

Different types of positive and negative information lead to a difference in consumer acceptance of nanotechnology food products

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Abstract

Nanotechnology is in its early state, leaving many questions unanswered and many open gaps in our current level of knowledge. The consequence of having many gaps in knowledge is that consumers can only be provided with marginal information. Which resolves in consumers being sceptic about nanotechnology. In this research we examine how information about benefits, costs and risks influence the acceptance of nanotechnology food products. We hypothesise that positive certain information leads to a higher acceptance than positive uncertain or no positive information, and that negative uncertain information leads to a higher acceptance than negative certain information. The design used to examine this is a 3 (positive certain, positive uncertain and no positive) between x 3 (negative certain, negative uncertain and no negative) within participant's design. The results confirm that positive certain information leads to a higher acceptance than positive uncertain and no positive information. Positive uncertain still leads to a higher acceptance than no information does. The results disconfirm that negative uncertain information leads to the highest acceptance. According to the results the acceptance is highest for both certain and no information. Companies should try to gain enough knowledge to be able to give both positive and negative certain information because that will lead to the highest consumer acceptance.

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1. Introduction

When in 1925, the Nobel Prize Laureate Richard Zsigmondy used the term 'nanometre', it was the first time that particles at this size were described, the so called nanoparticles. Following the work of Zsigmondy, more scientific work was done by scientists. For example, in 1959, Richard Feynman gave a lecture about manipulating matter at the atomic level. Richard Feynman is seen as the father of modern nanotechnology, a collective term for all technologies using nanoparticles. The European Union defined nanomaterial as: "*A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm.*" (EU, 2016). Because the surface area of material of nanoparticles is larger compared to the surface area of material made from larger particles, and thus the characteristics like strength, reactivity, and electrical properties can change or enhance Siegrist, Stampfli, Kastenholz, & Keller, 2008).

From the beginning of the 21st century there was an increased interest in nanotechnology and research was funded (Hulla, Sahu & Hayes, 2015). Nanotechnology can be used for many different aspects, like disease treatment, food security, new materials for pathogen detection, packaging materials and delivery systems (Bouwmeester et al., 2009). Researchers expect major benefits for the food industry by applying nanotechnology (Rossi et al., 2014). For example, food packages could be created which can prevent microorganisms from getting inside packages. Another use could be to use nanotechnology to change food products themselves, nutrients and flavours could be added, and pathogens could be detected (Bouwmeester et al., 2009). In the non-food area nanotechnology is already used in, among others, personal care products like sunscreens. They contain nanoparticles which filter UV light more efficiently than without those nanoparticles. Besides these positive effects, several drawbacks are discussed, for example if these insoluble nanoparticles can enter the human skin or not. Some studies suggest that insoluble nanoparticles cannot get into, or through human skin (Nohynek, 2011). Other studies suggest that nanoparticles are able to get through the outer layers of the skin (Maynard, 2006). Together these arguments show that, on the one hand, nanotechnology has the potential to stimulate scientific innovation and can be very beneficial for society, but on the other hand there might be risks to human health that we do not know about (Maynard, 2006).

The research on nanotechnology is in its early state, leaving many questions yet unanswered and open gaps in our current level of knowledge.

Problem

As mentioned above, researchers lack knowledge on the technology and for example long-term consequences of nanotechnology applied in food products are unknown. As a consequence, the consumers are provided with marginal information (Lee & Scheufele, 2006). It shall be noted, that the information provided by researchers to a consumer is often the only source and can be considered as the 'consumer's knowledge'. A lack of knowledge leads to scepticism about technological innovations (Wynne, 1991). Marginal information, thus a lack of consumer's knowledge, makes the consumer perceive the technology as risky, and thus nanotechnology is seen as a risky technology (Toumey, 2009). There are many concerns regarding nanotechnology coming from researchers, organizations and consumers.

The Action Group on Erosion, Technology and Concentration is concerned about how nanoparticles interact with the human body especially when the nanoparticles enter it. Compounds which are normally harmless to humans might be dangerous for human health when containing nanoparticles. In the past years, scientists create more and more new nanoparticles of which only little is known. This leads to more and more nanoparticles entering the environment, the food-chain, and the human body (Brumfiel, 2003). Maynard and Kuempel (2005) made two criteria to make clear which nanomaterials have the potential to risk human health. "The first criterion is that the material must be able to interact with the body in such a way that its nanostructure is biologically available. The second criterion is that the material should have the potential to elicit a biological response that is associated with its nanostructure." Based on these criteria, the potential risks would be high for new nanotechnology food-products.

