Attitudes and attitudinal ambivalence towards nanotechnology in the food domain: Analysing the effects of balanced information, decisional consequences and regulatory focus on ambivalence reduction.

Date: November 30, 2015

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Thesis code: MCB-80433

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Abstract

Public attitudes towards nanotechnology in the food domain are characterised by uncertainty, which can lead to neutral and/or ambivalent attitudes. For nanotechnology to be accepted and to develop, the public has to gain positive attitudes towards it. Research about the underlying processes how ambivalence is reduced point to consequences about the decision one must take. How we can influence the valence of the attitude during ambivalence reduction has not been widely researched. The way people approach gains and avoid losses (i.e. regulatory focus theory) might play a role whether people gain a positive or negative attitude. In the current study 242 Dutch students were primed in a regulatory focus and were provided with or without balanced information about nanotechnology in a yoghurt product and with or without decisional consequences. Results show that balanced information leads to more psychological discomfort. Furthermore, people who were pressured with the need to choose and uncertainty about a personally relevant outcome reduce ambivalence to a larger extent than people who were not. Regulatory focus does not seem to play a role in the valence of new attitude formation and does not make people less ambivalent. Providing information though seems to benefit acceptance in the long-term as people who already had knowledge about nanotechnology had a more positive final attitude than people who had less initial knowledge.

Introduction

In the previous decades technology in a variety of areas has been subjected to many innovations. Examples of these emerging technologies are genetic modification, food irradiation and pesticides, cloning and more recently nanotechnology. The consumer, being the end of the supply chain, is thus automatically involved in at least an important share of applications resulting from upcoming technologies. These applications provide benefits on both the individual level as society as a whole, for example by improving agricultural productivity and efficiency (the Green Revolution in the developed world), increasing food safety and contributing to personal health (e.g. Weiss, Takhistov & McClements, 2006; Romig et al., 2007). However, despite the beneficial outcomes of the aforementioned technologies, the public marked these technologies at least to some extent as controversial.

The introduction of new technologies brings uncertainties, which are perceived as a larger risk by the consumer. Previous accidents with products created with emerging technologies have made the public more aware of possible negative outcomes and cause people to be reluctant to accept new technologies (Gupta, Fischer & Frewer, 2012). This public scepticism towards technological innovations is problematic for the commercialisation of the applications these technologies can provide to us. It is widely recognised in the literature, that public acceptance is essential for a technological innovation to gain further development (e.g. Currall, King, Lane, Madera & Turner, 2006; Frewer et al., 2014). Moreover, a negative public attitude can limit governmental funding to further research technological innovations (Currall et al., 2006).

Scepticism towards the relatively recently emerged nanotechnology (the manipulation of material at nanoscale, i.e. 1 to 100 nanometres) seems to be limited and the more general attitude towards nanotechnology is slightly positive (Frewer et al., 2014), where Europeans are reported to be less optimistic than U.S. citizens (Gaskell, Ten Eyck, Jackson & Veltri, 2005). However, acceptance varies between product domains (Priest & Greenhalgh, 2011). Similar to genetic modifications, attitudes towards nanotechnology applications in the areas of medicines and electronics are rather positive, but in food products nanotechnology has received more scepticism (Priest & Greenhalgh, 2011; Frewer et al., 2011).

As nanotechnology applications have both risks and benefits, people's attitude towards nanotechnology can be based on opposing statements or beliefs (Fischer, Van Dijk, De Jonge, Rowe & Frewer, 2013). This would mean that those attitudes are not primarily positive or negative and thus are mixed attitudes. Where a positive or negative attitude is univalent, a mixed attitude can be characterised as ambivalent. Ambivalent attitudes can cause an internal conflict between the risks and benefits of an attitude object, comparable with cognitive dissonance (Festinger & Carlsmith, 1959). Due to the inconsistency within one's attitude people can encounter a state of psychological discomfort (Van Harreveld, van der Pligt & de Liver, 2009). The negative experience of discomfort should motivate people wanting to change their beliefs in order to gain a less ambivalent and more consistent attitude (Stone & Cooper, 2001). The question here is in which direction (that is, a positive or negative attitude) people go, while solving this inconsistency between beliefs towards risks and benefits of nanotechnology applications. Fischer et al. (2013) have shown that providing people with balanced information about nanotechnology, people's attitude can change in three ways: a positive univalent attitude, a negative univalent attitude or a mixed attitude. This means that when given risk and benefit information, some people suppress risks and come to a positive attitude, some people suppress benefits and come to a negative attitude and some people do not solve any inconsistency in their attitude. However, their paper does not provide us with the clear intermediate steps between the provision of balanced information and a univalent or mixed attitude. Therefore, there remains a gap about which direction one will go. Up to now, investigated predictors for public ambivalence towards nanotechnology have been limited to socio-demographic or cultural factors (Fischer et al., 2013; Kahan, Braman, Slovic, Gastil, & Cohen, 2009), but on the psychological domain there might be a lot going on, which has not been extensively researched. In ambivalent situations, the need to

make a decision and what outcomes a decision has might influence how people experience discomfort (Van Harreveld, van der Pligt & et al., 2009). In the current study we will elaborate on how decisional pressure and decisional consequences intensifies psychological discomfort. Furthermore, we will discuss how people might come to a positive or negative new attitude by means of how one approaches gains and losses. In other words, this research examines what role regulatory focus theory may play in the process of ambivalence reduction. A better understanding of these intermediate processes, which variables may moderate the level of experienced discomfort and whether benefits or risks will be suppressed under certain conditions are important for the knowledge about public acceptance of nanotechnology applications and therefore, for the development of nanotechnology. This paper aims to make a contribution in that field. Specifically, this leads to two primary research questions. Do decisional consequences increase discomfort in order to come to a less ambivalent attitude? Does a regulatory focus steer people to an either more positive or more negative attitude towards nanotechnology?

Attitudes and Attitudinal Ambivalence

What people believe of and feel towards objects, issues or situations is generally labelled as an attitude. Attitudes are commonly defined as positive or negative evaluations to the attitude object (Jonas, Broemer & Diehl, 2000). To determine an attitude, researchers often make use of expectancy-value models, like the one proposed by Fishbein and Ajzen (1975) (equation 1).

$$A = \sum_{1=i}^{n} b_i e_i \quad (1)$$

Attitudes are estimated by multiplying and then summing all evaluations one has towards the attributes of the attitude object (*e*) with the beliefs or probabilities that the attitude object has those attributes (*b*). The theory about attitudes of Fishbein and Ajzen (1975) proposes that by summing all the beliefs concerning the attitude one derives at a single univalent attitude about an attitude object. Their model leaves room for opposing evaluations towards an attitude object, whereby two equally positive and negative evaluations are evened out and thus lead to a neutral attitude. However, the option that people have strong opposing evaluations simultaneously and do not have a neutral attitude is excluded due to the summing of opposing evaluations in the aforementioned model. When people have two strong opposing evaluations towards the same attitude object simultaneously, they may not be neutral at all, but be conflicted between the two. This option has found to be the case and is defined as attitudinal ambivalence (Kaplan, 1972; Jonas et al., 2000). Many objects, issues or situations can have both advantages and disadvantages. Take for example a dairy product that incorporates a new innovation, which provides clear health benefits, but at the same time reduces the tastiness of the product. These types of situations might result in conflicting evaluations towards the attitude object.

Attitudes towards an attitude object can be positive, negative, neutral or ambivalent in nature and tend to differ on their level of attitude strength (Jonas, et al., 2000). The latter does not mean that a strong attitude is very positive or very negative per se, but that the attitude has a certain degree of stability. A strong attitude, in contrast to a weak attitude, is for example resistant to new information, persistent over time and high in certainty (Krosnick, Boninger, Chuang, Berent & Carnot, 1993; Jonas, et al., 2000). Because a strong attitude and a high level of certainty tend to imply a strong opinion about an issue, a strong attitude tends to guide behaviour. For an attitude to be ambivalent, the opposing evaluations have to be relatively equally extreme positive and extreme negative (otherwise an attitude is primarily positive or negative). Opposite evaluations that are weakly positive and negative tend to result in an indifferent or neutral attitude. Ambivalent attitudes might not be strong attitudes and may therefore not be regarded as a high quality guide where behaviour can be based on (Sawicki et al., 2013). Thus, ambivalent attitudes have found to be

unstable attitudes and have a low level of attitude certainty. An uncertain attitude is weak and therefore amenable for new information and less resistant for persuasive messages (Bassili, 1996).

