

Wageningen UR

How to introduce Nanotechnology to the low knowledge public.

Consequences of using different types of visual presentation
and framing

Master Thesis Wageningen University

MCB 80433

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Date : October 2012

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Abstract

The strength of the attitude of the low knowledge public towards Nanotechnology has great influence on the future of Nanotechnology. In the current research attitude extremity and ambivalence were examined as two concepts of attitude strength. The influence of visual presentation (depictions vs. descriptions vs. both) and types of frame (affective vs. cognitive) on attitude extremity and ambivalence was analysed by measuring judgements after providing 3 Nanotechnology scenarios. Results show that when information about Nanotechnology is presented by affectively framed depictions, the attitude will be the least ambivalent and most extreme. In contrast, when information is provided in cognitively framed descriptions, the attitude will be most ambivalent and least extreme. Providing both a depiction and a description does not seem to benefit either attitude strength nor extremity. Matching the two processing strategies however only seems to influence attitude ambivalence and extremity when information is presented in both depictions and descriptions. Against the expectations, the results are more in line with the unimodel than the dual processing theories. For the formation of non-ambivalent and extreme attitudes by low knowledge people, affective information about applications of Nanotechnology has to be presented by depictions.

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1.0 Introduction

Nanotechnology is a fast growing and promising industry in which companies and governments are investing millions of dollars. An increasing amount of 'nano-products' (products produced using Nanotechnology or products which contain nano-particles) have entered the market place in the absence of public awareness. Next to this, the public seem to have low knowledge about Nanotechnology, its applications and the consequences of its use for human health or the environment. Despite the fact that communication of scientific research can play a strategic role in technology development and adoption (Macnaghten, Kearnes et al. 2005), governments are slowly responding to the developments of Nanotechnology. This means governments did not implement nano-specific labelling requirements, or safety regulations (Scrinis and Lyons 2007). People are not exposed to information about Nanotechnology and therefore current knowledge structures (schemata) are lacking. Next to this, Nanotechnology is a complex concept and people find it difficult to understand what Nanotechnology is. Mental models have to be created to get an understanding of Nanotechnology and to place Nano-products in the 'suitable' schemata. When people have low knowledge about a subject they are likely to form an attitude which is weak (Petty and Krosnick 1995), neutral and ambivalent (Kaplan 1972). Such attitudes are unpredictable and easy to change by random information (Krosnick, Boninger et al. 1993). For the future development of Nanotechnology therefore, the public preferably holds a strong, non-ambivalent and more polarized attitude. In order to get more knowledge about the formation of an extreme and non-ambivalent attitude, first more knowledge about attitude formation of low knowledge people is needed.

Attitude is defined in different ways in the social psychology literature. In line with Eagly and Chaiken (1993, p.1) I define attitude as 'a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour. This evaluation may include people's thoughts and beliefs about the object (cognition), feelings or emotions towards the object (affect) and intentions of behaviour regarding that object (behaviour), which tend to be positively correlated (Eagly and Chaiken 1993). In the current research I focus on the cognitive and affective components of the attitude.

When forming an attitude, information can be processed using different mechanisms and different levels of processing depth. The depth of processing is determined by various parameters, organized by individual differences (such as need for cognition and relevant knowledge), and situational variables (such as time pressure and cognitive load) (Chaiken and Eagly 1989). Compared to individual differences, situational variables like "received information" are much easier to influence, and more importantly; used in daily life to inform people. There are many ways to visualise and

frame the information people receive. Sojka and Giese (2006) found different types of visual presentations and affective load to influence the attitude and emphasised the gap of knowledge in the potential synergetic combination of the two. Previous research has shown that the way we present and frame information can influence the system we use to process information or 'depth of processing', but also our processing fluency or 'ease of processing' (Cesario, Higgins et al. 2008; Oppenheimer 2008). Fluency may lead to a "it just feels right" experience, which can be transferred to subsequent judgments (Camacho et al., 2003). Processing fluency was found to enhance affective judgement (Winkielman and Cacioppo 2001) and enhance confidence about these judgements (Kelley and Lindsay 1993; Koriat 1993). Therefore it is reasonable to think that fluency also influences attitude extremity and attitude ambivalence.

As explained before, the presentation and framing of information can also influence the system which is used to process information. In social science literature, many theories have been written about the mechanism of processing information. Generally it can be said information is processed in a dual manner. Different dual processing theories have been developed like 'dual processing theory' and 'dual coding theory (Paivio 1976). According to Chaiken's (1978, 1980, 1982, 1987) dual processing theory, information can be processed using the systematic system, which demands high cognitive capacity and is effortful, and the heuristic system, which is automatic and demands less cognitive capacity. Subjects who lack knowledge about the message topic, generally are more involved in heuristic processing than expert about the message topic (Chaiken and Eagly 1989). However according to Gigerenzer (2011) experts also use heuristics in situations of uncertainty. In contrast to systematic processing, heuristic processing entails minimal data collection and analysis, it is often seen as the low end of a systematic-processing continuum (Chaiken and Eagly 1989). In other words heuristic processing is seen as low depth of processing and systematic processing is seen as deep processing of information. The depth of processing can be enhanced by elaboration (Craik and Tulving 1975).

A dual processing theory which explains the synergetic effect of the two information processing systems is the Dual Coding Theory (Paivio 1976). The Dual Coding Theory explains how the human brain processes and creates understanding of depictions and descriptions. This theory states depictions, descriptions and prior knowledge are qualitatively different information sources and contribute in qualitatively different ways to the process of knowledge acquisition (Paivio and Csapo 1973; Paivio 1976). The processing of depictions directly results in a mental model, processing of descriptions results first creates a propositional representation which is checked with the mental model. Both 'hypothetical mental models' are then integrated in one mental model (Schnotz and Bannert 2003). Research about the use of depictions and descriptions shows that depictions are

often processed more superficially and faster compared to descriptions (Weidenmann 1989). Therefore it is likely to think that depictions are processed more heuristically while descriptions are processed more systematically. A combination of both depictions and descriptions is found to enhance the ability of individuals to comprehend information (Carney and Levin 2002; Moreno and Valdez 2005; Schnotz 2005). Suggesting the combination of a depiction and a description leads to an enhanced depth of processing. Because deep systematic processing of information results in strong evaluations, beliefs and attitudes (Tesser and Conlee 1975; Tesser and Cowan 1977; Eagly and Chaiken 1993), the use of a combination of descriptions and depictions is expected to reduce ambivalence and enhance the extremity of the attitude. However the influence of different types of visual presentation and framing on attitude ambivalence and extremity remains unknown. Since depictions and descriptions are processed by different systems, the use of both a depiction and a description could also lead to an enhanced level of confusion and doubts and therefore result in a more ambivalent and neutral attitude. Furthermore we do not know how the relative importance of the used processing system and the perceived processing fluency.

Besides the influence of the presentation of information, we know that emotions can influence which system is used to process information. People who are highly affected by emotions, process information more heuristically than people who are not (Epstein 1994). Assuming affectively framed information induces emotions in people, this suggests affectively framed information is processed more by the heuristic system, and the opposing cognitively framed information is merely processed by the systematic system. As the framing of information can influence the processing system used, the frame of information therefore is expected to affect attitude ambivalence and extremity as well.

For the formation of strong and polarized public attitudes, the deep and therefore more systematic processing of information is found to be important (Tesser and Conlee 1975; Tesser and Cowan 1977; Eagly and Chaiken 1993; Griffin, Neuwirth et al. 2002). Besides the deep processing of information, the processing fluency can also influence the extremity of the attitude. Because Nanotechnology is a new complex concept and people have low knowledge, people are likely to process information more heuristically (Eagly and Chaiken 1993). At the moment we do not know the role of the visual presentation, framing and fluency in the attitude formation process. In order to gain more knowledge about these factors in the attitude formation process of low knowledge people, it is necessary to investigate how visual presentations and informational frames influence the information processing and attitude formation. A hypothetical model Figure 1 was created to explain 1) how people with low knowledge about Nanotechnology form their attitude towards Nano-products, 2) how the presentation- and framing of information influence the processing of information 3) how combinations of depictions and descriptions influences the attitude formation

process, 4) how matching the presentation- and framing of information influence the processing fluency of information? And 5) what the influence of these matching conditions is on the attitude ambivalence and attitude extremity?

Hypothetical model

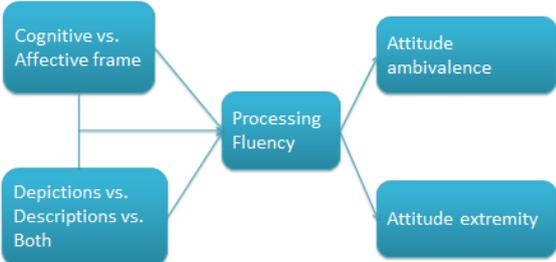


Figure 1 Hypothetical Model

2.0 Theoretical framework

We know the human brain uses different systems to process information. But how do people with low knowledge about Nanotechnology form an attitude towards this complex technology? And what is the influence of the presentation- and framing of information on attitude extremity and ambivalence? In the theoretical framework I will elaborate more on how presentation- and framing of information can influence the relative use of these different dual processing systems and processing fluency. Furthermore I address how different ways of presentation and framing of information influence attitude ambivalence and attitude extremity when combined.

2.1 Heuristic processing

When people are not motivated or have low ability to process information, information is processed heuristically. The heuristic system operates fast, automatic and does not take much effort. Therefore heuristic processing is perceived as more fluent processing. However, when using this system people use simple inferential rules, schemata or cognitive heuristics to formulate their judgments and decisions (Chaiken and Eagly 1989). People could have abstracted rules like 'length implies strength', 'more arguments are better arguments' or 'argument based on expert opinions are valid' (Chaiken 1987). Therefore heuristic processing is seen as low depth processing. In the following sections I will describe which types of informational presentation and framing encourage this way of processing.

2.1.1 The use of depictions

The depictive presentation of information is a way to encourage heuristic information processing.