Consumers attitude to novel foods and technology, like nanotechnology, are determined by the consumers' perception of benefits, risks, and costs of the novel foods and technologies (Ronteltap et al., 2007). Overall consumers are averse to new food technologies (Lusk, Roosen & Bieberstein, 2014). For example, for genetically modified food products consumers' perceptions were not very positive, there were many concerns about the long-term environmental effects (Lemkow, 1993), the risks for the future generations (Poortinga & Pidgeon, 2003), and the long-term food safety issues (Grove- White et al., 1997). A similar effect can be observed on the perception of nanotechnology, as Dutch consumers perceive nanotechnology for food as less positive than nanotechnology for other applications (Gupta, Fischer & Frewer, 2015). To increase consumers' acceptance of nanotechnology, their

perception of benefits, risks, and costs needs to be more positive. This can be achieved by increasing the knowledge of the technology (Ronteltap, Trijp, Renes, & Frewer, 2007).

To find out what knowledge is needed it is important to find out how people perceive information about benefits, costs and risks. So the following research question needs to be answered: *How does information about benefits, costs and risks influence the acceptance of nanotechnology food products?*

To be able to answer the research question, a few sub- questions need to be answered first.

Sub- questions:

1. How do positive certain, uncertain and no information influence consumers' acceptance of nanotechnology food products?
2. How do negative certain, uncertain and no information influence consumers' acceptance of nanotechnology food products?
3. How does the influence on consumers' acceptance of nanotechnology food products differs between positive and negative information?

2. Theoretical framework

Adoption of innovations can be explained with many different models and theories. Rogers (2003, p15-p16) identified five characteristics of innovations: relative advantage, compatibility, complexity, trialability, and observability. These characteristics can explain differences in adoption rates and explain how technologies are accepted or not accepted. Rogers model is very broad which makes it less suitable for this research. As Icek Ajzen (1991, p182) explained in the theory of planned behaviour, attitude is one of the factors that determines intention, which determines behaviour. The other two factors that influence intention are subjective norm and perceived behavioural control. Subjective norm means 'the perceived social pressure to perform or not to perform the behaviour'. And perceived behavioural control is how well someone thinks they can perform behaviour. The theory of planned behaviour explains how these three factors influence intention, and thereby indirectly also behaviour. Knowing this intention can be predicted by these three factors.

Ronteltap et al. (2007) replaced attitude from the theory of planned behaviour with perceived cost/ benefit, and perceived risk & uncertainty. They did this to distinguish perceptions about certain and uncertain factors. This research will focus on food products and food package products, which makes risk perception especially important. Food (package) products come in contact with the body which could lead to health problems. The adoption of an innovation, like nanotechnology, is determined by people's intention to use it. Figure 1 shows which different factors, according to Ronteltap, influence people's intention to use an innovation in the food area.

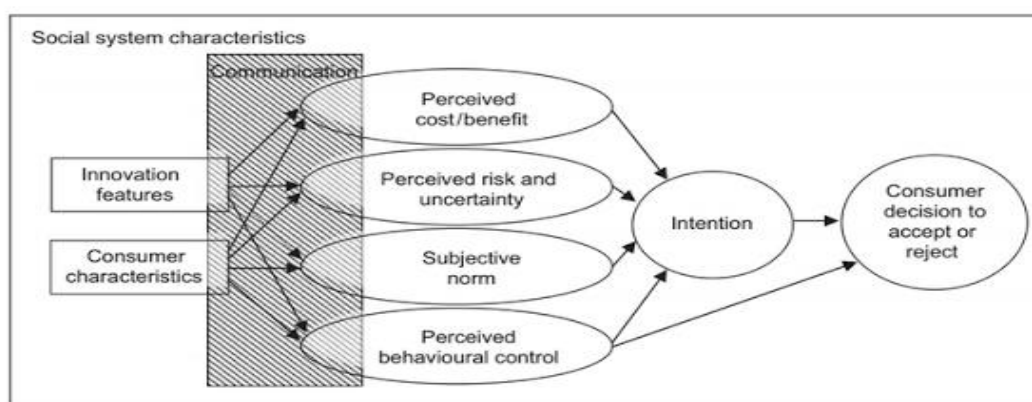


Figure 1. "Conceptual framework for research on acceptance of technology- based food innovation" (Ronteltap et al., 2007)

Social system characteristics

First of all, figure 1 shows that social system characteristics are very important, they can influence all other parts of the framework. For nanotechnology to be accepted, it has to fit within the public discourse (Te Molder & Gutteling, 2003). For this research we assume that people have a lack of knowledge about nanotechnology and that people perceive nanotechnology as a risky technology.