Experienced Discomfort

Attitudinal ambivalence literature recognizes two types of ambivalence: potential ambivalence and felt ambivalence (Van Harreveld, van der Pligt et al., 2009). People have potential ambivalence when they report to have both positive and negative evaluations. This means that there might be merely cognitive inconsistency, which can also exist at an unconscious level. Felt ambivalence (also subjective ambivalence or experienced ambivalence), on the other hand, is the acknowledgement of ambivalence. The latter often expresses itself in an unpleasant feeling. The coexistence of both a negative and a positive evaluation toward the attitude object can cause people to experience an internal conflict, which might feel as psychological discomfort (Hass, Katz, Rizzo, Bailey & Moore, 1992; Nordgren, van Harreveld & van der Pligt, 2006). So, when someone experiences felt ambivalence he or she may actually feel torn about an attitude object's positive and negative sides (Van Harreveld, van der Pligt, et al., 2009).

Opposing evaluations do not necessarily result in felt ambivalence and in experienced discomfort, because they are not always simultaneously accessible. One or the other may be more accessible or present in different situations or at different times (Van Harreveld, van der Pligt, et al., 2009). For example, whilst buying the aforementioned dairy product, the importance of good taste might be of such proportions at the moment right before the purchase, that the health benefit automatically is downgraded or forgotten. The intention to exert behaviour (in this case the purchase) is thus based on the attitude towards the dairy product (Ajzen, 1985). The attitude formation is driven by the evaluation of the risks and benefits of the behavioural outcome. In this case the perceived benefits (enhanced health) are that low that the attitude towards the new dairy product will be primarily negative and will guide corresponding behaviour (that holds: a dairy product with good taste and without the health benefits is to be bought). Because not both evaluations (i.e. risks and benefits) are equally present at the same moment, the likelihood that ambivalence is felt might be rather low. So, for ambivalence to be felt opposing evaluations *both* have to be accessible at the same time (Newby-Clark, McGregor & Zanna, 2002).

In situations where both evaluations are accessible, the requirement of making a choice between clear positive and negative evaluations confronts people with those opposing evaluations (Van Harreveld, van der Pligt, et al., 2009). Felt ambivalence is expected to be higher when one must choose than in a situation where no choice is required, because in the latter people do not need to commit to one of their opposing beliefs (Armitage & Arden, 2007). Moreover, when someone, who is holding an ambivalent attitude, does not necessarily have to make a choice, (s)he might postpone or avoid the decision and would not feel ambivalent (Luce, Bettman & Payne, 1997). Commitment has been argued to be the driving factor why making a choice increases felt ambivalence. By making a choice one commits oneself to an evaluation. When one still holds opposing evaluations towards the attitude object, that creates psychological discomfort. Even when one only anticipates on committing himself to one side or the other, discomfort is experienced (Hogarth, 1981).

Committing oneself to merely an anticipated choice has found to be not enough. Whether ambivalence and discomfort are felt does not solely depend on the requirement to decide, but on the consequences that the choice situation comprises (Cooper & Worchel, 1970). Someone would simply not feel torn between the potential negative and positive consequences, when the decision does not have consequences to feel ambivalent about. So committing oneself to consequences of a decision whilst holding also positive evaluations about the consequences of a different choice or negative evaluations about the current choice, seems to really induce psychological discomfort.

Moreover, for people with an ambivalent attitude and the obligation to choose, the experienced discomfort can be caused by the uncertainty of the consequences of the choice (Van Harreveld, Rutjens, Rotteveel, Nordgren, & van der Pligt, 2009). In addition, Van Harreveld, Rutjens et al. (2009) argue that an ambivalent attitude holder without the need to choose and without

uncertainty about possible outcomes has a similar amount of psychological arousal as a univalent attitude holder. Uncertainty seems to be of such importance, because in a choice setting, people anticipate on the possible negative emotions. This is because people are afraid that they might make a wrong decision and experience a feeling of regret (Van Harreveld, van der Pligt, et al., 2009). When one has a univalent attitude and is certain that a positive outcome will occur by making a certain choice, uncertainty, such fear and discomfort are unlikely to be experienced.

The feeling of anticipated regret also involves the personal relevance one assigns to a decision. Scher and Cooper (1989) have shown that people particularly experience discomfort when they feel personally responsible for the negative outcomes of their decision. So, for example, when buying a product that has the negative outcome of contributing to the enhancement of the Greenhouse effect, one may reason that he himself is hardly responsible for the negative effects of his choice. But when a decision leads, for example, to the situation where one makes a fool out of him/herself in public, people hold themselves responsible for failing to make the right choice.

To sum up, all previous notions (that is, being aware of opposing evaluations, the need to choose, the precondition for consequences, the level of uncertainty and personal relevance) as elaborated above are all on some level intertwined to lead to discomfort by exerting pressure on the ambivalent individual. For the purpose of clarity on the topic of experienced discomfort, this paper holds the term *decisional consequences* as an umbrella concept. The presence of decisional consequences is suggested to moderate the link between potential ambivalence and experienced discomfort positively and this is to a greater extent when a choice is necessary, the consequences are uncertain and one feels personally responsible for the outcomes.

Ambivalence Reduction

When attitudinal ambivalence leads to a feeling of discomfort people are motivated to reduce their felt ambivalence. People want their evaluations towards an object to be consistent (Bell & Esses, 2002) and they want to reduce uncertainty about the consequences (Van Harreveld, van der Pligt, et al., 2009). There are several ways how people can resolve ambivalence. On one side, people can reduce ambivalence by means of their already known evaluations of the attitude object. By downgrading the importance of the decision or trying to reduce personal responsibility that they experience regarding an issue, people may feel less psychological discomfort (Luce et al., 1997). On the other side, new information can change an ambivalent attitude. To reduce ambivalence people might search for extra information to come to a univalent attitude (e.g. Nordgren, et al., 2006). This can be reached by searching for enough information about the negative and positive sides of the attribute to come to a well-informed decision. Processing information systematically has found to be done in ambivalent situations, because by gaining more information and knowledge, people are able to reduce their uncertainty (Jonas, Diehl, & Brömer, 1997). Moreover, an issue that is of high personal relevance receives more systematic processing than a low personal matter (Chaiken, 1980).

However, people do not always have the cognitive ability to engage in very effortful processing and do not have the time to weigh every pro and contra argument related to their ambivalent attitude. For example, when a decision is very difficult, which it might be when one has a very ambivalent attitude, people may engage in more biased processing whereby either the positive or the negative side is more attended in information search (Brownstein, 2003). Taking it one step further, Van Harreveld, van der Pligt et al. (2009) also (carefully) state that people can reduce ambivalence based on heuristics. Motivated to reduce their ambivalence and probably constrained cognitively, high ambivalent attitude holders have found to not check the reliability of the source when they are provided with persuasive information that can reduce their ambivalence (Zemborain & Venkataramani Johar, 2007). Although researchers have found that the reduction of ambivalence is more successful when one has more cognitive ability (Nordgren et al., 2006), not checking the source implies that people heuristically can be persuaded (i.e. not systematically evaluating the reliability of the source). This implies that ambivalence reduction can also be done at a more unconscious level led by rules of thumb. Another example of heuristically reducing ambivalence is

given by Van Harreveld, van der Pligt et al. (2009), who note that during the ambivalence reduction process a person automatically can take the point of view of the person they regard as an expert. By taking the opinion of someone else, ambivalence might be easily reduced by decreasing the personal responsibility that one gives to the consequences of the decision.

Nanotechnology

Risks and Benefits

The use of nanotechnology in food has risen as it can provide benefits that cannot be accomplished by the methods that are conventionally employed in food production. Besides an increase in agricultural productivity and efficiency, nanotechnology is already used in foods itself to increase quality in many aspects. For example, nanotechnology is used to improve texture and taste (e.g. to give a fatty flavour without the calories the fat normally involves), but more importantly to improve health. Health related innovation is achieved by for example encapsulating a particular ingredient in a nano-material that protects the ingredient until it reaches its specific target (Pandey, Ahmad, Sharma, & Khuller, 2005). Nanotechnology is also used in the packaging of food products, among others, to prevent a product from contamination and thereby to extend the freshness of a product (Coles & Frewer, 2013).

The controversy and scepticism towards nanotechnology in the food domain is founded in the risks and especially in the uncertainty of negative outcomes. The disposal of products and packaging containing nano-particles might have negative environmental effects as it is not certain how those particles might interact with micro-organisms in the environment. Moreover, health risks seem to be a bigger concern for public acceptance of nanotechnology as people have positioned health issues as the most important perceived risk of nanotechnology applications (Priest & Greenhalgh, 2011). Nanoparticles are that small that they have the ability to cross biological barriers causing possibilities for nanoparticles to enter cells and organs. This can lead to the interaction of nanoparticles with normal biological processes and to toxic effects (Leroueil et al., 2007). How the human body will react on chemical nanoparticles remains uncertain, but the literature implies (possible) serious issues (Coles & Frewer, 2013). That health issues in particular are important is also shown by results that nanotechnology in food packaging is more accepted than nanotechnology in the food products, which people actually consume (Siegrist, Cousin, Kastenholz & Wiek, 2007).