Depictions consists of iconic signs which are associated with the content they represent through common structural features on either a concrete or more abstract level (Schnotz 2002). Numerous studies have shown that understanding of pictures is very fast and that semantic processing of pictures is far more effective than semantic processing of words (Paivio 1975; Nelson, Reed et al. 1976; Potter 1976; Pellegrino, Rosinski et al. 1977; Smith and Magee 1980; Stenberg, Radeborg et al. 1995; Kinjo and

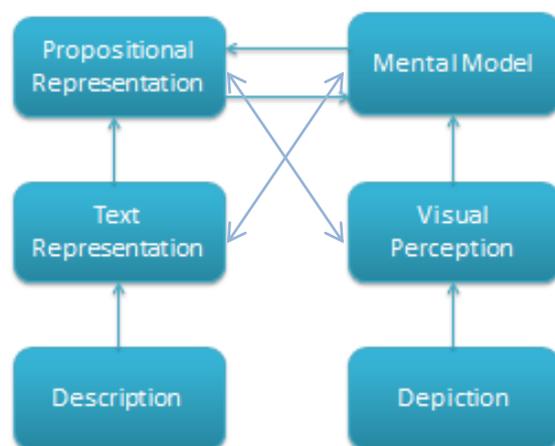


Figure 2 Model of Comprehension of depictions and descriptions (based on Schnotz and Bannert, 2003).

Snodgrass 2000). The processing of depictive information takes less mental effort than the processing of descriptive information (Salomon 1984) and depictive information is processed more

superficially than descriptive information (Weidenmann 1989). Therefore it is likely that presenting the information in a depictive manner encourages heuristic processing. Furthermore we know that the use of depictions also has an influence on the constructions of a mental model. A depiction can be seen as a propositional two dimensional mental model which conveys information about how its components are spatially arranged, and (in contrast to descriptions) enables a more direct construction of a mental model (Schnotz 1993). The reason that a mental model is created faster from a depiction than from a description might be an explanation why people generate an attitude more easily from plain pictures than from plain text. However, it can be questioned whether this is the case for fairly unknown applications of Nanotechnology. According to (Schnotz 2005) information which is only presented in a depictive manner, can be perceived as too complex. People could also underestimate the informational content of pictures and believe that a short look would be enough for understanding and for extracting the relevant (Mokros and Tinker 1987; Weidenmann 1989). Both scenarios are expected to lead to heuristically, low depth processing of the information. However because depictions are processed more fluently than depictions, people are more confident about their judgement than when information is processed dis-fluent (Kelley and Lindsay 1993; Koriat 1993). This confidence about judgement might also reduce ambivalence and enhance attitude extremity. To our knowledge this influence has never been shown by scientific literature. Therefore we expect the attitude ambivalence and attitude extremity to be influenced by the heuristic processing of information. The use of only depictions is expected to lead to a more neutral and ambivalent attitude.

2.1.2 The use of an affective frame

Framing is a situational factor which can influence the type of processing which people use. Because affectively framed information is more emotionally engaging, people are expected to think 'by heart' or with their feelings and experience. Therefore affectively framed information is expected to be processed by the heuristic system. Research found people who are affected by emotions think more in a manner that is categorical, personal, concrete, unreflective, and action oriented. Also the stronger the emotion, the more people's reasoning appears to them as self-evidently valid (Epstein 1994). The use of these abstract rules is typical for the heuristic processing system.

This means people who are provided with affectively framed information are expected to process information fluently. Although the information is processed fluently, which can result in more extreme affective judgements (Winkielman and Cacioppo 2001), we expect the low depth of processing to have the biggest influence on the overall attitude. Therefore we expect the heuristic processing of affectively framed information to result in a more neutral and ambivalent attitude.

2.2 Systematic processing

When using the systematic system, recipients deeply process information and therefore exert considerable cognitive effort in performing tasks. It can be said that systematic processing does not go fluently. People actively attempt to comprehend and evaluate the message's arguments as well as to assess their validity in relation to the message's conclusion. When forming an attitude, this system processes arguments, instead of the more accessible information such as source identity (Chaiken 1980). As a result of systematic processing, people possess stronger and more persistent beliefs and evaluations about an object (Haugtvedt and Petty 1992). However, people need the capacity and motivation to process systematically (Chaiken, 1989).

2.2.1 The use of descriptions

The use of descriptions is expected to encourage systematic processing. Descriptions comprise words and sentences which function as complex symbols. With sentences a subject matter is described by naming certain components, specifying attributes of these components, and by establishing relationships among the components (Schnitz, Picard et al. 1993). As can be seen in **Error! Reference source not found.**, a mental model of descriptive information is formed by a qualitatively different system. Descriptions are processed by the analyses of symbol structures. When people try to understand a text they form a text surface representation of the text, this symbolic representation is used as a basis for a propositional representation. This propositional representation is used for the construction of a mental model (Paivio 1978; Schnitz 1993). The processing of descriptions goes less fluently and takes more effort and time consuming than the processing of depictions (Weidenmann 1989). Therefore we consider the processing of descriptions as part of the systematic system. When people with low knowledge try to process complex information, the use of only descriptions can be insufficient to fully understand the information and form a mental model (Schnitz 2005). Since people have low knowledge about Nanotechnology, and Nanotechnology is a complex concept, we expect the use of only descriptions to be insufficient for the creation of a mental model. Therefore people are likely to process information using the heuristic system resulting in a more neutral and ambivalent attitude.

2.2.2 The use of a cognitive frame

It is likely that cognitively framed information encourages systematic processing of information. In the current experiment, the cognitively framed information is more technical, abstract and are not affectively loaded. Because of the technical and abstract traits of the information, cognitively framed information is expected to take more motivation and cognitive capacity to process (Paivio 1978). The brain therefore is expected to process the technical and abstract information using the systematic

system. Because of the complexity, of cognitively framed information will be processed less fluently than affectively framed information. As a result of systematic processing, people are expected to hold a non-ambivalent and polarized attitude (Griffin, Neuwirth et al. 2002).

Hypothesis 1A: When complex information is visualized a depictions and affective framing, information is processed very fluently by the heuristic system and will lead to a more neutral and ambivalent attitude.

Hypothesis 1B: When complex information is visualized using descriptions and cognitive framing, information is processed less fluently than depictions. The information will be perceived as too complex, and therefore processed by the heuristic system leading to a more neutral and ambivalent attitude.

Hypothesis 3A: Information which is processed heuristically will be processed more fluently and result in a more neutral and more ambivalent attitude.

Hypothesis 3B: Information which is processed systematically will be processed disfluent and result in a more extreme and less ambivalent attitude.

2.3 Matching the two systems

We know that systematic processing is encouraged by cognitive framing and the use of descriptions while heuristic processing is encouraged by the use of depictions and affective framing of information. A logical solution for the formation of polarized and non-ambivalent attitudes would then be to provide information about Nanotechnology in cognitively framed descriptions.

However people need to be motivated and have the cognitive ability to do this. When information is found to be too complex, people are more likely to process received information in a heuristic manner (Schnotz 2005). Especially when people which have low knowledge about a specific subject (Mayer 1989); (Mayer and Gallini 1990), or have difficulty understanding the relationships among the elements in a text (Levie and Lentz 1982). This makes it very likely to assume that the low knowledge public does not process information systematically when this information would be described and cognitively framed. The following chapter gives a potential solution for this problem and explains how a combination of the two systems can lead to enhanced comprehensibility of the information.

2.3.1. Combining of depictions and descriptions

Dual coding theory gives an explanation for the enhanced comprehensibility (Clark and Paivio 1991; Mayer and Anderson 1991). According to Paivio's dual coding theory, descriptions and depictions are processed in different cognitive systems and seen as different information sources (Paivio and Clark 1986). For instance Schnotz and colleagues (2005) elaborated on this theory and found that these two systems interact. They found that in case one source provides only little information or if one route does not work well, the other sources and routes becomes more important. This is especially relevant under low knowledge conditions, when the construction of a mental model from only written text or only a picture can become too difficult (Schnotz 2005). It can be said that the use of both depictions and descriptions enhances the capability of people to process information.

From a dual processing point of view I argue that when information is presented in both depictions and descriptions, both the heuristic and the systematic information processing systems are activated. As described above the evaluation of both depictions and descriptions lead to a propositional representation and a mental model. However in order to fully understand the information, these two mental models are integrated into a final mental model (see Figure 2)Figure 2 Model of Comprehension of depictions and descriptions (based on Schnotz and Bannert, 2003).. During this integration, structural deficits of a model can be corrected. Because two different cognitive pathways are used to create two mental models, more relations between the propositional representation and the mental model are made and therefore, contradictions are very likely to be solved (Schnotz 1993). Since the use of both depictions and descriptions enhance the cognitive ability, it can be said that the use of both types of visual presentation encourages systematic processing of complex information. Apparently, the addition of a depiction makes the information easier to process. In other words the information can be processed more fluently. When the processing of information is just about manageable, this acts as a magnet for learning new skills and increasing challenges (Csikszentmihalyi 1997). As a result of the message comprehensibility people are found to process information more fluently (Masson 1993). In the current experiment people could be challenged to understand the complex information about Nanotechnology by the addition of (easy to process) depictions. Therefore I expect the use of both depictions and descriptions to enhance processing fluency, making information easier to process and encouraging systematic processing of information simultaneously. Consequently, the use of both presentations is expected to have a negative influence on the ambivalence of the attitude and a positive effect on the extremity of the attitude.

Hypothesis 1C: When complex information is provided in both depictions *and* descriptions, information will be processed more fluently than descriptions and cognitively framed information.

Therefore the use of both depictions and descriptions will lead to more systematic processing of information and therefore result in a more polarized and less ambivalent attitude.