Innovation features & consumer characteristics

Innovation features are the objectively measurable characteristics of an innovation. These features may influence the acceptance and behavioural intention of nanotechnology (Ronteltap et al., 2007). In this research we will make sure that all features are of the same weight to make them comparable, this will be further explained in the method. Ronteltap et al. (2007) also define consumer characteristics, which are socio- demographic variables. This research will be based on a convenience sample, which means that the socio- demographic variables of the participants are more or less the same.

Communication

Communication is the most important source of information for consumers. Communication links innovation features and consumer characteristics with the rest of the framework. One of the most important factors why the European public is sceptical to accept nanotechnology is the lack of tangible benefits (Siegrist et al., 2008). Consumers have a lack of knowledge and experience with nanotechnology which makes it impossible for them to understand what the costs, benefits and risks are (Siegrist et al., 2008). This research will focus on how communicating different types of information leads to a different cost, benefit and risk perception, and thereby to a different intention and behaviour.

Perceived cost/ benefit

The four factors that influence intention directly and consumer decisions indirectly are perceived cost/ benefit, perceived risk & uncertainty, subjective norm and perceived behavioural control. Perceived cost/ benefit comes from a traditional economic point of view, ultimately one would have maximal social benefit and minimum social cost (Starr, 1969). In which costs are the certain losses that arise because of, in this case, nanotechnology. And benefits are the certain utilities that arise because of nanotechnology. If the cost of a nanotechnology is very high, and the benefit is low, people's intention will not be positive. The

cost benefit trade- off is often a personal consideration, hence the term perceived is important to use. People are loss averse. Loss aversion means that “losses loom larger than corresponding gains” (Tversky & Kahneman, 1991). For example, losing 10 euro’s feels much worse than that gaining 10 euro’s makes you feel good. So, since loss aversion leads to different weights in intention when it comes to benefits and costs, we will split perceived cost/ benefit into two factors, perceived cost and perceived benefit.

H1: Negative information has, compared to positive information of the same weight, a bigger influence on the consumer perception.

Perceived risk and uncertainty

In general risks are uncertain losses. Sparks and Shepherd (1994) define risk when it comes to novel food processing technologies as being involuntary, out of control of the consumer, unobservable, and risks have unknown, delayed and potentially fatal health effects. Risk perception depends on a few factors, like if the risk is voluntary or involuntary, immediate or delayed, observable or unseen, fatal or non- fatal and to what degree the risk is known to science and in control of the consumer (Slovic, 1987). In this research we also see uncertain gains as risks that are positive, the reason for this is that people can be risk averse or risk seeking. Risk aversion means “a preference for the sure outcome over a gamble that has higher or equal expectation” (Kahneman & Tversky, 1984). People are risk averse when it comes to gains and risk seeking when it comes to losses. This shows why the factor perceived risk & uncertainty is an important influence on people’s intention. For this research the term perceived risk will be used for both positive and negative uncertainties.

H2: Positive certain information, compared to positive uncertain information of the same weight, leads to a higher consumer acceptance.

H3: Negative certain information, compared to negative uncertain information of the same weight, leads to a lower consumer acceptance.

Subjective norm & perceived behavioural control

The factors subjective norm and perceived behavioural control are the same as in the theory of planned behaviour, as mentioned previously. In this research those two factors will not be evaluated.

Intention & behaviour

The decision cannot be measured since this research asks hypothetical questions, participants will not have to make real decisions, but people's intention can be measured.

3. Method

Design and participants

Data has been collected with a 3 (positive certain, positive uncertain and no positive) between x 3 (negative certain, negative uncertain, and no negative) within participant's design which can be seen in table 1. The table shows that in total nine different situations have to be examined. For this research we decided to make three groups. It would have been possible to make nine groups, in which every group would receive one type of situation, but than many more participant would have been needed. Alternatively, there could have been one group of participants that would have to answer questions about all nine different situations. We choose to use a 3 between x 3 within design to reduce the amount of needed participants and to reduce the amount of situations each participant had to read and answer questions about.

There were three groups of about 35 people who answered questions and received different types of information. Each participant received information about three different companies producing soup with nanotechnology, the combination of information about the soup was different for each company. The companies were called Horet, Mirar and Gatir, three fictitious names, to make them and the stories more realistic. In total there were nine conditions, which were, for convenience, combined into three groups. The groups were based on the positive information, each group received information about one type of positive and about the three different types of negative information. Group one received three times positive certain information in combination with three times different types of negative information. Group two received three times positive uncertain information in combination with three times different types of negative information. Group three received three times no positive information in combination with three times different types of negative information. Participants were randomly assigned to one of the groups that were based on the type of positive information. The questions within the groups were given in a random order.