Risk and Benefit Perception

An attitude towards a new technological application is often derived from the balance between the technology's risks and benefits, which are important factors for consumer acceptance (Siegrist et al., 2007; Frewer et al., 2011). Simplified this would mean that when the perceived benefits of a nanotechnology application outweigh the perceived risks a product with nanotechnology would be accepted. However, there are some complications, because this view would require a rational, cognitive evaluation of the risks and benefits. Perceived risk might be a more affective response than a cognitive contemplation (Finucane, Alhakami, Slovic & Johnson, 2000; Fischer & De Vries, 2008), so that risk is not a weighted state of mind based on the factual consequences of a technological application, but is a feeling state (Gupta et al., 2012). Moreover, not only do risk and benefit perception influence acceptance, the two concepts themselves are also interrelated (Alhakami & Slovic, 1994; Finucane et al., 2000). One could reckon that high benefits also involve high risks, for example the perceived fun might be higher when one drives faster, but the risk of a fatal car crash does also increase. On the contrary, research suggests that risk and benefit perceptions have a negative correlation in the mind of the individual (Alhakami & Slovic, 1994; Finucane et al,. 2000; Siegrist et al., 2007). This would imply that when benefits and risks are perceived at the same time,

the prominence of one triggers a process that influences the effect of the other. Giving, for example, positive information about the benefits of an attitude object does not only lead to an increase of the perceived benefits, but also to a decrease of the perceived risks. This effect is referred to as the affect heuristic (Finucane et al., 2000). As Alhakami and Slovic (1994) and Finucane et al. (2000) researched a wide area of different attitude objects, King and Slovic (2014) have investigated the affect heuristic in the domain of product innovations and the results show an even bigger effect than what can be seen in the research by Finucane et al. (2000).

Shedding the previous notions in the light of this paper, the affect heuristic with the prominence of either the benefits or the risks and the reduction of the other might be an ambivalence reduction process. When one is presented with new information and the risks and benefits would still be perceived as equally important, there is still ambivalence (when one holds an ambivalent attitude). The affect heuristic has found to have effect especially when one is cognitively loaded (King & Slovic, 2014). As we have earlier discussed, ambivalence reduction is more successful when one has cognitive ability to alter one's attitude, but the affect heuristic might be an efficient way to reduce ambivalence when one does not have that cognitive ability. All in all, this highlights the importance that risks and benefits should be studied together as their combination can result in attitudinal ambivalence and in the reduction process.

Information Provision and Attitude Change

Studies have found that the public knowledge about nanotechnology is rather low and may rely more on a few possible contradictory statements (Satterfield, Kandlikar, Beaudrie, Conti & Herr Harthorn, 2009; Vandermoere, Blanchemanche, Bieberstein, Marette & Roosen, 2011). Because the public has relatively little experience with nanotechnology, their attitudes are likely to be characterised by uncertainty (Vandermoere et al., 2011). Either way, with ambivalent or uncertain, perhaps more neutral attitudes towards a nanotechnology object, it implies that the attitude of the public is weak. When people are uncertain about their attitude, this attitude is more likely to be altered when new information presents itself or is sought by the attitude holder than is the case with a certain attitude (Krosnick et al., 1993). Therefore, the provision of balanced information with both positive (benefits) and negative (risks) arguments might lead to a different attitude (Fischer et al., 2013). Providing this kind of information has found to be changing attitudes, which leads to a positive univalent, a negative univalent or a more ambivalent attitude (Fischer et al., 2013; Van Dijk, Fischer, De Jonge, Rowe & Frewer, 2012).

Kahan et al. (2009) have provided scientific support how new information changes attitudes regarding nanotechnology. They distinguished individualistic and hierarchical people from egalitarian and communitarian people on how they evaluate risks and benefits. In terms of environmental risks for example, the first group downgraded environmental risk, because such risks would threaten the autonomy of markets, whereas the latter group valued environmental risk much higher, because they evaluated unregulated markets as being harmful to society. So, Kahan et al. (2009) argue that this distinction contributes to the clarification of how people with different traits view risks and benefits differently. Risk/benefit perceptions towards nanotechnology were equal among both groups when they did not receive extra information. However, the difference between both groups was enormous when they were provided with information about nanotechnology. The individualistic group perceived the benefits larger than the risks and the egalitarian people perceived the risks larger than the benefits.

Interestingly, the results from Kahan et al. (2009) do not only reveal that people can either focus on the benefits or risks after new information, but the authors also test a moderator in terms of a world view, by which one can predict when an individual is leaning to the benefits or to the risks of nanotechnology. Thus, their results put forward the idea that focusing on the positive or the negative side of an attitude object may depend on how one more generally views risks/losses and benefits/gains. In this case, however, the view on approaching gains and losses had a cultural basis.

How people approach gains and losses can be a relevant topic regarding risks and benefits of nanotechnology in the food domain. The way people view gains and losses is covered in regulatory focus theory, a psychological approach. The theory suggests two opposing ways of focusing on desired end-states: the promotion focus and the prevention focus. The promotion focus refers to the approach of potential future gains and the prevention focus refers to the avoidance of potential future losses (Higgins, 1997). Being in a promotion focus relates to an eagerness for advancements and benefits, whereas being prevention focused will lead to an emphasis on safety and on the avoidance of risks. Moreover, being more promotion or prevention focused can be both a trait and a state, so that people can generally be one or the other, but it is also context dependent (Avnet & Higgins, 2006).

Because nanotechnology is a complex issue for the public, ambivalence towards it can be cognitively intensive and people might not engage in systematic processing. Therefore, only one-sided information might be attended unconsciously when reducing attitudinal ambivalence towards a nanotechnology application (Brownstein, 2003). As argued before by means of the affect heuristic, people might be influenced in their ambivalence reduction process by a certain (feeling) state they are in at the moment. So whether people lean to the benefits or the risks of nanotechnology might depend on how they view gains and losses at the moment of ambivalence reduction. Therefore, a regulatory state might influence how people reduce ambivalence and it can be a relevant moderator in the ambivalence reduction process.

Model of Ambivalence Reduction and Current Research

The current research is in particular an extension of the work done by Fischer et al. (2013). They provided people with balanced information about nanotechnology and examined whether attitudes became more positive, more negative or remained ambivalent. However, the aim of this paper is to unravel particles of the 'black box' between the provision of balanced information as input and a changed attitude regarding nanotechnology applications in the food domain as output.

New information about nanotechnology has found to be changing attitudes (Kahan et al., 2009; Fischer et al., 2013). Giving positive information about the benefits of a product innovation leads to higher perceived benefits and lower perceived risks (King & Slovic, 2014). One-sided information changes the attitude, but balanced information about both the benefits and risks of nanotechnology seems to also influence the valence of an attitude (Fischer et al, 2013). However, there is lack of knowledge about which direction the attitude changes towards. The current study aims to make a step in that direction. The conceptual model presented in Figure 1 hypothesizes this research.

The provision of balanced information (i.e. the combination of both risks and benefit about a nanotechnology application) tends to lead to the awareness of positive and negative arguments about nanotechnology, which might also be seen as potential ambivalence. As argued before, potential ambivalence does not necessarily lead to experienced discomfort when there is no pressure. This might be a reason why in the article of Fischer et al. (2013) there still was a group of respondents who, after being presented with balanced information, remained ambivalent. Decisional consequences are therefore introduced as a moderator for the link between potential and felt ambivalence (the latter being labelled as experienced discomfort in Figure 1).

The experienced psychological discomfort is a motivation for people to reduce their ambivalence by the suppression of either their positive or their negative evaluations towards a nanotechnology application. Hereby, we argue that whether this is the positive side or the negative side might depend on the regulatory focus people are in. If one is in a prevention focus, one is expected to suppress the nanotechnology benefits and a promotion focus would lead to the suppression of the risks. Suppression would result in a changed attitude towards nanotechnology in food product applications. However, when an experienced discomfort and a clear regulatory focus did not lead to a suppression of risks or benefits, one might still have a mixed or somewhat ambivalent attitude.