2.3.2 Combining visual presentation and framing

In real life, different types of visual presentation and framing are often combined. However to our knowledge, no research has been conducted on the effect of the different combinations on attitude extremity and ambivalence. So, how do we know which frame needs to be applied to which presentation of information? The theory of regulatory fit gives an explanation to this question. This theory applies to any motivational orientation with a preferred manner of goal pursuit (Cesario, Higgins et al. 2008). When combining the theory of regulatory fit with Dual coding theory, this could mean that the a goal of processing of depictions is to create a mental model. Comparably, the processing of descriptions has the creation of a propositional representation as a goal. In line with this we could say processing of affectively framed information uses the same route or 'manner of goal pursuit' as processing as depictions (heuristic processing). Similarly, the processing of cognitively framed information uses the same route as the processing of descriptions for the creation of a propositional representation. So, when combining visual presentations with framing this means affectively framed depictions (both heuristic system) and cognitively framed descriptions (both systematic system) are processed more fluently than cognitively framed depictions and affectively framed descriptions (both systems). When both the visual presentation and the frame of information pursuit the same goal, I call this 'a match'. Matches as a result of this regulatory fit are found to increase strength of engagement in the message processing activity and could make the message feel easier to process (Lee and Aaker 2004; Cesario, Higgins et al. 2008). This is what I define as *subjective processing fluency*. This subjective fluency is found to influence people's attitudes and judgements (Oppenheimer 2008). Processing fluency is expected to enhance the elaboration likelihood and therefore depth of processing (Cesario, Higgins et al. 2008). We know that depth of processing has a positive influence on the strength of evaluations, beliefs and the attitude. Therefore I expect a less ambivalent and more extreme attitude in conditions where the information is matched than when information is mis-matched.

2A: A match between type of visual information and type of frame will lead to enhanced processing fluency resulting in a more polarized and less ambivalent attitude.

2B: A mis-match between type of visual information and type of frame will lead to enhanced processing fluency resulting in a more neutral and less ambivalent attitude.

3.0 Method

3.1 Sample

The 184 students participated in the current research, however due to a technical error, 16 participants had to be removed out of the affective text condition. Another participant did not complete the entire experiment and was also removed. Response times below 1 s. or above 15 s. were omitted from the data analyses. The answers of 167 students at the Wageningen university were used. Participants were within in a range of 17 to 26 years old. The sample consists of 99 woman and 68 men. More than 75% of the participants was currently subscribed in a technology related study. The average age was 20 (SD=1.85) years. The experiment lasted about ten minutes and took place at a quiet computer room at the University. The independent variables (visual presentation and frame) are presented in a two (Cognitive vs. Affective frame)* three (Depictive vs. Descriptive vs. Both.) between subjects factorial design.

3.2 Stimulus material

Participants were provided with information about Nanotechnology in general and three examples of completely different applications of Nanotechnology. Three applications of Nanotechnology from different industries were chosen: Nanonaise (a type of Mayonnaise), Solar Cells and Cancer treatment. Depictions and descriptions were created using information and pictures from the internet and modified using PowerPoint and paint. The stimulus material was presented as an advantage and disadvantage of a specific application of Nanotechnology. Every participant was presented with all three applications. As can be seen in appendix III, the depicted scenario's contain a few words to keep the information content equal.

3.2.1 Pre-test

The overall valence of the information needs to be neutral. Different studies show that providing positively or negatively framed information can influence the depth of information processing as well as the system of information processing (Block and Keller 1995). An extremely positive or negative valence of the information can lead to false inferences about the processing of fluency. Also when one conditions provides more information about an application than other conditions, this influences the knowledge level of the participant and therefore could lead to false inferences about the conditions. The stimulus material therefore should provide the same amount of information in, each type of visual presentation and both types of framing. To check if 1) the information content of depictions and descriptions was equal, 2) neutral of valence, 3) was understood properly, 4) was perceived as credible, 5) and spoke to the participants feelings, or 6) encouraged thinking, a pre-test (n=24) was executed. A convenient sample of twenty-four Dutch Wageningen university students were asked to fill in some questions about the stimulus material. Each student received a hardcopy

which started with very brief and general explanation of Nanotechnology, followed by the stimulus material of different experimental conditions. After each depiction or description information about the applications of Nanotechnology, students were asked to rate the information on several aspects. Variables were measured on a seven point scale and open questions. Answers were judged differently. When the difference between the average positive rating and the general negative rating was lower than the absolute value of 1.5 points, the stimulus material was adjusted according to the ratings of the participants. The quality of the affective and cognitive frame was judged on the average rating on the affective-cognitive seven point scale. The norm for the affective and cognitive load was an average rating lower than neutral ($M < 4$). The norm for the cognitively framed information was set higher than neutral ($M > 4$) on this seven point scale. Similarly the perceived apprehensibility and credibility had to be higher than neutral ($M > 4$) on average. The information content of the depicted information was measured by asking open questions like: Which effect was visualised by this picture? What is the cause of this effect according to the picture? The quality of participants answers were categorised good, medium or bad. The average judgement of the information content should be judged medium too good to be used in the final experiment. Furthermore participants were asked to which extent they found the information understandable, credible, positive or negative and appeal to the sentiment or motivated thinking. Results of the pre-test can be checked in Appendix III Results pretest'. When the affective stimuli were found to encourage the participants to thinking, the affective load was enhanced and possessive pronounce words were removed. The credibility of the stimulus material was enhanced by making the stimulus material a little less extreme. Furthermore the stimulus material was made more understandable by standardising the organisations of depictions and using other more clear depictions.

3.3 Independent variables

3.3.1 Presentation of the information

The information in the scenarios can be either presented in depictions, descriptions or both descriptions and depictions. In line with Schnotz (2002) we define depictions as; consisting of iconic signs which are associated with the content they represent through common structural features on either a concrete (e.g. photo) or more abstract level (e.g. graph). Descriptions are defined as comprising complex symbols as words and sentences. With sentences a subject matter is described by naming certain components, specifying attributes of these components, and by establishing relationships among the components (Schnotz, Picard et al. 1993).

3.3.2 Framing of the information

A distinction between the affectively framed and cognitively framed information is made by framing two to three words or depictions of every advantage and disadvantage. Affectively framed descriptions contained two to three words with an affective load e.g. 'clotting's of blood', 'tasty' or 'creaminess'. The cognitively framed information is more technical and abstract and has no affectively load. Cognitively framed depictions contain abstract drawings like graphs or scales. Cognitively framed descriptions contain technical terms like 'thrombosis' 'lipids' and 'mouthfeel'.

3.4 Dependent variables

3.4.1 Attitude extremity

Both the extremity of the different attitudinal components and the attitude ambivalence is measured using a four point unipolar Semantic Differential Scale. The positive scale is anchored by *extremely positive* (4) - *not positive at all* (1), the negative scale is anchored by *extremely negative* (4) – *not negative at all* (1) (Kaplan 1972; Thompson, Zanna et al. 1995). I define attitude extremity as 'an attitude which is polarised and non-ambivalent'. The following calculation is used to make a clear distinction between the extreme and ambivalent attitudes:

$$\text{Attitude Valence} = \frac{\text{Positive Component} + (5 - \text{Negative Component})}{2}$$

$$\text{Attitude extremity} = |\text{Attitude Valence} - 2.5|$$

The outcome of an extreme attitude will be between 0 (=ambivalent attitude) and 1.5 (=most extreme attitude).

3.4.2 Attitude ambivalence

Attitude ambivalence is defined as 'the degree to which an attitude is positive and negativ at the same time (Jonas, Broemer et al. 2000) Ambivalence is calculated as half the intensity of the positive (P), and negative (N) judgements, minus the absolute difference (similarity) between the two (Thomson, 1995).

$$\text{Ambivalence} = (P+N)/2 - |P-N|.$$

3.4.3 Affective-Cognitive ambivalence

In the current experiment both the affective and cognitive components of the attitude are measured. A distinction between affective and the cognitive scales is made by manipulating the salience of belief-based information (e.g. 'How positive do you *think* about the application of Nanotechnology in Nanonaise?'), thereby promoting thoughtful considerations; or the salience of feeling-based information, focusing the attention on feelings related to the attitude object (e.g., 'how positive do

you *feel* about the application of Nanotechnology in Nanonaise?'), thereby promoting emotion-based responding (Millar and Tesser 1986).

An absolute value of Affective-Cognitive ambivalence is calculated in line with Maio, Esse and Bell (2000). First the affective and cognitive evaluations are summed resulting in a generally positive or negative evaluation. To calculate the affective cognitive ambivalence, answers are divided in opposing and non-opposing answers. Example: If a participant's general evaluation of the affective component is +6 (positive) and the general evaluation of the cognitive component is negative (-3), The participant has six (3*2) opposing answers. The amount of non-opposed answers is simply equal to the total amount of answers (6+3), minus the amount of opposed answers (6). To calculate the Cognitive-Affective ambivalence, the amount of non-opposed valences are subtracted from the opposed valences resulting in an ambivalence value. For more detailed information about this calculation: See Maio, Esse and Bell (2000).

3.4.4 Processing fluency

We define fluency as the ease or difficulty experienced while processing information. Processing fluency was operationalized by objective processing fluency (response time) and subjective processing fluency (self-reports). In line with (Lee and Aaker 2004) the subjective processing fluency was measured by self-report on a seven point Likert scale ($\alpha=.855$). The following questions were asked; 'How easy did you process the presented information?' (1 = *difficult to process*, 7 = *easy to process*), and 'What do you think about the comprehensibility of the information?' (1 = *difficult to understand*, 7 = *easy to understand*).

To determine whether compatibility may affect the motivation to process the appeals, participants were also asked to indicate their involvement on a four-item seven point scale ($\alpha=.846$). The scale was anchored by (1 = *not at all involved, not at all interested, skimmed it quickly, paid little attention*) to (7 = *very involved, very interested, read it carefully, paid a lot of attention*) (Lee and Aaker 2004).

The objective processing fluency is measured by recording different time intervals, namely first click, second click, last click and click to submit. The questions at which the objective processing fluency was measured were presented at separate screens. Since most of the respondents only clicked once, only the first click was used for analyses. Other time intervals were neglected. The objective processing fluency is the time interval measured the time in (milliseconds) between opening of the question window and the first click of the participant. Hereby we assumed the first click to be the answering response of the participant. Because normal distribution is preferred, the natural logarithm (LN) of the response times was used for analyses.