		Positive information		
		Certain information	Uncertain information	No positive information
Negative information	Certain information	Benefit & cost	Risk & cost	Cost
	Uncertain information	Benefit & risk	Risk	Risk
	No negative information	Benefit	Risk	No information

Table 1: 3 x 3 design of the nine different information conditions

To make sure enough participants filled in the survey a convenience sample was used. Participants were reached through Facebook Groups and people in the Wageningen university buildings Leeuwenborch and Forum were asked to participate.

The groups all received information about the same product characteristics of soup. The positive information was always about nutrients/ health effects and the negative information about the shelf life of the soup. For each different type of information, the weight was the same. An example of given information that was positive certain and negative uncertain is shown below.

Example given information: Gatir is een van de bedrijven die momenteel werken met nanotechnologie. Gatir past eigenschappen van soep aan door gebruik van nanotechnologie. De inname van nutriënten wordt met een kwart verhoogd. Een verhoogde inname van nutriënten leidt tot een betere gezondheid. Een bijwerking is dat een andere eigenschap, de houdbaarheid van het product, ook veranderd. De houdbaarheid van de soep neemt af van 1 jaar naar 4 maanden. De kans dat deze verandering daadwerkelijk plaatsvindt is 50%.

Measures

The questions were asked with Qualtrics, every participant answered the same nine questions three times, the questions were:

1. Ik zou dit product kopen
2. Ik denk dat dit product voordelen heeft
3. Ik denk dat dit product nadelen heeft

4. Ik zou dit product eten
5. Wat is de verhouding tussen de voor- en nadelen van dit product?
6. Hoe veilig voelt u zich bij het eten van dit product?
7. Ik denk dat dit product risico's heeft
8. Ik denk dat dit product positieve bijwerkingen heeft
9. Ik denk dat dit product negatieve bijwerkingen heeft

Questions 1 to 4 were asked with a slider from 0 to 100, in which 0 meant totally disagree and 100 meant totally agree. Question 5 was asked on a 7 point likert scale, in which 1 meant there are much more costs than benefits and 7 meant there are much more benefits than costs. Question 6 was asked on a 5 point likert scale, 1 meant very unsafe and 5 meant very safe. Questions 7 to 9 were asked on a slider from 0 to 100, in which 0 meant none and 100 meant a lot.

All data was analysed in SPSS using factorial repeated measures ANOVA.

Questions 2 and 5 were used to measure the benefit perception. Questions 3 and 5 to measure the cost perception. Questions 6, 7, 8 and 9 to measure risk perception and question 1 and 4 to measure intention.

Procedure

Participants were randomly distributed between positive certain, positive uncertain and no positive information. They only received the positive information of the one group they were distributed to. Then they were, in a random order, given situations with the same type of positive information in combination with negative certain, negative uncertain and no negative information. Each participant answered nine questions per given situation. So since each participant received information of three different situations, in total 27 questions had to be answered by each participant.

4. Results

The data received from Qualtrics has been analysed with IBM SPSS Statistics 24. In total 116 people participated, 46 people filled in the questions with positive certain information, 33 people with positive uncertain information and 37 with no positive information. For all three conditions there were more women than men that participated. In relation to the positive certain and no positive groups there were not many men in the positive uncertain group. Many participants are or were WO Bachelor students. The average age in all three groups is 32 for positive certain, 31 for positive uncertain and 30 for no positive. A question was asked to see how well people think they already know nanotechnology. On a scale from 0 to 100 in which 0 means no knowledge and 100 means a lot of knowledge the average people say they know is 27.

For each question repeated measures was done. The perceived benefit was analysed with questions benefit and benefit cost ratio. The perceived cost was analysed with questions cost and benefit cost ratio. The perceived risk was analysed with questions risk, safety feeling, positive side effects and negative side effects. Intention was analysed with questions buying intention and eating intention. An overview of the results can be found in table 2.