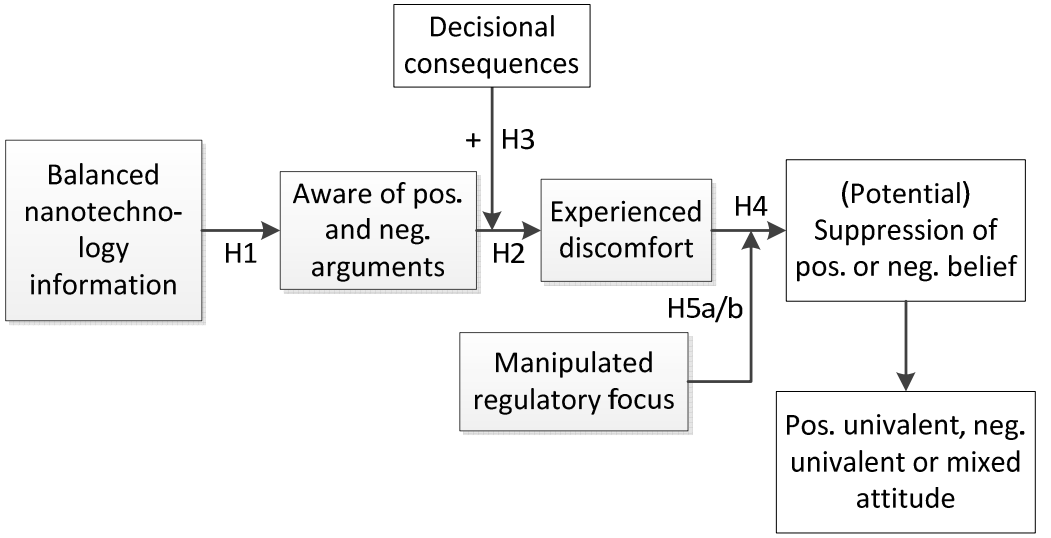

Figure 1. Model of attitudinal ambivalence reduction

In the current research we are going to test our conceptual model. Most importantly, we investigate whether decisional consequences really induce experienced discomfort and whether a manipulated regulatory focus causes people to form a univalent attitude in coherence with that focus. Decisional consequences will be expressed by the obligation to choose, uncertainty and potential personally relevant outcomes of their decision.

In accordance to the proposed conceptual model, this research has some clear expectations. We expect that providing people with balanced risk and benefit information about nanotechnology in the food domain will lead to awareness of positive and negative arguments about nanotechnology. Further, the existence of opposing arguments that one is both aware of will increase an experienced discomfort. By putting people under pressure with decisional consequences the expectation is that the relationship between the awareness and experienced discomfort will strengthen. Due to their experienced discomfort, we expect people to be motivated to reduce their ambivalence by the suppression of either the positive or negative evaluations towards nanotechnology. By providing people with a more clearly regulatory focus, people are to a larger extent expected to suppress either the risks or the benefits of nanotechnology in the food domain. In particular, the expectations are that with a promotion focus people will lean more to the benefits and with a prevention focus people will come to a more negative attitude. Thus, the following hypotheses are composed.

H1: Providing people with more balanced information about nanotechnology creates more awareness of both positive and negative arguments in their minds.

H2: Being more aware of both positive and negative arguments leads to more experienced discomfort.

H3: When decisional consequences are present the effect of H2 will increase.

H4: Experienced discomfort will lead to a more univalent attitude.

H5a: With a clear presence of a regulatory focus the effect of H4 will increase.

H5b: A promotion focus will lead to a more positive attitude and a prevention focus will lead to a more negative attitude compared to the no focus group.

Methods

Participants

Participants were recruited at Wageningen University, The Netherlands, by handing out flyers and putting messages on social media. There were 249 people who participated in the survey. However, after revising their answers, seven participants were excluded from the data due to not filling out the survey correctly, which led to a total of 242 participants. The large majority of participants was student and in exchange for taking part in the experiment, participants were rewarded with a snack representing a monetary value of about € 1,00. The group participants consisted of 43% men (mean age= 21.8 years) and 57% women (mean age=21.2 years). The participants were relatively unfamiliar with nanotechnology. When being asked if they already knew something about nanotechnology, 78.1% rated a 4 or less on a 7-point scale with an overall average of 2.88. The majority of participants (89.3 %) reported to like a yoghurt product normally.

Design

The experiment utilised a 3x2x2 between-group design. Regarding the manipulated regulatory focus there were three conditions: a promotion focus, a prevention focus and no focus. The balanced information had two conditions: providing balanced information about nanotechnology and providing no information about nanotechnology. The same held for the decisional consequences: one condition with decisional consequences and one condition without any consequences. As the textual provision of balanced information about nanotechnology and the decisional consequences were combined, there were in practise four conditions regarding these two aspects. So, in total there were twelve different conditions and participants were randomly assigned to one of them.

Manipulations

To prime participants in a specific regulatory focus the manipulation from Lockwood, Jordan and Kunda (2002) was used, because this has found to be successful (Wan, Hong & Sternthal, 2009). To prime a promotion focus participants were asked how they promote academic success and in the prevention focus they were asked how they prevent academic failure. In addition, there was a no focus condition to test H5a. To prevent differences in results due to the cognitive load that was put on the participants in the promotion and prevention condition versus the no focus condition, participants in the no focus condition were asked what they had done in the past hour as this was considered as most neutral. In all the three conditions participants were asked to write a text between 200 and 250 words, but in practise their written text needed to consist of at least 750 characters (including spaces), which represents about 125 to 150 words.

Depending on the condition participants were or were not provided with balanced information about nanotechnology and/or were or were not put under pressure with decisional consequences. The condition that required the most reading was the ‘with balanced information and with decisional consequences’ condition. These participants had to read to following text (for the other conditions the sentences in italic were partly or in total not provided):

> This study is about nanotechnology, which to an increasing extent is being used in the food production domain. Nanotechnology is the manipulation of material at a nanoscale, which usually is between 1 and 100 nanometres. One nanometre is a millionth of a millimetre.
> *Consider yourself standing in the super market and you are noticing a new yoghurt product that has a nanotechnology application. It draws your attention, because you recently read an article in the paper about nanotechnology. A part of that article stated:*

Because some ingredients in dairy products considerably contribute to and strengthen your intestinal flora, they can be encapsulated with a nano-material. Without this protective capsule the ingredients would not survive the digestive juices in the stomach and lose their value. The nano-capsule recognizes its target organ and releases the ingredients. However, as the nano-capsules are that small, they have the ability to cross biological barriers to other organs after the release of their ingredients. This might result in an interaction of nanoparticles with normal biological processes with possible toxic effects as a result.

Tonight you are going to have dinner with your closest friends and you decide to buy everyone some kind of yoghurt for dessert. Because your friends are still unfamiliar with nanotechnology, you wonder how they would respond to your choice. You really hope they like your choice. All in all, as you need one type of yoghurt product now, you are pondering whether you are going to take the nano yoghurt or a conventional yoghurt.

Participants in one of the other three conditions received a part of this textual information depending on the condition. Participants in the 'no balanced information and without decisional consequences' condition only received the first three phrases to read as an introduction to nanotechnology (see the Appendix for the exact textual information per condition).

Measures

Rather than using the terms benefits and risks in the survey, we chose to use advantages and disadvantages, because those words are thought to be perceived as more neutral. To measure the awareness of positive and negative arguments participants were asked to rate two statements about the advantages and disadvantages (totally unaware – totally aware on a 7-point scale): 'I am aware of the (dis)advantages of the use nanotechnology in yoghurt products'. To assess whether someone was aware of advantages and disadvantages the lowest value of the two statements concerning awareness was chosen as the final awareness score. The average of both statements was on purpose not taken, because a final score of '4' could represent a combination of a '4' on advantages and a '4' on disadvantages, but also a '7' on advantages and a '1' on disadvantages. In the latter scenario, someone would still not be aware of both the advantages and disadvantages.

Experienced discomfort was measured by three statements with the adjectives 'conflicted', 'mixed' and 'torn' (e.g. 'I actually feel torn between the advantages and disadvantages of the use of nanotechnology in yoghurt products.'). These statements were based on the discussion in Jonas et al. (2000) on how experienced ambivalence should be measured. Participants were asked to rate the statements on a 7-point scale anchored by "totally disagree – totally agree". The internal reliability of the statements was acceptable (Cronbach's $\alpha = .79$). Therefore, to calculate experienced discomfort, the three statements were averaged.