3.5 Procedure

Participants were contacted by flyers in and around the University. The flyer invited students to participate in an experiment about consumers and technology. In return for participation students received a sweet snack. Students who arrived at the computer room were instructed not to communicate with each other during the experiment and could choose a computer. After students were seated, the program Qualtrics randomly assigned the participants to one of the six experimental conditions (1= affective depictions, 2= cognitive depictions, 3= affective descriptions, 4= cognitive descriptions, 5= both depiction and description with affective frame, 6= both depiction and description with cognitive frame). Participants were instructed to read the introduction on the computer screen. The introduction gave information about the type of questions which were going to be asked during the experiment and provided practical instructions. After the introduction, the knowledge level of the participants was measured using eighteen multiple choice questions about their objective and subjective knowledge about Nanotechnology. When the questions about the knowledge level of the participants were finished, the participants first received some general information about a randomly assigned application of Nanotechnology. The general information was followed by the stimulus material, advantages and disadvantages were shown on separate screens. To control for any possible order effects, half of the participants received information about the advantage of the application first, the other half received information about the disadvantage of the application first. Questions about participants feelings were asked before questions about thoughts. Immediately after being exposed to the information about the application, questions concerning the attitude of the participant are asked e.g. 'How positive do you feel about the application of Nanotechnology in Nanonaise?'. First questions about the affective part (feelings) of the attitude are asked, where after questions are asked concerning the cognitive part of the attitude (thoughts). At the end of the survey the participant's Need for Cognition is measured and some personal questions about age and education were asked.

4.0 Results

The results were analysed using the program SPSS. An α of 0.05 was used for all statistical tests. Due to a computer error, the participants were not equally distributed over the six conditions (table 1). The application Nanonaise was left out of the analyses because of structurally different results. Also results on attitude ambivalence between feelings and thoughts were left out of the report. Results for the Need for Cognition (NFC) was not found to be a coverable.

Table 1 Sample Distribution

Visual Presentation	Description	Description	Depiction	Depiction	Depiction & Description	Depiction & Description
Frame	Affective	Cognitive	Affective	Cognitive	Affective	cognitive
Condition #	1	2	3	4	5	6
N	30	31	15	30	31	29

4.1 Hypothesis 1

Hypothesis 1A: When complex information is visualized by depictions or affective framing, information is processed very fluently by the heuristic system and will lead to a more neutral and ambivalent attitude.

Hypothesis 1B: When complex information is visualized using descriptions or cognitive framing, information is processed less fluently than depictions. The information will be perceived as too complex, and therefore processed by the heuristic system leading to a more neutral and ambivalent attitude.

Hypothesis 1C: When complex information is provided in both depictions *and* descriptions, information will be processed with more fluency than the processing of descriptions and cognitive framing. Therefore the use of both depictions and descriptions will lead to more systematic processing of information and therefore result in a more polarized and less ambivalent attitude.

4.1.1 Influence of the Type of Visual Presentation

Objective processing fluency

To test the hypotheses about visual presentation (depiction vs. description), the dependent variable objective processing fluency was analysed between subjects using a Repeated Measures ANOVA. The assumption of equal variances was met for all the response times ($p < .05$) and the covariance matrices (Box's $M = 81.85$, $p = .42$). The factor visual presentation does not seem to influence the objective processing fluency of the participants $F(2,116) = .04$ $p = .96$ between subjects. Therefore the hypothesis 1A, 1B and 1C are not supported by the results.

Subjective fluency

To test the hypothesis about the influence of visual presentation (depictions vs. descriptions vs. both) the dependent variable, subjective fluency was analysed between subjects using a repeated measures ANOVA. The assumption of equal variances was met for all the measures of subjective fluency ($p > .05$) except for the understanding of information about Solar Cells $F(2,163) = 9.62$ $p = .00$. Variances of the covariance matrices seem to be unequal (Box's $M = 108.16$, $p = .00$). Variances between differences were equal except for the three subjective fluency measures (Machly's $W = .89$ $p = .00$). Therefore the results of the Huyn Feldt test were used to make inferences. The results show a significant influence of the type of visual presentation on the subjective processing fluency $F(1,163) = 5641.09$ $p = .02$.

In order to analyse the differences between the conditions, a post hoc pairwise comparison was performed. For the type I error was corrected using the Bonferroni approach ($\alpha = .017$). Participants perceived processing depicted information as most fluent ($M = 5.85$, $SD = .12$) compared to described information, this was perceived to be processed least fluent ($M = 5.32$, $SD = .14$) $t(2,163) = 2.87$ $p = .01$. These results support the hypothesis 1A and 1B. When a depiction is added to a description, the perceived fluency increases ($M = 5.58$, $SD = .12$). However this condition was not found to be significantly different from the conditions only depiction and only description $F(2,163) = 1.61$ $p = .11$. Therefore no significant support for hypothesis 1C was found.

General ambivalence

The hypothesis about the influence of visual information on the dependent variable 'general ambivalence' was tested by a Kruskal-Wallis test. The type of visual information has a marginally significant influence on the ambivalence of the attitude towards the application of Nanotechnology in Cancer treatment $H(2)=5.04$ $p=.08$, but had no significant influence on the ambivalence of the attitude towards the application of Nanotechnology in Solar Cells $H(2)=3.56$ $p=.17$. A follow-up tests was conducted to evaluate pairwise differences among the three groups, controlling for Type I error across tests by using the Bonferroni approach. A Mann-Whitney tests ($\alpha=0.03$) was conducted.

The results show that the general ambivalence was the lowest when information about the application of Nanotechnology in Cancer treatment was provided using only depictions (Median=1,25) in comparison to when information was visualised using both depictions and descriptions (Median=1,5) or only descriptions (Median=1,5). This means type of visual information does influence the general ambivalence. Therefore the influence of visual presentation as stated in hypothesis 1A and 1B was confirmed, however the effect was opposing. The addition of a depiction to a description did not significantly reduce the ambivalence. The conditions five $U(106)=1296.5$ $p=.62$ and six $U(122)=1554.5$ $p=.11$ (Median=1,5) were not significantly different from the rest. This means no significant support was found for hypothesis 1C.

Extremity

The hypothesis about the type of visual information (depiction vs. descriptions vs. both) on the dependent variable attitude extremity was tested using a Repeated Measures ANOVA. Differences between feelings and thoughts and the two products were measured within subjects, while extremity was analysed between subjects. The assumption of equality of covariance matrices was met $F(20,81)=.570$ $p=.94$. Measures of extremity also held equal variances ($p>.05$) except for the extremity of thoughts about the application of Nanotechnology in Cancer treatment. Results show a significant influence of the type of visual information on the extremity of the attitude $F(2,16)=3.43$ $p=.04$. A Pairwise Comparison was conducted to test the differences in attitude extremity between the different conditions.

Results of these tests show that when information is visualised using only a depictions, this led to a more extreme attitude ($M=.615$, $SD=.03$) then when information is visualised by a description ($M=.511$, $SD=.04$) $t(122)=2.17$ $p=.03$ or both depictions and descriptions ($M=.514$, $SD=.03$) $t(122)=2.27$ $p=.023$. Adding a depiction to a description does seem to enhance the extremity of the attitude, however this conditions was not significantly different from the other conditions $t(106)=.06$ $p=.95$.

This means no significant support was found for hypothesis c. The results confirm the influence of visual presentation and therefore confirm hypothesis 1A and 1B however show an opposing influence on attitude extremity.

4.1.2 Influence of the Type of Frame

Objective fluency

To test the hypothesis about the independent variable type of frame (affective vs. cognitive), the dependent variable objective processing fluency was analysed using a Repeated Measures ANOVA. In this analyses the differences between feelings, thought and products were measured within subjects, while objective fluency was measured between subjects. The assumption of equal variances was met for all the response times ($p < .05$) and the covariance matrices (Box's $M = 81.85$, $p = .42$).

The factor visual information does not seem to influence the objective processing fluency of the participants $F(2,116) = .04$ $p = .96$ between subjects. Therefore the hypothesis 1A, 1B and 1C were not supported. The type of frame does not significantly influence the objective processing fluency.

Subjective fluency

To test the hypothesis about the influence of the type of frame (affective vs. cognitive) on the dependent variable subjective fluency, a repeated measures ANOVA was conducted. In this analyses the differences between feelings, thought and products is measured within subjects, while subjective fluency was measured between subjects. Mauchly's W did not support the assumption of sphericity for the different measures of subjective processing fluency ($M = .89$ $p = .00$). Therefore the results of the Huyn Feldt test were used to make inferences. Variances of the covariance matrices seem to be unequal (Box's $M = 56.49$, $p = .00$). Also the variances of the measures understanding Solar Cells $F(1,164) = 7.35$, $p = .007$ and Cancer treatment $F(1,164) = 8.43$ $p = .00$ was equal. No significant effect of the factor type of frame on the subjective processing fluency was found $F(1,164) = 1.97$ $p = .06$. Therefore the hypothesis was not supported. The type of frame does not significantly influence the subjective processing fluency

General ambivalence

Because the factor frame only has two levels, and the dependent variable general ambivalence does not meet the assumption of normality, the influence of the factor frame on the general ambivalence is analysed using a Mann-Witney Test. The affective framing of information does not lead to a significantly different attitude ambivalence (Median=1,5) than the cognitive framing of information (Median=1,5). This factor does not influence either the general ambivalence towards Solar Cells

$U(167)=2979.0$ $p=.11$ nor Cancer treatment $U(167)=3419.0$ $p=.89$. Therefore no support for the hypothesis was found.

Attitude extremity

The hypothesis about the independent variable type of frame (affective vs. cognitive) on the dependent variable attitude extremity was tested using a Repeated Measures ANOVA. The extremity values held equal variances ($p>.05$). The variance in covariance matrices were also found to be equal $F(10,12)=.61$ $p=.80$. However no significant influence of the type of frame on the extremity of the attitude was found $F(1,17)=831.09$ $p=.61$. Therefore the hypothesis was not supported.

4.2 Hypothesis 2

2) A match between type of visual information and type of frame will lead to enhanced processing fluency resulting in a more polarized and less ambivalent attitude. A mis-match between type of visual information and type of frame will lead to enhanced processing fluency resulting in a more neutral and less ambivalent attitude.

Objective fluency

To test the hypothesis about the influence of a match vs. mismatch on the objective processing fluency a Repeated Measures ANOVA was conducted. Analysing the factor match between subjects. The assumption about the equality of variances was met ($p>.05$). Also the covariance matrices were homogeneous Box's $M=242.65$ $p=.22$.

Results show no significant influence of a the factor match on the objective processing fluency between subjects $F(1,11)=2219.40$ $p=.57$., and therefore do not support hypothesis 2.