	Positive certain			Positive uncertain			No positive		
	Negative certain	Negative uncertain	No negative	Negative certain	Negative uncertain	No negative	Negative certain	Negative uncertain	No negative
Buying intention	67.43 ± 25.51	59.61 ± 25.61	66.83 ± 23.23	53.69 ± 27.69	47.73 ± 27.39	54.70 ± 25.77	42.08 ± 28.88	38.03 ± 28.94	40.26 ± 31.30
Costs	46.04 ± 25.13	57.09 ± 26.56	44.04 ± 26.85	54.73 ± 24.85	53.21 ± 23.82	48.64 ± 26.14	64.08 ± 23.48	69.42 ± 25.17	66.24 ± 22.41
Benefits	71.39 ± 23.13	65.43 ± 23.13	70.76 ± 21.49	62.45 ± 22.24	55.21 ± 25.13	62.61 ± 24.07	45.54 ± 25.33	39.76 ± 28.65	44.55 ± 28.32
Eating intention	69.48 ± 26.04	63.09 ± 25.98	66.88 ± 26.35	55.79 ± 29.81	53.67 ± 29.34	53.21 ± 29.05	45.08 ± 27.49	39.16 ± 29.68	38.21 ± 27.09
Ratio c/b	5.02 ± 1.41	4.57 ± 1.55	5.22 ± 1.59	4.55 ± 1.73	4.19 ± 1.65	4.85 ± 1.70	3.08 ± 1.62	3.00 ± 1.58	3.14 ± 1.46
Safety feeling	3.37 ± 0.90	3.20 ± 0.88	3.28 ± 0.93	3.00 ± 1.03	2.91 ± 0.98	2.97 ± 0.95	2.70 ± 1.05	2.55 ± 1.08	2.53 ± 1.06
Risks	36.00 ± 25.33	43.13 ± 25.63	35.91 ± 27.44	44.94 ± 31.79	45.49 ± 30.04	40.06 ± 31.67	46.68 ± 28.49	55.43 ± 28.98	52.43 ± 31.06
Pos. side effects	62.63 ± 22.95	55.02 ± 24.56	62.61 ± 23.94	46.94 ± 28.14	44.94 ± 30.06	52.61 ± 30.01	28.92 ± 28.14	32.27 ± 29.69	27.59 ± 25.39
Neg. side effects	36.35 ± 28.12	39.00 ± 27.71	35.11 ± 28.04	36.79 ± 27.48	43.73 ± 27.11	36.46 ± 29.54	51.16 ± 32.14	61.49 ± 28.48	52.84 ± 31.82

Table 2: means and standard deviations of all questions and situations

Benefit perception

Mauchly's test of sphericity has a p of 0.246 for the benefit perception. Therefore, in the table within- subjects effects we look at sphericity assumed.

The results from Levene's test of equality of error variances are significant for negative uncertain information ($p = 0.048$). Negative certain and no negative are not significant ($p = 0.122$ & $p = 0.051$).

The mixed ANOVA showed a significant main effect of the type of positive information on benefit perception, $F(2, 113) = 14.01$, $p < .05$, $\eta^2 = .20$. The main effect of the type on negative information on benefit perception is also significant, $F(2, 209) = 13.22$, $p < .05$, $\eta^2 = .11$. There is no significant main effect of the interaction, $F(4, 209) = 0.11$, $p > .05$, $\eta^2 = .00$.

The mean difference between positive certain and positive uncertain is not significant. The mean difference between positive certain and no positive is 26.40 and significant. The mean difference between positive uncertain and no positive is 17.30 and significant. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is 6.67. And a significant mean difference between negative uncertain and no negative, the mean difference is -6.21. There is no significant difference between negative certain and no negative information.

Means for benefit are 60.60 for negative certain, 54.21 for negative uncertain and 59.99 for no negative information.

Cost perception

Mauchly's test of sphericity has a p of 0.779 for the cost perception. Therefore, in the table within- subjects effects we look at sphericity assumed.

The results from Levene's test of equality of error variances are not significant for the types of negative information. Negative certain has a p of 0.659, negative uncertain has a p of 0.587 and no negative has a p of 0.312.

The mixed ANOVA showed a significant main effect of the type of positive information on cost perception, $F(2, 113) = 7.42$, $p < .05$, $\eta^2 = .12$. The main effect of the type on negative information on cost perception is also significant, $F(2, 209) = 5.13$, $p < .05$, $\eta^2 = .04$. There is no significant main effect of the interaction, $F(4, 209) = 2.27$, $p > .05$, $\eta^2 = .04$.

The mean difference between positive certain and positive uncertain is not significant. The mean difference between positive certain and no positive is -17.50 and significant. The mean difference between positive uncertain and no positive is -14.36 and significant. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is -4.79. And a significant mean difference

between negative uncertain and no negative, the mean difference is 6.63. There is no significant difference between negative certain and no negative information.

Benefit cost ratio

Mauchly's test of sphericity has a p of 0.003 for the benefit cost ratio. Therefore, in the table within- subjects effects we look at Greenhouse- Geisser.

The results from Levene's test of equality of error variances are significant for negative certain information ($p = 0.048$). Negative uncertain and no negative are not significant ($p = 0.898$ & $p = 0.765$).

The mixed ANOVA showed a significant main effect of the type of positive information on benefit cost ratio, $F(2, 113) = 18.14$, $p < .05$, $\eta^2 = .24$. The main effect of the type on negative information on benefit cost ratio is also significant, $F(2, 209) = 11.27$, $p < .05$, $\eta^2 = .09$. There is no significant main effect of the interaction, $F(4, 209) = 1.52$, $p > .05$, $\eta^2 = .03$.