Attitudes and their valence were measured by using unipolar 7-point scales based on the attitude measurement executed by Fischer et al. (2013). Eight statements (e.g. 'How disagreeable is the use nanotechnology in yoghurt products to you personally') were similar to Fischer et al. (2013) and anchored by "not at all agreeable – extremely agreeable", "not at all favourable – extremely favourable", "not at all likeable – extremely likable", "not at all positive – extremely positive", "not at all disagreeable – extremely disagreeable", "not at all unfavourable – extremely unfavourable", "not at all unlikeable – extremely unlikable", "not at all negative – extremely negative". Finally a self-reported level of attitudinal ambivalence was asked as an additional way to measure participant's ambivalence. Both the positive anchored statements (Cronbach's $\alpha = .86$) and the negative anchored statements (Cronbach's $\alpha = .84$) had a good reliability. In order to assess the reliability of the eight statements altogether, the four negative statements were recoded to reversed scales. Total internal reliability of the eight statements was good (Cronbach's $\alpha = .90$). Ambivalence was measured by the self-reported ambivalence scale and by a calculation of the eight attitude statements. The four positive and four negative statements were both averaged in order to calculate ambivalence. Implicit

attitudinal ambivalence was calculated as suggested by Thompson, Zanna and Griffin (1995) with equation 2.:

$$Ambivalence = \frac{Pos.\ att. + neg.\ att.}{2} - |pos.\ att. - neg.\ att.| \quad (2)$$

The final attitude was calculated by averaging all the positive scores and the reversed negative scores.

Procedures

Participants that decided to participate in the study were invited in a room, where only the researcher and the participants were present, on the Wageningen University campus. The experiments were conducted on a computer provided by the University and the survey was created with the use of Qualtrics; an online software for making surveys.

At the beginning of the survey, depending on the condition, participants were asked to write down what they did the past hour, how they would promote positive academic outcomes or how they prevent negative academic outcomes. They were told that this part of the survey was developed to investigate students study behaviour. This was done in order to prevent participants from linking a regulatory focus to the upcoming questionnaire, which might have altered their answers and might have decreased the experiment's construct validity.

After they wrote their story, participants were thanked for participating in the first part and told that the second part of the study was about to commence. Participants were provided with the information corresponding to their condition (i.e. (no) balanced information and/or (no) decisional consequences). Then they were asked by means of two statements to rate their awareness of the advantages and disadvantages of nanotechnology applied to a yoghurt product. Subsequently participants rated their experienced discomfort on the three statements. Participants continued with the statements concerning attitude and self-reported ambivalence. When they completed this, participants were asked to provide some demographics and whether or not they like or would normally buy yoghurt products and to what extent they already did know something about nanotechnology.

Results

Table 1.
Descriptive Statistics: M (SD) of the 12 Conditions per Dependant Variable

			Awareness	Discomfort	Calculated ambivalence	Self-reported ambivalence	Final attitude
Without information	Without consequences	No focus	1.96 (1.00)	3.11 (1.34)	4.03 (0.80)	4.13 (1.48)	4.48 (0.81)
		Prev. focus	2.52 (1.17)	3.33 (1.21)	3.70 (1.08)	3.76 (1.34)	4.30 (1.14)
		Prom. focus	1.56 (0.70)	2.67 (1.18)	3.92 (0.84)	3.56 (1.42)	4.64 (0.72)
	With consequences	No focus	2.13 (1.39)	2.81 (1.26)	3.73 (0.74)	3.43 (1.62)	4.43 (0.94)
		Prev. focus	2.25 (1.21)	3.05 (1.41)	3.65 (0.77)	4.20 (1.44)	4.49 (0.99)
		Prom. focus	1.53 (0.80)	2.80 (1.19)	3.81 (0.72)	3.65 (1.77)	4.32 (0.93)
With information	Without consequences	No focus	3.40 (1.31)	4.33 (1.07)	3.96 (0.79)	4.70 (1.08)	4.38 (0.81)
		Prev. focus	3.21 (1.47)	3.86 (1.32)	4.00 (0.76)	4.21 (1.51)	4.38 (0.73)
		Prom. focus	3.90 (1.65)	4.35 (1.30)	3.80 (0.85)	5.20 (1.01)	4.23 (1.07)
	With consequences	No focus	3.06 (1.34)	3.69 (1.16)	3.29 (1.00)	4.38 (1.54)	4.61 (1.30)
		Prev. focus	3.32 (1.83)	3.65 (1.19)	3.73 (1.02)	4.74 (1.45)	4.21 (1.12)
		Prom. focus	3.32 (1.46)	3.63 (1.33)	3.65 (0.90)	4.12 (1.67)	4.62 (0.98)

In Table 1 an overview is given of the means and standard deviations of all the twelve conditions per dependant variable, i.e. awareness, discomfort, calculated ambivalence, self-reported ambivalence and the final attitude.

Results on the Hypotheses

Awareness of (dis)advantages. A one-way ANOVA with information as a predictor of awareness was conducted to test H1 and found a significant result ($F(1, 240) = 63.51$, $p < .001$). People who were provided with balanced information ($M = 3.38$, $SD = 1.51$) reported to be significantly more aware of the advantages and disadvantages of nanotechnology in a yoghurt product than people who did not receive balanced information ($M = 2.02$, $SD = 1.12$). Hereby, H1 has been confirmed.

Psychological discomfort. With an ANCOVA the effect of awareness (as covariate) on discomfort was tested moderated by the decisional consequences (as fixed factor). Results showed that being aware of the advantages and disadvantages resulted in an increased psychological discomfort ($F(1, 238) = 43.69$, $p < .001$). Consequently, H2 has been confirmed.

Decisional consequences. The same ANCOVA of H2 was used to test the moderating effect of the decisional consequences. The interaction effect of the consequences with awareness ($F(1,238) = 0.60$, $p > 0.05$) did not have an effect on the level of discomfort. Hereby, H3 cannot be confirmed.

Ambivalence. The calculated ambivalence and the self-reported ambivalence were only weakly correlated ($r(240) = .18$, $p < .01$), what indicates that they did not measure the exact same construct. Thereby, the data revealed two measures of ambivalence for testing the hypotheses. To test H4, a regression analysis was conducted on both measures of ambivalence with discomfort, information, consequences and the regulatory focus as the predictors. The analysis showed that psychological discomfort did not reduce the calculated ambivalence ($\beta = .11$, $t(237) = 1.55$, $p > .05$). Psychological discomfort did turn out to effect self-reported ambivalence in a way that with the more discomfort the more ambivalent participants reported to be ($\beta = .50$, $t(237) = 8.46$, $p < .001$). Therefore, H4 cannot be confirmed.

Regulatory focus and ambivalence. We expected that the presence of a regulatory focus would cause people to come to a less ambivalent attitude by means that an interaction between the regulatory focus and discomfort would exist. A regression analysis was conducted with the predictors of ambivalence being balanced information, consequences, discomfort, the regulatory focus *and* the interaction effect of the presence or absence of a regulatory focus with discomfort. This interaction effect did not have a significant effect as with both the calculated ambivalence ($\beta = .30$, $t(236) = 1.50$, $p > .05$) and the self-reported ambivalence ($\beta = .01$, $t(236) = .08$, $p > .05$) the participants were not significantly less ambivalent than the no focus group. Thereby, H5a cannot be confirmed.

Final attitude formation. Concerning H5b, we expected that people in a promotion focus would gain a more positive attitude and people in a prevention focus would gain a more negative attitude. A regression analysis did not support the hypothesis. Compared to the no focus group ($M = 4.47$, $SD = 0.94$), people in a promotion focus ($M = 4.46$, $SD = 0.94$) did came to a more positive attitude ($\beta = -.01$, $t(158) = -.18$, $p > .05$) and people in a prevention focus ($M = 4.35$, $SD = 1.00$) did not came to a more negative attitude ($\beta = -.06$, $t(157) = -.80$, $p > .05$). For the sake of completeness, we also ran the regression analysis without the controlling effect of the no focus group to compare the promotion and prevention group with each other. This analysis revealed that people in a promotion focus did not came to a significantly more positive attitude than people in a prevention focus ($\beta = .06$, $t(154) = .71$, $p > .05$). H5b cannot be confirmed.

Additional Results

While analysing the effects on ambivalence in H4, the decisional consequences were found to affect calculated ambivalence. That regression analysis showed that the presence of decisional consequences led participants to a less ambivalent attitude (β = -.14, t(237) = -2.08, p < .05). Consequences did not affect self-reported ambivalence (β = -.00, t(237) = -0.06, p > .05).

In addition, a series of ANOVAs was conducted to test the effect of the manipulations on the final values, i.e. information, consequences and the regulatory focus as the predictors of the two types of ambivalence and the final attitude. Five additional results were found.

Firstly, an ANOVA revealed that providing people with balanced information appeared to increase the level of discomfort (F(1, 230) = 34.40, p < .001) and the level of self-reported ambivalence (F(1, 230) = 16.54, p < .001).

Secondly, this same ANOVA, in which the awareness variable is omitted, yielded a significant main effect of the decisional consequences on discomfort (F(1, 230) = 4.30, p < .05). However, their relationship was negative implying that decisional consequences reduced discomfort, so H3 remains unconfirmed.

