them, respondents relied more on affect when indicating their willingness to buy.

§5.5 Limitations

In this research, manipulations were not entirely equal across groups. The risk information that was provided, was divided into vivid and statistical information, whereas the benefit information was divided into hedonic and utilitarian benefit information. This led to difficulties in making the manipulations commensurable. For future research using similar manipulations, it might be beneficial to create overarching constructs for both risk and benefit information. A suggestion might be to use hedonic and utilitarian information for both risk and benefit information, thus creating a hedonic and utilitarian risk.

§5.6 Scientific and practical implications

This research adds to the growing collection of risk-benefit perception related research focussed on new food technologies. It helps marketeers better understand how consumers deal with information and how this influences consumer perceptions towards new food technologies. Subsequently, it can help marketeers understand why certain novel foods are more easily accepted by consumers. New food technologies have the potential to provide countless benefits and faster consumer acceptance helps us achieve those benefits more quickly.

Although our research did not find the distinction between cognitive and affective benefit perceptions as we set out to do, a contribution to the risk-benefit perception literature was still made. We have set the first steps towards researching cognitive and affective aspects of benefit perceptions and provided advice for future research on this topic. We have shown the importance of affect in risk and benefit perceptions and their influence on consumer acceptance of new food technologies. For now we know, not only in risk but also in benefit perceptions; *feelings matter*.

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§7 Appendix

Appendix 1: Nanotechnology introduction text translated to Dutch

"Nanotechnologie is een specialistische technologie gewijd aan het bestuderen, creëren en gebruiken van materialen tussen de 1 en 100 nanometer. Om een beeld te schetsen, een mensenhaar is ongeveer 100.000 nanometer dik. Omdat deze deeltjes zo klein zijn, bieden ze een tal van mogelijkheden voor allerlei applicaties. Producenten kunnen nano-deeltjes maken door grotere deeltjes zeer fijn te malen of door individuelen atomen of moleculen te manipuleren in nano-structuren.

Nanotechnology wordt al voor verschillende applicaties gebruikt en wordt nu ook in de voedingsmiddelenindustrie toegepast. Er kunnen nano-deeltjes worden toegevoegd aan het voedingsmiddel zelf of aan de verpakking. Wanneer dit gebeurt, noemen we die producten nano-foods."

Appendix 2: Dutch translation of research conditions

Appendix 2, Table 2: Overview of five conditions translated to Dutch

Application		Condition	Additional Text in the Questionnaire
Nano-outside		Introduction	"Nanotechnologie kan worden gebruikt in voedselverpakkingen. Dit wordt gezien als een van de meest actieve gebieden van nanotechnologie in de voedingsmiddelenindustrie. Hierbij worden metaal of metaaloxide nano-deeltjes (bv. zilver, zink of titanium oxide) gebruikt als een coating aan de binnenkant van verpakkingen, ook wel actieve verpakking genoemd."
	1.	Control	Geen extra tekst
	2.	Hedonic Benefit	"Door deze vorm van actieve verpakking te gebruiken, kan nanotechnologie ervoor zorgen dat voedingsmiddelen lekkerder ruiken en er beter uit zien. Hierdoor smaakt het product uiteindelijk ook beter."
	3.	Utilitarian Benefit	"Door deze vorm van actieve verpakking te gebruiken, kan de nanotechnologie ervoor zorgen dat de houdbaarheidsdatum van een product wordt verlengd. Daardoor kan een product tot wel vier keer langer worden bewaard, en is er minder voedselverspilling."
	4.	Risk Probability	"Door deze vorm van actieve verpakking te gebruiken, is er een kleine kans dat nano-deeltjes vanuit de verpakking in het voedingsmiddel terecht komen. Dit kan dan tot negative consequenties leiden."
	5.	Vivid Risk	"Nano-deeltjes kunnen vanuit de verpakking in het voedingsmiddel terecht komen. Deze vrije nano-deeltjes kunnen in het menselijk lichaam door celmembranen passeren. Deze, soms schadelijke, deeltjes kunnen zich dan ophopen in de hersenen of voortplantingsorganen."
Nano-Inside		Introduction	"Nanotechnologie kan gebruikt worden voor de productie van voedingsmiddelen. Er worden dan nano-ingrediënten of nano-deeltjes aan een specifiek voedingsmiddel toegevoegd. Hierdoor kunnen bepaalde aspecten van een product worden toegevoegd of verwijderd."
	1.	Control	Geen extra tekst
	2.	Hedonic Benefit	"Door deze nano-deeltjes toe te voegen aan voedselproducten of tijdens voedsel productie, is het mogelijk om producten extra smaak te geven, te voorzien van een lekkerdere geur en er beter uit te laten zien."
	3.	Utilitarian Benefit	"De toevoeging van nano-deeltjes aan voedingsmiddelen zorgt voor een efficiëntere levering van voedingsstoffen zoals eiwitten, vitamines en antioxidanten. Hierdoor worden producten gezonder."
	4.	Risk Probability	"Er is nog veel onzekerheid over het toevoegen van nano-deeltjes aan voedingsmiddelen. Het is mogelijk dat dit tot negatieve consequenties kan leiden. Of en hoe het menselijk lichaam precies reageert op deze nano-deeltjes is nog onduidelijk."
	5.	Risk Vividness	"De inname van sommige nano-deeltjes leidt tot ontstekingsreacties in het spijsverteringsstelsel. Herhaaldelijke inname kan leiden tot giftige reacties zoals lever en nierfalen en sommige vormen van kanker."

Appendix 3: Survey questions

Cognitive risk perception: Please indicate to what degree do you think each of the following words applies to the risks of the nano-application described. (1 = not at all to 7 = very much)

- Unsafe, Harmful, unhealthy, disadvantageous

Cognitive benefit perception: Please indicate to what degree do you think each of the following words applies to the benefits of the nano-application described. (1 = not at all to 7 = very much)

- Useful, beneficial, valuable, wholesome

Affective risk perception: Please indicate to what degree you experienced the following emotions when reading about the risks of the nano-application described (1 = not at all to 7 = very much)

- Worried, disgusted, unpleasant surprise, disappointment

Affective benefit perception: Please indicate to what degree you experienced the following emotions when reading about the benefits of the nano-application described (1 = not at all to 7 = very much)

- Pleasant surprise, acceptable, joy, fascination

Consumer acceptance: I would buy a food product that is produced using nanotechnology (1 = Certainly not to 7 = Certainly)

Manipulation check: The information about nanotechnology that was presented to you was focussed on… (1 = Completely disagree to 7 = Completely agree)

- …the chance that nanotechnology will bring negative consequences
- …the explanation of the possible negative consequences of nanotechnology
- …the functional benefits of nanotechnology
- …the pleasure enhancing benefits of nanotechnology

Control variables:

Familiarity: Before entering this survey, how familiar were you with nanotechnology?

1. Not familiar at all (never heard about it)
2. Not familiar (I have heard about it but never done anything with it)
3. A little familiar (I have heard about it and read about it but I don't know the details)
4. Familiar (Intentionally looked for information and read this)
5. Very familiar (I know a lot about it/I did research on nanotechnology)

Gender: What is your gender?

1. Male
2. Female
3. Other/Prefer not to say

Age: What is your age? (18-99)

Level of education: What is your highest achieved degree? (If you are currently enrolled, please select that educational level)

1. Less than high school
2. High school
3. Bachelor

4. Master
5. Doctorate
6. Other