The mean difference between positive certain and positive uncertain is not significant. The mean difference between positive certain and no positive is 1.86 and significant. The mean difference between positive uncertain and no positive is 1.45 and significant. The pairwise comparisons table showed no significant differences between the three types of negative information.

Risk perception

Mauchly's test of sphericity has a p of 0.000 for the risk perception. Therefore, in the table within- subjects effects we look at Greenhouse- Geisser.

The results from Levene's test of equality of error variances are not significant for all three negative information types.

The mixed ANOVA showed no significant main effect of the type of positive information on risk perception, $F(2, 113) = 2.68$, $p > .05$, $\eta^2 = .05$. The main effect of the type on negative information on risk perception is also significant, $F(2, 209) = 4.50$, $p < .05$, $\eta^2 = .04$. There is no significant main effect of the interaction, $F(4, 209) = 1.27$, $p > .05$, $\eta^2 = .02$.

Although the between- subjects effect showed no significant difference between the types of positive information, the pairwise comparisons table does show a significant difference of -13.17 between positive certain and no positive information. The mean difference between positive certain and positive uncertain is not significant. Also the mean difference between positive uncertain and no positive is not significant. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is -5.48. And a significant mean difference between negative uncertain and no

negative, the mean difference is 5.21. There is no significant difference between negative certain and no negative information.

Safety feeling

Mauchly's test of sphericity has a p of 0.397 for the buying intention. Therefore in the table within- subjects effects we look at sphericity assumed.

The results from Levene's test of equality of error variances are not significant for all three negative information types.

The mixed ANOVA showed a significant main effect of the type of positive information on safety feeling, $F(2, 113) = 5.48, p < .05, \eta^2 = .09$. The main effect of the type on negative information on safety feeling is also significant, $F(2, 209) = 6.58, p < .05, \eta^2 = .06$. There is no significant main effect of the interaction, $F(4, 209) = 0.79, p > .05, \eta^2 = .01$.

The mean difference between positive certain and positive uncertain and the difference between positive uncertain and no positive is not significant. The mean difference between positive certain and no positive is 0.70 and significant. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is 0.14. And a significant mean difference between negative certain and no negative, the mean difference is 0.10. There is no significant difference between negative uncertain and no negative information.

Positive side effects

Mauchly's test of sphericity has a p of 0.157 for the positive side effects. Therefore, in the table within- subjects effects we look at sphericity assumed.

The results from Levene's test of equality of error variances are significant for negative uncertain information.

The mixed ANOVA showed a significant main effect of the type of positive information on positive side effects, $F(2, 113) = 14.94, p < .05, \eta^2 = .21$. The main effect of the type on negative information on positive side effects is also significant, $F(2, 209) = 3.10, p < .05, \eta^2 = .03$. There is a significant main effect of the interaction, $F(4, 209) = 5.23, p < .05, \eta^2 = .09$.

The mean difference between positive certain and positive uncertain is 11.93 and significant. The mean difference between positive certain and no positive is 30.49 and significant. The mean difference between positive uncertain and no positive is 18.57 and significant. The pairwise comparisons table indicated a significant mean difference -3.53 between negative uncertain and no negative information. And no significant mean difference between negative certain and negative uncertain and between negative certain and no negative.

The estimates table shows that the mean of positive side effects is the highest when positive certain is combined with either negative certain (mean=62.63) or no negative (mean= 62.61) information. The mean is lowest when no positive information is combined with either negative certain (mean= 28.92) or no negative (mean= 27.60) information.

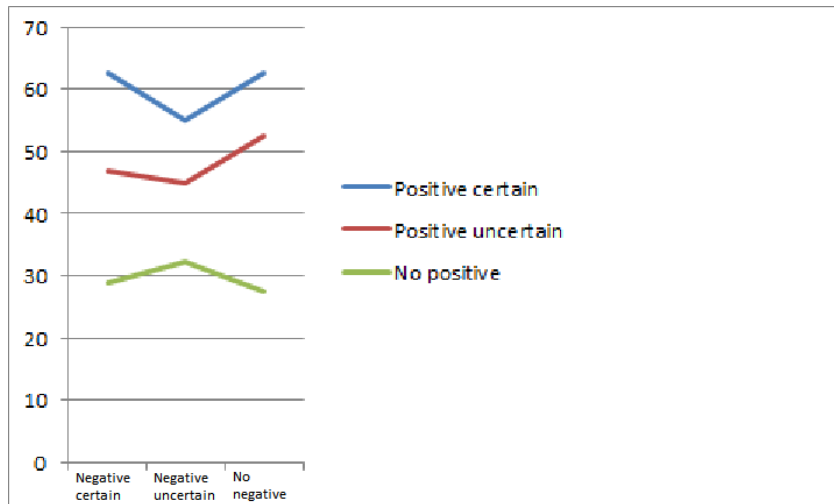


Figure 2: interaction effect positive side effects

Negative side effects

Mauchly's test of sphericity has a p of 0.139 for the negative side effects. Therefore, in the table within- subjects effects we look at sphericity assumed.