Thirdly, an ANOVA revealed a marginally significant interaction effect between the regulatory focus and the decisional consequences on self-reported ambivalence (F(2, 230) = 2.99, p = .052). The presence of decisional consequences caused a reduced ambivalence in the no focus group (M = 4.41 without consequences vs. M = 3.90 with consequences) and in the promotion focus group (M = 4.38 without consequences vs. M = 3.88 with consequences), but it caused an increased ambivalence in the prevention focus group (M = 3.99 without consequences vs. M = 4.47 with consequences). This effect becomes significant when the no focus group is ignored in the analysis (F(1, 151) = 4.36, p < .05) and we only plot the promotion group against the prevention group (Fig. 2).

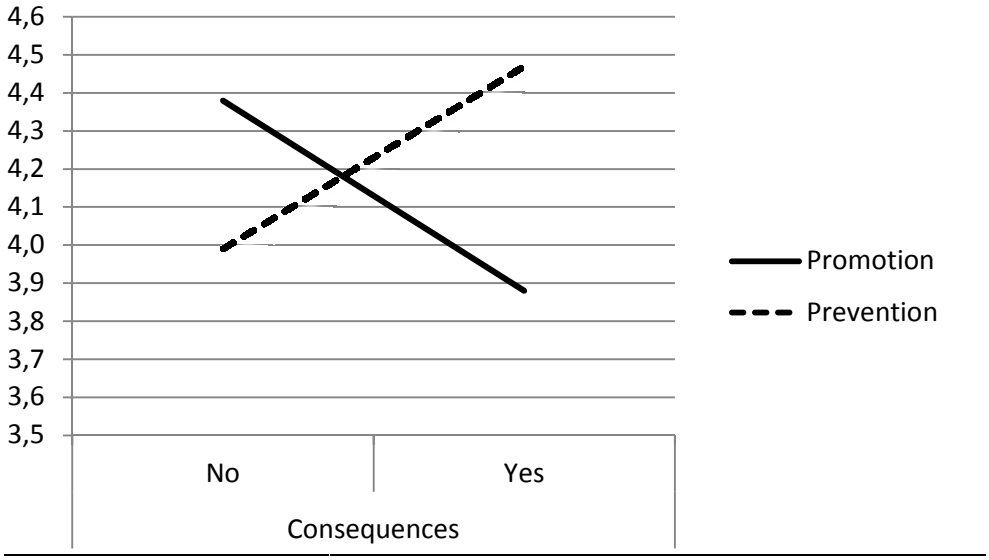

Figure 2. Effect of consequences * regulatory focus on self-reported ambivalence

Fourthly, an ANOVA was run including the knowledge participants already had about nanotechnology. Whether people did already have some knowledge about nanotechnology seemed to influence the level of calculated ambivalence. People who to an increasing extent reported to already knew something about nanotechnology had a decreased calculated ambivalence (F(6, 177) = 3.25, p < .01). Results also revealed that the participants who were provided with balanced information reported higher levels of initial nanotechnology knowledge (F(1, 230) = 8.02, p < .01), which suggests that people who received more information tended to think they knew more.

Finally, the only factor that seems to be playing a role in the valence of the final attitude is the initial knowledge of nanotechnology. An ANOVA showed several significant three-way interaction effects consisting of the initial knowledge with other predictor variables. An ANOVA without the interaction effects and merely main effects revealed that the initial knowledge was the only driving force of these significant results ($F(6, 231) = 2.72$, $p < .05$).

Discussion

Our study found significant results for two hypotheses and did not find significant results for the others. H1 and H2 are confirmed, implying that balanced information leads to more awereness of the risks and benefits of nanotechnology and that more awareness causes people to experience discomfort concerning those risks and benefits. The outcomes of H3 and H4 were not what we had hypothesised. The decisonal consequences did not affect the relationship between awareness and discomfort and people who were experiencing more discomfort did not come to a more univalent attitude. Both H5a and H5b suggest that the regulatory focus did not have any significant effect on ambivalence reduction.

On the other hand, our study shows relationships we did not hypothesise. Providing people with balanced information did not only increase awareness but also positively affected discomfort and self-reported ambivalence. The decisional consequences did not moderate the relationship between awareness and discomfort, but while ignoring the awareness variable the decisional consequences directly caused people to report less experienced discomfort. Additionally, participants who were pressured with decisional consequences came to a less calculated ambivalence. Furthermore, the results showed and interaction effect between the decisional consequences and the regulatory focus on self-reported ambivalence. Being promotion focused led to a decreased ambivalence with the presence of consequences and with a prevention focus people reported to be more ambivalent with the presence of consequences. Finally, participants who reported to already know something about nanotechnology were less ambivalent (calculated ambivalence) than people who lacked nanotechnology knowledge and also had a more positive final attitude.

The vast majority of participants reported to be relatively unaware of nanotechnology. This indicates that their initial attitude is characterised by uncertainty, which is in accordance with previous research that reports that knowledge of nanotechnology is limited (Satterfield et al., 2009; Vandermoere et al., 2011). With uncertain attitude, people are likely to be influenced by new information (Krosnick et al., 1993; Bassili, 1996). Our study supports this and found that giving people more information about risks and benefits of nanotechnology makes them more aware of those risks and benefits. This finding may speak for itself, but this given is necessary to show that the provision of balanced information increases the coexistence of both positive and negative evaluations to the attitude object, i.e. potential ambivalence (van Harreveld, van der Pligt et al., 2009). As our results also support the notion that information and awareness contribute to the experience of discomfort, they suggest that the underlying causes for this experienced discomfort is the coexistence of opposing evaluations. In line with previous research, we confirmed that discomfort due to ambivalence is in particular felt when one is aware of both positive and negative evaluations (Newby-Clark et al., 2002; van Harreveld, van der Pligt et al., 2009).

Furthermore, the current research aimed to investigate the role of decisional consequences on ambivalence reduction. At first sight the decisional consequences did not what we had expectated as we did not find an interaction effect between awareness and decisional consequences on experienced discomfort. Surprisingly, we observed a direct effect of the consequences on experienced discomfort that shows that the presence of consequences mitigated the level of discomfort. Pressuring people with the need to choose (Armitage & Arden, 2007), uncertainty about

the outcome (Van Harreveld, Rutjens et al., 2009) and eliciting anticipated regret by making it personally relevant (Scher & Cooper, 1989) has found to increase discomfort in the literature. Although we did not find this exactly, we have reason to assume that the consequences manipulation worked as we theorised. The reasoning for this lies in what we have actually measured at the discomfort stage. For reasons of equality for every participant during the survey, we decided that every participant received the information at the same point in the survey. Whether this was with or without consequences did not matter in that case. As the consequences were provided altogether at the start of the survey it is possible that this caused people to immediately become pro or contra the nanotechnology option of the yoghurt product. The decisional consequences negatively affected discomfort suggesting that the level of experienced discomfort was already decreased due to the resolution of ambivalence. This notion indicates that we did not measure experienced discomfort *before* ambivalence reduction, but *after*. Consequently, we believe that the inconsistency within the participant's attitudes was solved (in case it was solved) directly after the provision of information and consequences and that we, with our experimental design, did not get the opportunity to measure the experienced discomfort before reconciliation.

Importantly, this is backed up by our findings on calculated ambivalence. The provision of decisional consequences led in our study to a less ambivalent attitude in terms of calculated ambivalence, which indicates that the presence of consequences indeed triggered an ambivalence reduction process. The literature suggests that pressure from decisional consequences induces discomfort and the latter being the motivation to reduce ambivalence (Stone & Cooper, 2001). By limiting the opportunity to postpone the decision with consequences about the outcome, people are even more driven to resolve ambivalence (Luce et al., 1997). So our results concerning the relationship between decisional consequences and ambivalence reduction seem to be in line with existing literature. The only difference is that the in-between step of induced discomfort due to the consequences is not shown in our findings. Thus, the experienced discomfort was an ambivalence measurement after ambivalence reduction in stead of a level of discomfort that should be the motivation for people to reduce ambivalence and come to a new level of ambivalence. This all would mean that we can conclude that decisional consequences do indeed reduce the level of attitudinal ambivalence regarding the risks and benefits towards nanotechnology in a dairy product.