Subjective fluency

To test the hypothesis about the influence of a match vs. mismatch on the subjective processing fluency a Repeated Measures ANOVA was conducted. In this analyses the differences between feelings, thought and products was measured within subjects, the subjective fluency is analysed between subjects. The assumption about the equality of variances was met ($p>.05$) for all measures of subjective fluency except for the measures understanding of Solar cells $F(5,160)=5.54$ $p=.00$ and perceived fluency of processing information about Solar Cells $F(5,160)=2.98$ $p=.01$. Covariance matrices were not homogeneous Box's $M=261.74$ $p=.00$. The different measures of subjective

fluency violated the assumption of sphericity Mauchly's $W=.89$ $p=.00.$, therefore the Huyn-Feldth test was used to make inferences about the within subject variables.

Results show that the combination of different types of visual presentation and different types of framing result in a significantly influences subjective processing fluency between subjects $F(5,160)=2.34$ $p=.04$. To test the difference between the conditions, a pairwise comparison was conducted. The results show that a the match and mismatch conditions did not lead to significantly higher processing fluency. However, when information was depicted, a match with an affective frame leads to a marginally higher processing fluency $t(45)=-1.74$ $p=.08$ than a mismatch with a cognitive frame. Mismatching depictions leads to a significantly lower processing fluency ($M=5.14$, $SD=.17$) than affectively framed descriptions (Condition 1)($M=5.83$, $SD=.17$) $t(60)=-2.81$ $p=.01$, cognitively framed descriptions (Condition 2) $t(61)=-2.99$ $p=.00$ or both depictions and descriptions in combination with an affective frame (Condition 5)($M=5.64$, $SD=0.17$) $t(61)=-2.04$ $p=.04$. No significant distinction could be made between the use of both depictions and descriptions in combination with a cognitive frame (Condition 6)($M=5.50$, $SD=.18$) and the other conditions ($p>.05$). These results indicate that it is important to add a matching frame when only using depictions. Therefore the influence of the factor match as stated in hypothesis 2 is confirmed.

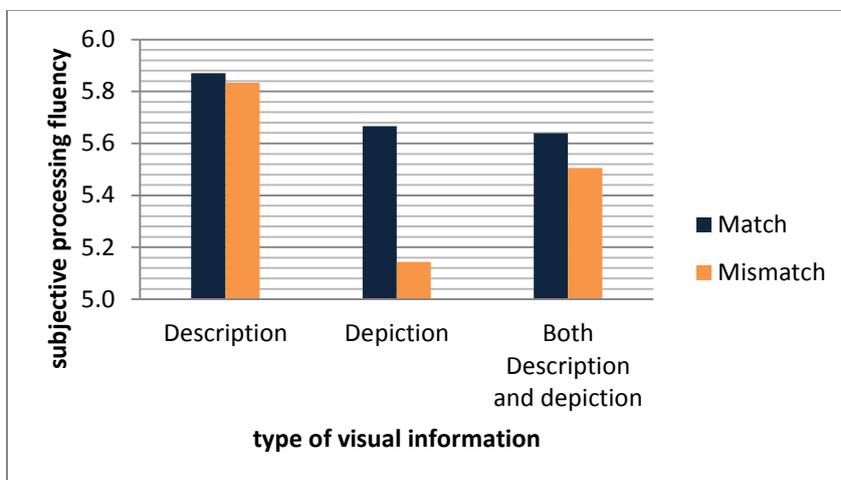


Figure 3 Subjective processing fluency as a function of the factor Match

General ambivalence

Because of the data of the dependent variable general ambivalence did not meet the assumption of normality, and the factor match counts 6 conditions, a Kruskal-Wallis test was conducted to test the hypothesis. The independent variable match was found to influence the general ambivalence of the attitude towards the application of Nanotechnology in Solar Cells $H(167)=16.64$ $p=.01$ but not about

the application of Nanotechnology in Cancer treatment $H(167)=8.90$ $p=.11$. A Witney U test was conducted to test the differences between matches and mismatches. Results show that match does not influence attitude ambivalence when information is presented in only depictions $U(45)=217.5$ $p=.99$ or only descriptions $U(61)=398$ $p=.31$. However when information is presented using both depictions and descriptions, cognitively framed information resulted in a significantly higher ambivalence (Median=1,5) than the affectively framed information (Median=1,0) $U(61)=242.5$ $p=.00$. Because in this situation the addition of an affective frame to both a depiction and a description is seen as a match, the hypothesis about the influence of matching on the general ambivalence was confirmed.

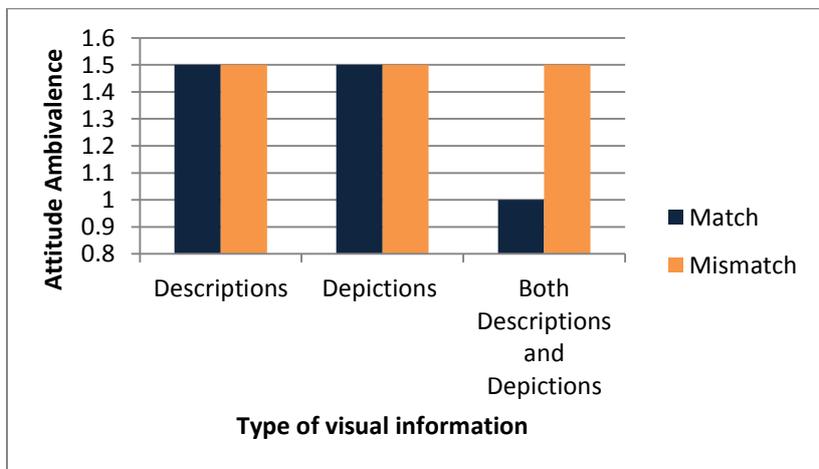


Figure1 Medians of General Ambivalence as a function of 'Match'

Attitude extremity

The hypothesis about the influence of the independent variable match, on the dependent variable attitude extremity was analysed using a Repeated Measures ANOVA. In this analyses the differences between feelings, thought and products was measured within subjects, while the attitude extremity was measured between subjects. Variances of the different measures of attitude extremity were equal ($p>.05$). Also covariance matrices (Box's $M=51.11$ $p=.57$.) were found to be equal. The assumption of sphericity could not be tested because of a lack of levels between subjects. The influence of the factor match on the extremity of the attitude was significant $F(5,161)=793,47$ $p=.045$. To test the difference between conditions, a pairwise comparison was conducted.

The results show a marginally significant influence of matching the information presentation and frame when both depictions descriptions are used to visualise information $t(60)=-1.90$ $p=0.56$. Matching does not influence the attitude extremity when information was presented using only depictions $t(45)=-.71$ $p=.48$ or only descriptions $t(61)=-.73$ $p=.46$.

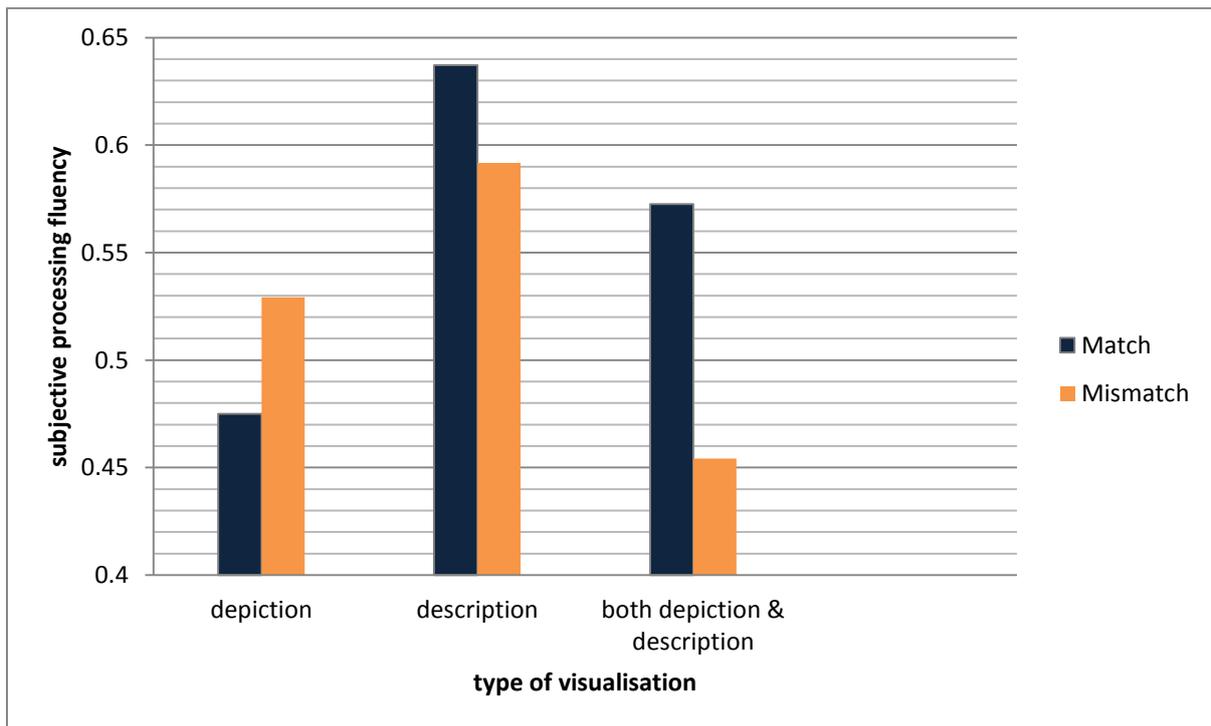


Figure 2, The effect of the factor match on the attitude extremity.

4.3 Hypothesis 3

Hypothesis 3a) Information which is processed heuristically will be processed more fluently and result in a more neutral and more ambivalent attitude.

Hypothesis 3b) Information which is processed systematically will be processed dis-fluent and result in a more extreme and less ambivalent attitude.