The results from levene's test of equality of error variances are not significant for all types of negative information.

The mixed anova showed a significant main effect of the type of positive information on positive side effects, $F(2, 113) = 5.32, p < .05, \eta^2 = .09$. The main effect of the type on negative information on positive side effects is also significant, $F(2, 209) = 10.15, p < .05, \eta^2 = .08$. There is no significant main effect of the interaction, $F(4, 209) = 0.97, p > .05, \eta^2 = .02$. The mean difference between positive certain and no positive is -18.34 and significant. The mean difference between positive uncertain and no positive is -16.17 and significant. The difference between positive certain and positive uncertain is not significant. The pairwise comparisons table indicated a significant mean difference of -6.64 between negative certain and negative uncertain information. The mean difference between negative uncertain and no negative is 6.60. The difference between negative certain and no negative is not significant.

Buying intention

Mauchly's test of sphericity has a p of 0.000 for the buying intention. Therefore, in the table within- subjects effects we look at Greenhouse- Geisser.

The results from Levene's test of equality of error variances are significant for no negative information ($p = 0.007$). Negative certain and negative uncertain are not significant ($p = 0.375$ & $p = 0.453$).

The mixed ANOVA showed a significant main effect of the type of positive information on buying intention, $F(2, 113) = 10.01, p < .05, \eta^2 = .81$. The main effect of the type on negative information on buying intention is also significant, $F(2, 209) = 11.06, p < .05, \eta^2 = .09$. There is no significant main effect of the interaction, $F(4, 209) = 0.42, p > .05, \eta^2 = .01$.

The pairwise comparisons table indicates that there is a significant difference between the positive certain, uncertain and no positive information conditions. The mean difference between positive certain and positive uncertain is 12.58, the mean difference between positive certain and no positive is 25.07 and the mean difference between positive uncertain and no positive is 12.48. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is 6.42. And a significant mean difference between negative uncertain and no negative, the mean difference is -5.85. There is no significant difference between negative certain and no negative information.

Means for buying intention are 55.44 for negative certain, 49.25 for negative uncertain and 54.78 for no negative information.

Eating intention

Mauchly's test of sphericity has a p of 0.639 for the eating intention. Therefore, in the table within- subjects effects we look at sphericity assumed.

The results from Levene's test of equality of error variances are not significant for the types of negative information. Negative certain has a p of 0.555, negative uncertain has a p of 0.358 and no negative has a p of 0.700.

The mixed ANOVA showed a significant main effect of the type of positive information on eating intention, $F(2, 113) = 10.03, p < .05, \eta^2 = .81$. The main effect of the type on negative information on eating intention is also significant, $F(2, 209) = 9.23, p < .05, \eta^2 = .08$. There is no significant main effect of the interaction, $F(4, 209) = 1.32, p > .05, \eta^2 = .02$.

The pairwise comparisons table indicates that there is a significant difference between the positive certain, uncertain and no positive information conditions. The mean difference between positive certain and positive uncertain is 12.25, the mean difference between

positive certain and no positive is 26.21 and the mean difference between positive uncertain and no positive is 13.96. Pairwise comparison indicated a significant mean difference between negative certain and negative uncertain information, the mean difference is 5.25. And a significant mean difference between negative certain and no negative, the mean difference is 4.14. There is no significant difference between negative uncertain en no negative information.

5. Conclusion

The acceptance of nanotechnology food products depends on the perception people have towards it. This research looked at the benefit perception, the cost perception, the risk perception, and the intention and how both positive and negative information influence those perceptions and intentions. First of all, we will look at the differences in influence of positive uncertain, certain and no information. Then we look at the differences in influence of negative uncertain, certain and no information. And at last we will look at the overall difference between positive and negative information.

First of all, the differences in influence between the three types of positive information. As expected there is a difference in acceptance of food products between given positive certain, positive uncertain or no positive information. Based on the theory of Tversky and Kahneman (1991), who explain that people are risk averse when it comes to gains, we hypothesised that people prefer positive certain information over positive uncertain information. The obtained results confirm the hypothesis, results show that positive certain information leads to the highest acceptance, followed by positive uncertain information, and no positive information leads to the lowest acceptance. So the first hypothesis is accepted.