This conclusion though has to be adopted with caution, because the decisional consequences did not affect self-reported ambivalence in the way it influenced experienced discomfort and calculated ambivalence. The experienced ambivalence, that is the direct self-reported ambivalence measure or the results from our measures of experienced discomfort (I feel torn between... etc.), is by some authors regarded as the true measure of ambivalence (Thompson et al., 1995) and a calculated ambivalence can be merely a prediction of 'real' ambivalence (Priester & Petty, 1996). Others state that none of them is superior, but that they are mainly different measures (Jonas et al., 2000). In congruence with the definition of attitudinal ambivalence, calculated ambivalence measures the coexistence of opposing evaluations including evaluations that might not be accessible when one has to report experienced ambivalence (Jonas et al., 2000). While experienced ambivalence assumes that what is accessible counts, discomfort in addition might comprise factors besides the opposing evaluations within one's own attitude that elicits psychological discomfort (Jonas et al., 2000). For example, the opinion of peers may be important here and this is where our decisional consequences come into sight. These differences between ambivalence measures are also the reason that we only found a weak correlation between our different types of ambivalence (Priester & Petty, 1996; Jonas et al., 2000). We cannot settle the dispute which one is a better or the more true measure of ambivalence, but we are interested in ambivalence reduction. That includes that both the feeling of discomfort *and* the inconsistency between opposing evaluations should be reduced in order to have satisfying results. In our study this was to some extent the case as the level of experienced discomfort and calculated ambivalence were decreased due to decisional consequences, but the level of self-reported ambivalence was not per se.

For self-reported ambivalence the effect of decisional consequences depended on the regulatory focus. It suggests that people in a prevention focus on some level failed to resolve

ambivalence when compared to people in a promotion focus. People in a promotion focus are found to be eager for advancements, whereas a prevention focus leads people to focus on the avoidance of bad outcomes (Higgins, 1997). The approach gains versus avoid losses mentality could have been of influence when people were pressured by decisional consequences. Being focused on meeting goals, people in a promotion focus might have been more motivated by decisional consequences to resolve ambivalence. People in a prevention focus might want to avoid a decision in the first place and experienced more ambivalence, because they could not avoid a decision with the pressure of consequences. In the situation were no decisional consequences were provided prevention focused people could easily avoid the decision and did not experience conflict. People in a promotion focus, however, just might wanted to make a decision, but without the consequences they found themselves having a hard time doing so and thus felt more ambivalence. It is not clear why this effect only occurred with self-reported ambivalence and why there were no similar results concerning the experienced discomfort and calculated ambivalence. It is also not clear that for all the other expectations the regulatory focus was of no influence. All in all, the decisional consequences and regulatory focus interaction effect on self-reported ambivalence is not as prominent as results on discomfort and calculated ambivalence and might matter to a lesser extent in the process of ambivalence reduction.

Our study did not find empirical support for idea that with a primed regulatory focus people would resolve ambivalence to a greater extent. The reasoning for this can lie in the possibility that the manipulation failed, so that people did not really get into a promotion or prevention focus or that something else is playing a role why our results were not significant. First we address the likelihood of failure of our manipulation to get people in a regulatory focus. In our experiment, participants were obliged to type at least 750 characters (including spaces) concerning their regulatory focus. Due to this target some participants got frustrated and those might have merely been engaged in the process of typing than getting really into a regulatory focus. Although we excluded the participants who did not fill out the survey seriously, this might have distorted results. Nevertheless, the majority of the participants wrote a fine text without showing signs of frustration. In addition, this manipulation of Lockwood et al., (2002) has found to be succesful (Wan et al., 2009). We therefore do not consider the manipulation as such to be the problem. Consequently, we might have to consider that the regulatory focus does not play a role in the ambivalence reduction process. Perhaps in our experiment the settlement of opposing evaluations did not occur on an unconscious level and people might have had the cognitive ability to process information without needing rules of thumb. DeMarree and Wheeler (2008), who previously researched ambivalence with regulatory focus theory did also not find a relationship between regulatory focus and ambivalence reduction.

What we in particular wanted to see besides ambivalence reduction itself is the actual valence of that reduction. Our hypothesised moderator, again the regulatory focus, did not have any effect. People in a promotion focus did not come to a more positive attitude and people in a prevention focus did not come to a more negative attitude. Hereby, we have similar conclusions as Fischer et al. (2013) stating that some people will hang in ambivalence, while others go either to the positive or the negative side. Concerning this aspect of our research we were not able to unravel particles of the ‘black box’ between information provision and ambivalence reduction. Only one of our variables has found to be a predictor of the valence of the final attitude towards nanotechnology. Having existing knowledge about nanotechnology creates a more positive attitude.

A possible limitation of the current research is the 750 characters requirement for the participants. Based on verbal comments during debriefing we noticed that some participants got frustrated. It is still untraceable though to find out who actually might have got frustrated and in how many cases this requirement led to the failure of getting into a clear regulatory focus. We can argue that 750 characters might have been too much, but it was a considered decision. With too few typed characters participants may not had thought long enough about their academic outcomes to get into a clear promotion or prevention focus. Because most participants took the task seriously we do not

regard the manipulation as failed by this requirement. All in all, for future use of this manipulation, we would recommend to omit this requirement and just say that participants should type a certain number of words, but not make it mandatory. One can still see in the survey results if there were participants who did not take the task seriously and the researchers can consequently exclude them from the data.

The fact that we were not able to measure the level of discomfort before ambivalence was reduced can be seen (perhaps especially from our point of view) as a limitation. To research whether decisional consequences do indeed increase discomfort which in return will reduce ambivalence was one of our key aims. Although we have seen that consequences reduce ambivalence and unraveled this part of the 'black box', future research can focus on our hypothesised relationship. Perhaps it would be interesting to see what will happen when participants are given a longer time frame to decide. Decisional consequences could be presented first, but the moment that people really have to decide is delayed. This might lead to the situation in which people are not finished with their ambivalence reduction process and the possibility for the researcher to measure discomfort before that ambivalence reduction. Moreover, as decisional consequences have found to have an effect, it would be interested to investigate which type of decisional consequence has the largest effect. It is still possible that only one of the consequences presented in the experimental conditions was primarily responsible for the relationship we have found.

All in all, the current research can at least make one practical implication. The moderators in our study do not seem suitable for predicting the valence of a new attitude. We only saw that people with initial knowledge had a more positive attitude in our experiment. So, when a company or organisation wants a nanotechnology product in the food domain to succeed, we can say that providing information to the consumer will favour the adoption of nanotechnology products. Importantly, this occurs when the attitude will be based on more long-term knowledge. We have seen that initial knowledge increased the likeability of our nanotechnogoly yoghurt product. This suggests that the more often people come in contact with nanotechnology the more positive they become towards it. This is referred to as the mere exposure effect (Zajonc, 1968).

Knowledge that has just been gathered, like the balanced information we have provided, will in the short-term lead to a feeling of discomfort. So for the short-term there are two strategies two avoid the feeling of discomfort in the mind of the consumer. The safe option is to provisionally postpone nanotechnology implementation and wait untill the public has perhaps gained a more positive attitude. The other option is to implement nanotechnology, but not to inform the public. This latter option seems rather risky and may very well backfire when the public finds out. As controversy should be avoided, we explicitly do not recommend this risky option. For the mid- to long-term we suggest to keep informing people about nanotechnology with all its aspects and in particular to avoid situations that can cause public conflict. People need some time to adopt the idea of nanotechnology as an emerging technology. Providing information in situations where people are not in a direct purchase environment would perhaps be succesful. Thus, people can at ease elaborate on the idea and perhaps come to the acceptance of nanotechnology. At least it is essential that the development of nanotechnology takes place without errors that lead to public controversy, for then the road is clear for nanotechnology to explore the whole world.

References

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behavior* (11-39). Heidelberg: Springer.

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis, 14*(6), 1085-1096.

Armitage, C. J., & Arden, M. A. (2007). Felt and potential ambivalence across the stages of change. *Journal of Health Psychology, 12*(1), 149-158.

Avnet, T., & Higgins, T. E. (2006). How regulatory fit affects value in consumer choices and opinions. *Journal of Marketing Research, 43*(1), 1-10.

Bassili, J. N. (1996). Meta-judgmental versus operative indexes of psychological attributes: The case of measures of attitude strength. *Journal of Personality and Social Psychology*, *71*(4), 637-653.

Bell, D. W., & Esses, V. M. (2002). Ambivalence and response amplification: A motivational perspective. *Personality and Social Psychology Bulletin, 28*(8), 1143-1152.

Brownstein, A. L. (2003). Biased predecision processing. *Psychological Bulletin, 129*(4), 545-568.

Chaiken, S.M. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology, 39*(5), 752-766.

Coles, D., & Frewer, L.J. (2013). Nanotechnology applied to European food production – A review of ethical and regulatory issues. *Trends in Food Science & Technology, 34*(1), 32-43.

Cooper, J., & Worchel, S. (1970). Role of undesired consequences in arousing cognitive dissonance. *Journal of Personality and Social Psychology, 16*(2), 199-206.