4.3.1 Influence of Objective Fluency

Attitude Extremity

The hypothesis about the influence of objective processing fluency and attitude extremity was tested using logistic regression, with objective fluency as an independent variable and attitude extremity as the dependent variable. Because the Repeated Measures ANOVA found a significant distinction in processing fluency was found between the feelings and thoughts. Feelings and thoughts were analysed in separate models. The model with the objective processing fluency of thoughts did not fit the model $F(4,124)=0.06$ $p=.73$ and did not have any predictive value about the extremity of feelings ($r^2=.02$). Also the model with the objective processing fluency of feelings did not fit the model

$F(4,159)=2.00$ $p=.10$ and did not have any predictive value about the extremity of thoughts ($r^2=.05$). Therefore the results do not support the hypothesis.

	B	SE	β	Sig.
Thoughts about Solar Cells				
Positive	-.04	.06	.07	.53
Negative	.00	.05	.01	.93
Feelings about Solar Cells				
Positive	-.06	.06	-.10	.26
Negative	-.06	.049	-.11	.23
Thoughts about Cancer treatment				
Positive	.07	.05	.13	.20
Negative	-.01	.05	-.01	.90
Feelings about Cancer treatment				
Positive	-.00	.06	-.00	.97
Negative	-.07	.04	-.14	.10

Note $R^2=.02$ for the model of feelings about the two applications, $R^2=.05$ for the model of Thoughts about the two applications

Table 2 Results Logistic Regression

General Attitude Ambivalence

The hypothesis about the influence of objective processing fluency and attitude ambivalence was tested using logistic regression, with objective fluency as an independent variable and attitude ambivalence as the dependent variable.

No significant correlation between objective processing fluency and the general ambivalence of the attitude towards the application of Nanotechnology in Solar Cells $F(4,157)=2.41$ $p=.05$ and Cancer treatment $F(4, 126)=1.18$ $p=.32$ was found. Therefore the results do not support hypothesis 3.

	B	SE	β	Sig.
Thoughts about Solar Cells				
Positive	-.13	.12	-.10	.29
Negative	-.01	.11	-.01	.94
Feelings about Solar Cells				
Positive	.46	.15	.29	.00
Negative	-.11	.14	-.08	.43
Thoughts about Cancer treatment				
Positive	-.07	.16	-.05	.67
Negative	.10	.14	.07	.47
Feelings about Cancer treatment				
Positive	.24	.16	.15	.14
Negative	.14	.15	.09	.37

Note $R^2=.03$. for the model of the application Solar Cells, $R^2=.04$ for the model of the application Cancer treatment

4.3.2 Influence of Subjective Processing Fluency

Attitude Extremity

The hypothesis about the influence of subjective processing fluency and attitude extremity was tested using logistic regression, using subjective fluency as an independent variable and attitude extremity as the dependent variable.

The model with the subjective processing fluency of thoughts did not fit the model very well

$F(6,165)=.83$ $p=.55$ and did not have any predictive value about the extremity of thoughts ($r^2=.03$).

Also the model with the subjective processing fluency of feelings did not fit the model $F(6,165)=.831$

$p=.55$ and did not have any predictive value about the extremity of thoughts ($r^2=.03$).

		B	SE	β	Sig.
On the extremity of Thoughts					
Solar Cells	Understanding	.068	.031	.269	.03
	Ease of Processing	-.023	.036	-.089	.53
	Perceived Fluency	-.018	.031	-.074	.56
Cancer treatment	Understanding	.046	.028	.174	.10
	Ease of Processing	-.034	.032	-.136	.30
	Perceived Fluency	.002	.031	.009	.93
On the extremity of Feelings					
Solar Cells	Understanding	.034	.033	.131	.30
	Ease of Processing	.015	.038	.056	.70
	Perceived Fluency	.005	.033	.020	.88
Cancer treatment	Understanding	-.016	.030	-.059	.59
	Ease of Processing	-.033	.033	-.127	.33
	Perceived Fluency	.009	.033	.032	.80

General Attitude Ambivalence

The hypothesis about the influence of subjective processing fluency on attitude ambivalence was tested using logistic regression, with subjective fluency as an independent variable and attitude ambivalence as the dependent variable. Subjective processing fluency did not have a correlation with either the ambivalence of the attitude towards Solar Cells $F(3,166)=1.40$ $p=.25$, as the ambivalence of the attitude towards Cancer treatment $F(3,165)=1.34$ $p=.26$. Therefore the results do not support the hypothesis.

	B	SE	β	Sig.
Solar Cells				
Understanding	-.17	.08	-.24	.04
Ease of Processing	.10	.09	.14	.30
Perceived Fluency	.07	.08	.04	.75
Cancer treatment				
Understanding	-.10	.07	-.14	.17
Ease of Processing	.02	.08	.03	.79
Perceived Fluency	-.04	.08	-.06	.64

Note R2=.06. for the model of the application Solar Cells, R2=.02 for the model of the application Cancer treatment

5.0 Discussion/Conclusion

The strength of the public's attitude towards applications of Nanotechnology can play a major role in the future development of this technology. In the current research I examined how people form an attitude towards applications of nanotechnology. More specifically, I examined how presentation and framing of information can influence the extremity and ambivalence of the attitude. After analysing the literature a hypothetical attitude formation model was set up and tested using a student sample. Results suggest presentation of information (depiction vs. description vs. both) is of major importance concerning attitude ambivalence and extremity, however fluency is not the central concept in the attitude formation model.

Participants seem to respond very differently on the different applications. Responses to the application Nanonaise were not comparable to responses towards the applications Solar Cells and Cancer treatment. The application Nanonaise was removed from the analyses in order to make inferences about the results. I expect the application Nanonaise to be more hedonic, while the applications Solar Cells and Cancer treatment are more utilitarian applications. Similar to Siegrist, Cousin and Kastenholtz (2007) I researched the perception of different Nanotechnology-applications in food, and found differences in attitude between different applications. According to Siegrist and his colleagues, the factor affect influenced the risk and benefit perception of the different applications. Therefore it can be said that the attitude formation process is different when people are exposed to hedonic applications of nanotechnology in comparison to utilitarian applications. However, more research is needed on the influence of hedonic vs. utilitarian applications on the attitude formation process. This means that results from this study can only be generalized to utilitarian applications of nanotechnology.

Furthermore, I expected the use of two processing systems to influence the ambivalence between feelings and thoughts. The results did not confirm our expectations. Apparently there is no interaction between feelings and thoughts when presenting or framing information using both information processing systems. This could mean the heuristic system and the cognitive system do not interact during the processing of information about applications of Nanotechnology, but only one system is relatively dominant. This finding is not in line with the dual coding theory and will be further explained in the sixth paragraph.

The results of the experiment indicated that the concept 'framing of information' and 'objective processing fluency' are not incorporated in the attitude formation mechanism. Because the

information was complex, it is possible that the 'emotional brain' was turned down, which prevented the participants from getting affected by the information. Dillen, Heslenfeld and Koole (2009) researched the influence of cognitive load on the expression of emotions. Similar to the current research, participants cognitive capacity was occupied with cognitive load. However cognitive load was not incorporated by mathematic calculations, but by complex information about Nanotechnology. Results of this study show that cognitive load is capable of turning down the emotional brain. However, this unexpected result can also be due to the method; the frame of the presented information could not be strong enough. To find whether the method or the construct caused these unexpected results, I suggest to do further research about the operationalization of fluency and framing, and on emotional blocking and the effect of repetition on informational comprehension. It is also possible that the factors framing and presentation of information do not influence the objective processing fluency. Since our sample consists of university students, it is possible that the processing of descriptions goes more automatic, fluent and therefore faster than the average person. Furthermore university students have are expected to have a higher need for cognition and processing capacity than the average person. One of the first psychologists who studied reading was Edmund Burke Huey. He states that repetition makes reading more effective, by reducing the amount of effort and attention spend on the process and details (Huey, 2009 cf. 1908). However the fact that I found differences in this homogeneous population emphasises the importance of the factors informational presentation and framing. A second methodological explanation of these result would be that the time of reading was incorporated in the processing fluency measure. This could have led to more variation than expected and therefore fade the difference in speed of processing.

Findings furthermore indicate that processing fluency is not a mediator when constructing an attitude towards Nanotechnology applications. We expected the depicted and affectively framed information to be processed more fluently by the heuristic system and therefore lead to a more neutral and ambivalent attitude. The results of the experiment confirm that participants perceived the processing of depictive information as more fluent than descriptive information. However, in contrast to the hypothesis, heuristic processing led to a more extreme and less ambivalent attitude than described information. The fact that only subjective fluency seems to be influenced by the presentation and framing of information and objective fluency stays unaffected, indicates that fluency does not lead to deeper processing of information like stated by but the attitude extremity and attitude ambivalence are influenced by another factor. First I will explain why depictions and affectively famed information lead to a less ambivalent and more extreme attitude using Figure 2 Model of Comprehension of depictions and descriptions (based on Schnotz and Bannert, 2003).

Because a depiction is seen as propositional mental model, it is used by the human brain to build a mental model. In contrast to description, depictions give information about the spatial arrangements of elements, therefore the mental model can be constructed more easily. This means that the fluency of building a mental model from depictions is relatively high. An unforeseen circumstance of this enhanced fluency is that it leads to inferences about the truth value of information and confidence (Unkelbach 2007; Alter and Oppenheimer 2009). Apparently when people are exposed to a propositional mental model, they do not question the truth value of this model and more or less automatically turn it to their 'final mental model'. When people do not get a propositional mental model, they have built this model all by themselves, which costs them more effort. When building the mental model from scratch, they may consider more options. Furthermore they do not get the feeling of truth and confidence because of the dis-fluent processing of information and end up with a less extreme and more ambivalent attitude. This indicates that it is not the processing fluency which causes an extreme and less ambivalent attitude, but the inferences made by perceived processing fluency. This finding was confirmed by the lack of influence of subjective fluency on attitude extremity and attitude ambivalence. This suggests that fluency does not play a central role with respect to the attitude extremity and ambivalence. However it is known that depending on the perceived processing fluency, certain inferences about confidence, liking or truth value are made. I advise to do future research about the influence of these inferences on attitude ambivalence and extremity.