The perception of benefits and costs, and the intention change depending on the given positive information, however, the risk perception does not. The risk perception might not change depending on the positive information because risks are often seen as something negative. If this is the case, positive information should not influence risks, but also costs should not be influenced. But, the results show that positive information does have influence on costs. This can be explained because risks are often seen as being negative, so then positive information does not have any influence on the risk perception. With this reasoning one would also expect costs not to change depending on the positive information. But we think that people link costs to benefits, by seeing costs as the opposite of benefits. People might argue that having many benefits means that there are few costs, even when nothing is said directly about costs. If someone is given certain positive information, he or she might feel that that means that there are no certain negative effects, or that if there are certain negative effects, they are out weight by the positive information. So giving more positive information leads to the perception of less costs.

It becomes more interesting when looking at negative information and how that information influences the acceptance of food products. The results are different from what we expected

based on Tversky and Kahneman's (1991) theory, and thus our second hypotheses is rejected. Tversky and Kahneman argue that people are risk seeking when it comes to losses. But this research showed the opposite, people are risk averse when it comes to negative information. The acceptance of the soup was lower when negative uncertain was given compared to both negative certain and no negative information. Overall there was no difference in acceptance between given negative certain and no negative information.

And last, the difference of influence between positive and negative information. Based on Tversky and Kahneman (1991) statement that "losses loom larger than gains" we hypothesised negative information to have a bigger influence on the acceptance than positive information of the same weight. This hypothesis has to be rejected because for each of the nine questions the eta squared showed that the biggest part of the variance could be explained by the positive information. This means that the positive information has a bigger influence on people's perception than the negative information. Especially for both the buying and the eating intention the explained variance by the positive information was very big. Which means that positive information had a very big influence on people's buying and eating intention. This conclusion is limited because we used a 3 between x 3 within design, comparing the between and the within outcomes might not be fair because the proportions might be different.

So overall there are some differences in perception depending on the given information. The results showed that when positive information was given, certain information was received best. When negative information was given, certain and no information were both received as better than uncertain information. And there is a difference between the perception of positive and the perception of negative information. The impact of positive information is bigger than the impact of negative information.

6. Discussion

Limitations of this research

Following the previous paragraph one of the biggest limits is that we only used two product features. The positive information was always about a better health because of nutrients and the negative information was always about a shorter shelf life. It could be possible that although the weight is the same, nutrients are always perceived as more important than shelf life. Maybe if the negative information would have been about a longer shelf life, and the positive information about a worse health because of nutrients the conclusion would have been the other way around. It would also be interesting to do some further research to find out how positive and negative information do weight differently. Companies could use information about how much positive information outweighs negative information.

Another limit is that although it was a 3x3 design, only three groups were made. This was done for convenience reasons but other groups might have been better. We could have made nine groups, so each group would only answer questions about one positive and one negative type of information. Another option would have been to have all participants answer questions about all nine combinations of information. We choose to correct the limitation of having only three groups by assigning groups randomly, and within the groups the three different types of information were given in a random order.

The subject studied in this work was very interesting and much more work and analysis is needed to extend the study to a broader scale, for example, the differences between different ages and nationalities could be studied more.

Overall conclusion

For nanotechnology food products to be accepted by consumers, companies should think carefully about how they inform consumers about the negative and positive features the product has. Since a convenience sample was used, the conclusions can only be drawn for one part of the Dutch society. Also conclusions for non-food products might have been different.

It is important for companies to understand that there is a difference between the influence of positive and negative information. First of all, when giving positive information it is best to give certain information. But giving uncertain positive information is still better than giving no positive information. So when nothing is known about a certain feature, there is no information available, but it would be possible that that feature changes positively,

companies should name that possibility. It would be unethical for a company to lie about the effects a product might have, if a company knows that certain features will not change they should not name them as a possibility. Lying leads to consumers not trusting your company and product. On the long term lying about effects could lead to consumers not trusting nanotechnology at all.

When giving negative information it is best to give certain information or no information at all. Once again, it would be unethical to lie by giving no information when the company actually does have knowledge about negative effects. So when a company has knowledge about a negative feature, they should research this feature so they are able to give certain information instead of uncertain information.

It is also essential to know that positive information outweighs negative information. Companies can use this by always combining negative information with positive information of the same weight, by doing this they can make sure that people will not perceive products as negative. Even if the negative and positive information are of the same weight, people will perceive the product as positive. It would even be possible to give positive information that weighs less than the negative information and to still keep a positive perception. Since only two features were used this conclusion is not certain until further research is done.

So overall this research is very useful for companies working with nanotechnology food products, if possible companies should always give certain positive and negative information and reduce giving no positive information and giving uncertain negative information.

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