Currall, S.C., King, E.B., Lane, N., Madera, J., & Turner, S. (2006). What drives public acceptance of nanotechnology? *Nature Nanotechnology, 1*(3), 153-155.

DeMarree, K.G., & Wheeler S.C (2008). *Regulatory Focus as a determinant of feelings of ambivalence and ambivalence reduction*. Manuscript in preparation. Retrieved from Time-sharing Experiments for the Social Sciences (TESS) website: http://www.tessexperiments.org/data/demarree684.html.

Festinger, L., & Carlsmith, J.M. (1959). Cognitive consequences of forced compliance. *Journal of Abnormal and Social Psychology, 58*(2), 203-210.

Finucane, M.L., Alhakami, A., Slovic, P., & Johnson, S.M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making, 13*(1), 1-17.

Fischer, A.R.H., & De Vries, P.W., (2008). Everyday behaviour and everyday risk: An approach to study people's responses to frequently encountered food related health risks. *Health, Risk and Society, 10*(4), 385-397.

Fischer, A.R.H., Van Dijk, H., De Jonge, J., Rowe, G., & Frewer, L.J. (2013). Attitudes and attitudinal ambivalence change towards nanotechnology applied to food production. *Public Understanding of Science, 22*(7), 817-831.

Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, Mass: Addison-Wesley.

Frewer, L.J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., & Vereijken, C. (2011). Consumer response to novel agri-food technologies: implications for predicting consumer acceptance of emerging food technologies. *Trends in Food Science & Technology, 22*(8), 442-456.

Frewer, L.J., Gupta, N., George, S., Fischer, A.R.H., Giles, E.I., & Coles, D. (2014). Consumer attitudes towards nanotechnologies applied to food production. *Trends in Food Science & Technology, 40*(2), 211-225.

Gaskell, G., Ten Eyck, T., Jackson J., & Veltri., G. (2005). Imaging nanotechnology: Cultural support for technological innovation in Europe and the United States. *Public Understanding of Science, 14*(1), 81-90.

Gupta, N., Fischer, A.R.H., & Frewer, L.J. (2012). Socio-psychological determinants of public acceptance of technologies: a review. *Public Understanding of Science, 21*(7), 782-795.

Hass, R. G., Katz, I., Rizzo, N., Bailey, J., & Moore, L. (1992). When racial ambivalence evokes negative affect, using a disguised measure of feelings. *Personality and Social Psychology Bulletin, 18*(6), 786-797.

Higgins, T. E. (1997). Beyond Pleasure and Pain. *American Psychologist, 52*(12), 1280-1300.

Hogarth, R. M. (1981). Beyond discrete biases: Functional and dysfunctional aspects of judgmental heuristics. *Psychological Bulletin, 90*(2), 197-217.

Jonas, K., Broemer, P., & Diehl, M. (2000). Attitudinal ambivalence. *European Review of Social Psychology*, *11*(1), 35-74.

Jonas, K., Diehl, M., & Brömer, P. (1997). Effects of attitudinal ambivalence on information processing and attitude-intention consistency. *Journal of Experimental Social Psychology, 33*(2), 190-210.

Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature Nanotechnology, 4*(2), 87-90.

Kaplan, K.J. (1972). On the ambivalence-indifference problem in attitude theory and measurement: A suggested modification of the semantic differential technique. *Psychological Bulletin, 77*(5), 361-372.

King, J., & Slovic, P. (2014). The affect heuristic in early judgments of product innovation. *Journal of Consumer Behaviour, 13*(6), 411-428.

Krosnick, J. A., Boninger, D. S., Chuang, Y. C., Berent, M. K., & Carnot, C. G. (1993). Attitude strength: One construct or many related constructs? *Journal of Personality and Social Psychology, 65*(6), 1132-1151.

Leroueil, P.R., Hong, S., Mecke, A., Baker, J.R., Orr, B.G., & Banaszak-Holl, M.M. (2007). Nanoparticle interaction with biological membranes: does nanotechnology present a Janus face? *Accounts of Chemical Research, 40*(5), 335-342.

Lockwood, P., Jordan, C.H., & Kunda, Z. (2002). Motivation by positive or negative role models: regulatory focus determines who will best inspire us. *Journal of Personality and Social Psychology, 83*(4), 854-864.

Luce, M. F., Bettman, J. R., & Payne, J. W. (1997). Choice processing in emotionally difficult decisions. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*(2), 384-405.

Newby-Clark, I. R., McGregor, I., & Zanna, M. P. (2002). Thinking and caring about cognitive inconsistency: When and for whom does attitudinal ambivalence feel uncomfortable? *Journal of Personality and Social Psychology, 82*(2), 157-166.

Nordgren, L. F., van Harreveld, F., & van der Pligt, J. (2006). Ambivalence, discomfort, and motivated information processing. *Journal of Experimental Social Psychology, 42*(2), 252-258.

Pandey, R., Ahmad, Z., Sharma, S., & Khuller, G.K. (2005). Nano-encapsulation of azole antifungals: Potential applications of improve oral drug delivery. *International Journal of Pharmaceutics, 301*(1), 268-276

Priest, S. H., & Greenhalgh, T. (2011). Nanotechnology as an experiment in democracy: How do citizens form opinions about technology and policy? *Journal of Nanoparticle Research, 13*(4), 1521-1531.

Priester, J.R., & Petty, R.E. (1996). The gradual threshold model of ambivalence: Relating the positive and negative bases of attitudes to subjective ambivalence. *Journal of Personality and Social Psychology, 71*(3), 431-449.

Romig Jr, A.D., Baker, A.B, Johannes, J., Zipperian, T., Eijkel, K., Kirchhoff, B., . . . Walsh, S. (2007). An introduction to nanotechnology policy: Opportunities and constraints for emerging and established economies. *Technological Forecasting & Social Change, 74*(9), 1634-1642.

Satterfield, T., Kandlikar, M., Beaudrie, C.E.H., Conti, J., & Herr Harthorn, B. (2009). Anticipating the perceived risk of nanotechnologies. *Nature Nanotechnology, 4*(11). 752-758.

Sawicki, V., Wegener, D.T., Clark, J.K., Fabrigar, L.R., Smith, S.M., & Durso, G.R.O. (2013). Feeling conflicted and seeking information: When ambivalence enhances and diminishes selective exposure to attitude-consistent information. *Personality and Social Psychology Bulletin, 39*(6), 735-747.

Scher, S. J., & Cooper, J. (1989). Motivational basis of dissonance: The singular role of behavioral consequences. *Journal of Personality and Social Psychology, 56*(6), 899-906.

Siegrist, M., Cousin, M.E., Kastenholz, H., & Wiek, A. (2007). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite, 49*(2), 459-466.

Stone, J., & Cooper, J. (2001). A self-standards model of cognitive dissonance. *Journal of Experimental Social Psychology, 37*(3), 228-243.

Thompson, M.M., Zanna, M.P., & Griffin, D.W. (1995). Let's not be indifferent about (attitudinal) ambivalence. In R.E. Petty & J.A. Krosnick (Eds.), *Attitude Strength: Antecedents and Consequences* (361-386). Mahwah, NJ: Erlbaum.

Wan, E. W., Hong, J., & Sternthal, B. (2009). The effect of regulatory orientation and decision strategy on brand judgments. *Journal of Consumer Research, 35*(6), 1026-1038.

Weiss, J., Takhistov, P., & McClements, D.J. (2006). Functional materials in food nanotechnology. *Journal of Food Science, 71*(9), 107-116.

Vandermoere, F., Blanchemanche, S., Bieberstein, A., Marette, S., & Roosen, J. (2011). The public understanding of nanotechnology in the food domain: The hidden role of views on science, technology, and nature. *Public Understanding of Science, 20*(2), 195-206.

Van Dijk, H., Fischer, A.R.H., De Jonge, J., Rowe, G., & Frewer, L.J. (2012). The impact of balanced risk-benefit information and prior attitudes on post-information attitudes. *Journal of Applied Social Psychology, 42*(8), 1958-1983.

Van Harreveld, F., van der Pligt, J., & de Liver, Y.N. (2009). The agony of ambivalence and ways to resolve it: Introducing the MAID model. *Personality and Social Psychology Review, 13*(1), 45-61.

Van Harreveld, F., Rutjens, B.T., Rotteveel, M., Nordgren, L.F., & van der Pligt, J. (2009). Ambivalence and decisional conflict as a cause of psychological discomfort: Feeling tense before jumping off the fence. *Journal of Experimental Social Psychology, 45*(1), 167-173.

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2), 1-27.

Zemborain, M. R., & Venkataramani Johar, G. (2007). Attitudinal ambivalence and openness to persuasion: A framework for interpersonal influence. *Journal of Consumer Research, 33*(4), 506-514.