Another interesting finding was that the interaction between the heuristic and systematic processing systems as stated by dual processing theories can be questioned. The results did not confirm the expected synergistic effect of combining depictions and descriptions. These results are not in line with the dual processing theory (Chaiken, 1989) which explicates the heuristic and systematic system can work together simultaneously and explains that the two systems can interact. This result is more in line with findings of Kruglanski and Thompson's unimodel (1999), which replaces the qualitative dichotomy by a quantitative continuum. In the unimodel, the quantity of processing is determined by capacity and motivation. With respect to the current research this means that providing two types of information (easy to process depictions and difficult to process descriptions) does not enhance the depth of processing information of low knowledge people. In case of providing complex information about Nanotechnology application to the low knowledge public; the limit of people's cognitive capacity is reached in an early stage because of the complexity of the information, so when providing easy to process depictions and affectively framed information, the highest depth of processing can be reached.

This indicates that high knowledge people are best informed with cognitively framed descriptions. However no current literature is available about the relation of knowledge level and informational presentation and framing is currently available. Therefore I suggest to do further research in this area.

This finding also explains why the addition of a matching frame to the depiction and description it can enhance extremity and reduce ambivalence. Although no influence of framing on attitude extremity and ambivalence was found, framing seem to influence attitude extremity and ambivalence when both depictions and descriptions were used. In line with our expectations, cognitively framed depictions and descriptions decreased the subjective processing fluency and result in a more neutral and ambivalent attitude. This result emphasises the importance of the ease of processing. In general it means that when you use both depictions and descriptions in order to inform people about new technologies, it is beneficial to affectively frame the information in order to enhance depth of processing.

For the future of Nanotechnology it is important that the public's attitude is in line with reliable information and not changed by random information (Krosnick, Boninger et al. 1993). Providing information in the a manner that results in a more extreme and less ambivalent attitude can have great influence on both the processing of information as well as judgement. Finally, it can be concluded that when providing information about utilitarian applications of Nanotechnology, within the sample processing fluency and informational presentation are important concepts. Although fluency is not a central concept in the attitude formation process, the use of easy to process types of visual presentation and framing will lead to the least ambivalent and most extreme attitudes.

Some limitations of the current study should be addressed. Second, due to a technical error, participants had to be removed from the sample. This means the sample size per condition was not equal. This influenced the statistical analyses in a way that some effects could be insignificant while they might be significant in real life.

This research emphasises the importance of the presentation and framing of information when introducing applications of Nanotechnology to the market. Taking the results of the experiment into account, it is advised to do more research about the role of fluency in the attitude formation process and the operationalization of the fluency concept.

The new model gives an indication on how attitudes towards applications of Nanotechnology are formed and points on the importance of the use of depictions when informing low knowledge people about utilitarian applications of Nanotechnology. The fact that presentation of information structurally influence both attitude ambivalence and attitude extremity means they have to be taken into account when informing consumers about Nanotechnology and its applications. Results confirm that the concepts attitude extremity and attitude ambivalence are related, and together they give an indication about attitude strength (Krosnick, Boninger et al. 1993). In order to create a non-ambivalent and less extreme attitude we advise organisations to provide complex information about a new technologies to the low knowledge public in a way which is easy to process. The use of only depictions therefore will create the least ambivalent and most extreme attitude.

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Appendix I; Stimulus material

Condition 5: Affective Depiction and Description

Nadeel: Giftigheid onbekend

The diagram shows two circular insets on the left. The top inset is labeled 'Nano-vetdeeltjes' and contains small yellow dots. The bottom inset is labeled 'Normale vetdeeltjes' and contains larger yellow dots. From the nano-fat inset, a blue arrow points to a yellow triangular toxicity symbol with a skull and crossbones. From the normal fat inset, a blue arrow points to a red triangular toxicity symbol with a skull and crossbones. Both arrows then point towards a human figure labeled 'mens' and a dog labeled 'dier', which have anatomical diagrams of their internal organs.

Nano-vetdeeltjes

Normale vetdeeltjes

mens

dier

De giftigheid van het vet kan veranderen.

Dit kan negatieve gevolgen hebben voor zowel mensen als dieren.

Voordeel: Zelfde romigheid en smaak

The top part shows a jar of 'Nano-Butter' next to three bottles of 'SPA' water and a bottle of yellow oil. An equals sign follows, leading to a woman eating a slice of bread with butter. The bottom part shows a jar of 'MAYONNAISE' next to three bottles of yellow oil and a bottle of 'SPA' water. An equals sign follows, leading to the same woman eating a slice of bread with mayonnaise.

Nano-Butter

SPA

SPA

SPA

+

=

terwijl de lekkere smaak en romigheid hetzelfde blijven.

Een groot deel van het dikmakende vet kan vervangen worden door water,

Voordeel: Vervangen fossiele brandstoffen

The top part shows a silicon wafer and a small chip with an arrow pointing to a woman using a laptop. The bottom part shows a quantum dot wafer and a small chip with an arrow pointing to a woman holding a tablet. To the right, there are images of a gas burner, a car, and a solar panel.

Silicium

Quantum dot

We kunnen op een veel goedkopere manier genieten van elektronische producten,

daarnaast kan het gebruik van fossiele brandstoffen drastisch verminderd worden.

Nadeel: Giftigheid onbekend

The diagram is identical to the one in the first block, showing nano-fat particles and normal fat particles with toxicity symbols pointing to human and animal figures.

Nano-vetdeeltjes

Normale vetdeeltjes

mens

dier

De giftigheid van het vet kan veranderen.

Dit kan negatieve gevolgen hebben voor zowel mensen als dieren.

Voordeel: Geen Pijn

Bestraling

Nano-robotjes

Doordat de nano-kankerbehandeling geen gezonde cellen doodt

-in tegenstelling tot de huidige behandelingsmethoden- veroorzaakt deze behandelingsmethode geen pijn, terwijl het kankergezwel toch wordt bestreden.

Nadeel: Gevolg leefomgeving onbekend

Quantum dots

Gevolg bij muizen:

- Lever met bloedpropjes
- Longen met bloedpropjes

Wanneer zonnepanelen kapot gaan, kunnen quantum dots in de leefomgeving verspreid worden. Hier kunnen ze tot bloedpropjes in de longen en lever van muizen leiden. Er is nog niet bekend wat de gevolgen zijn voor de mens.

Condition 6 Cognitive Depiction and Description

Nadeel: Onbekende toxiciteit

Normaal vet

Niet toxisch

Nano vet

Niet toxisch

De toxiciteit van de lipide druppeltjes kan veranderen.

Dit kan negatieve gevolgen hebben voor zowel de mens als het dierenrijk.

Voordeel: Zelfde mondgevoel en aroma

Nanonaise

Uitslag smaakpanel

Hoe is het mondgevoel van Nanonaise?

Heel waterig Heel romig

Hoe vind je de aroma van de Nanonaise?

Heel smerig Heel lekker

Mayonaise

Hoe is het mondgevoel van Mayonaise?

Heel waterig Heel romig

Hoe vind je de aroma van de Mayonaise?

Heel smerig Heel lekker

Een groot deel van de lipiden met hoge nutritionele waarde kan vervangen worden door water, terwijl het gewenste mondgevoel en aroma hetzelfde blijven.

Voordeel: Goedkoper

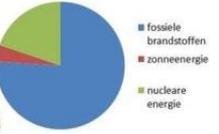
Gewone zonnecellen



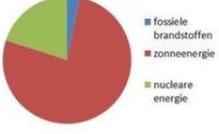
Nano-zonnecellen



Gebruikte energiebronnen

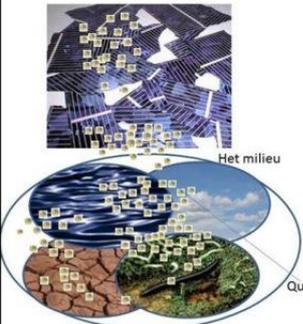


Gebruikte energiebronnen



We kunnen voor een lagere prijs elektriciteit consumeren, daarnaast kunnen we het verbruik van fossiele brandstoffen tot wel 80% reduceren.

Nadeel: Verspreiding milieu

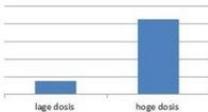


Het milieu

Quantum dots

Uitslag onderzoek bij muizen:

Kans op trombose in lever en longen



lage dosis hoge dosis

Effect op de mens:

?

Zonnepanelen kunnen kapot gaan waardoor quantum dots in het milieu verspreid worden. Hier kunnen ze tot trombose in de longen en lever van muizen leiden. Er is nog niet bekend wat de gevolgen zijn voor de mens.

Nadeel: Afvalproduct

Afval stoffen



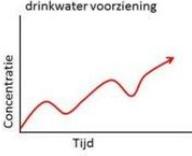
Nano-robotjes



~~biologisch afbreekbaar~~



Afval nano-robotjes in drinkwater voorziening



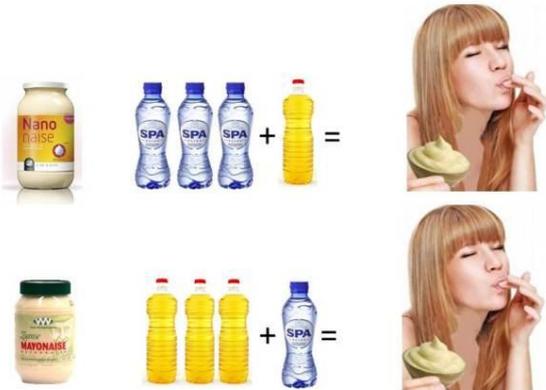
Concentratie

Tijd

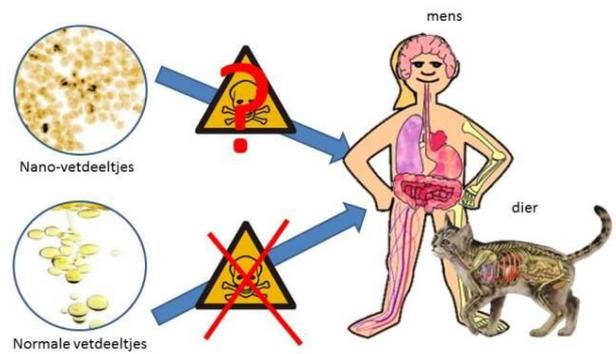
De stukjes nanorobot zijn heel klein, en zijn niet biologisch afbreekbaar. Dit betekent dat de robotdeeltjes kunnen ophopen in bijvoorbeeld de drinkwater voorziening.

Condition 3: Only Affective Depictions

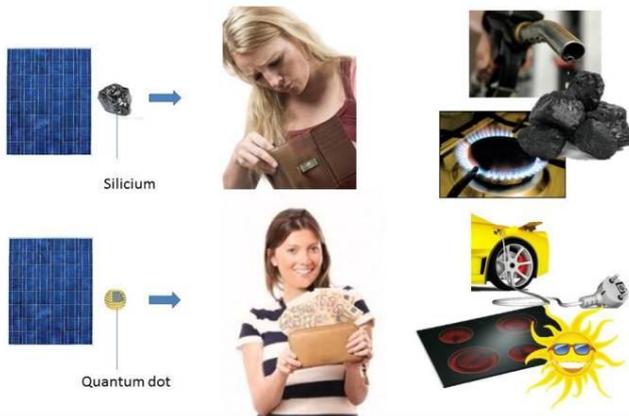
Voordeel: Zelfde romigheid en smaak



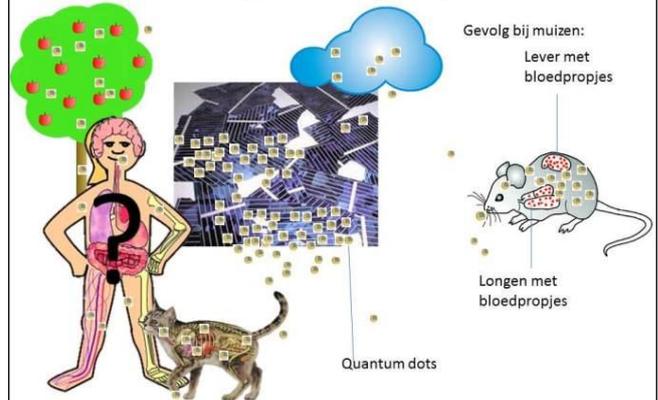
Nadeel: Giftigheid onbekend



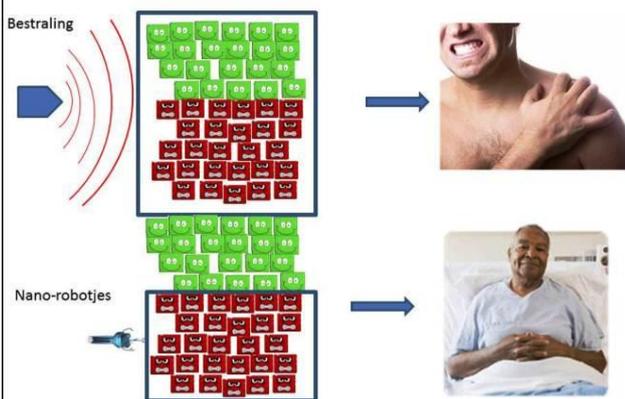
Voordeel: Vervangen fossiele brandstoffen



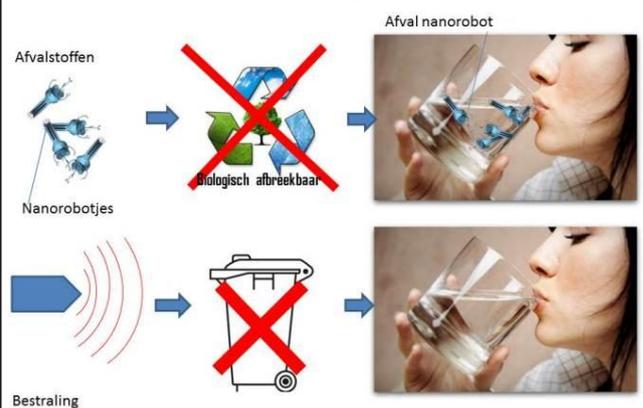
Nadeel: Gevolgen leefomgeving onbekend



Voordeel: Geen Pijn

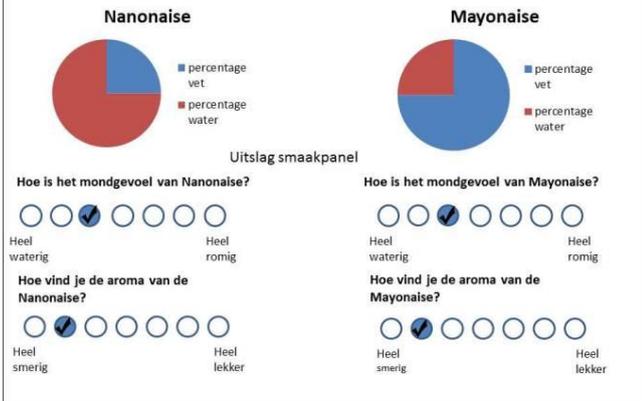


Nadeel: Afvalproduct

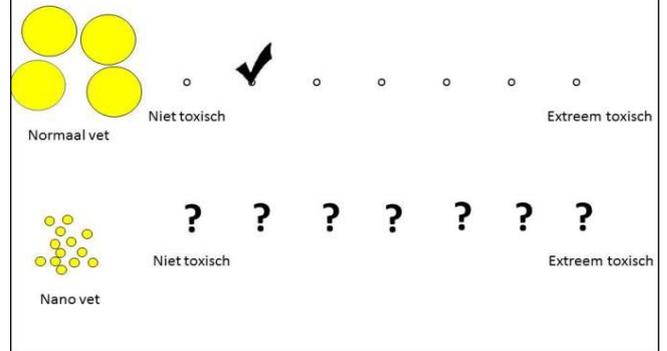


Condition 4: Only Cognitive Depictions

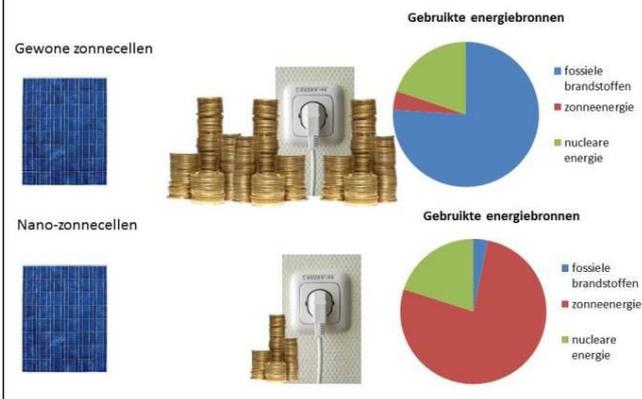
Voordeel: Zelfde mondgevoel en aroma



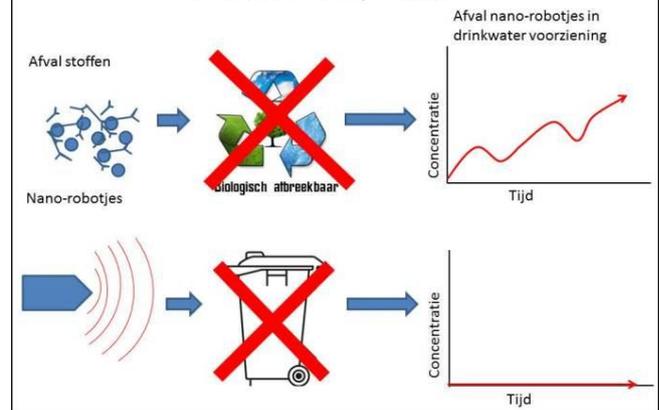
Nadeel: Onbekende toxiciteit



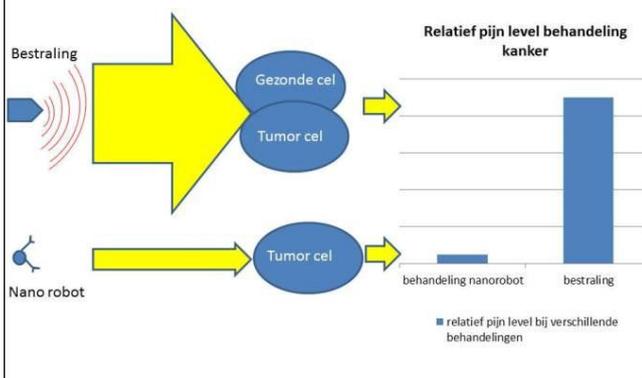
Voordeel: Goedkoper



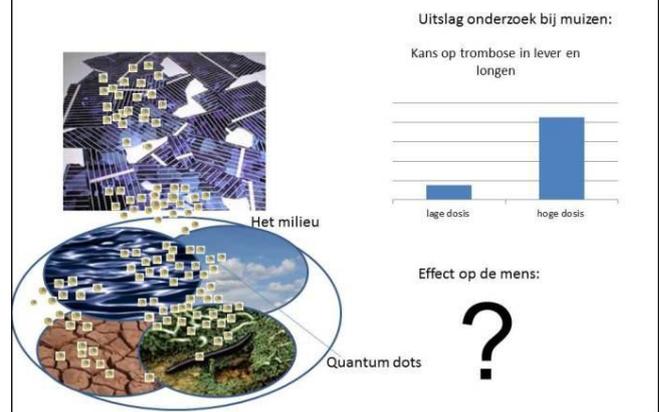
Nadeel: Afvalproduct



Voordeel: Geen Pijn



Nadeel: Verspreiding milieu



Condition 2: Only cognitive descriptions

Voordeel:
Een groot deel van de lipiden met hoge nutritionele waarde kan vervangen worden door water, terwijl het gewenste mondgevoel en aroma hetzelfde blijven.

Nadeel:
De toxiciteit van de lipide druppeltjes kan veranderen.

Dit kan negatieve gevolgen hebben voor zowel de mens als het dierenrijk.

Voordeel:
We kunnen voor een lagere prijs elektriciteit consumeren, daarnaast kunnen we het verbruik van fossiele brandstoffen tot wel 80% reduceren.

Nadeel:
Zonnepanelen kunnen kapot gaan waardoor quantum dots in het milieu verspreid worden.

Hier kunnen ze tot trombose in de longen en lever van muizen leiden.

Er is nog niet bekend wat de gevolgen zijn voor de mens.

Voordeel:
Doordat de nano-kankerbehandeling geen gezonde cellen uitschakelt

-in tegenstelling tot de huidige behandelingsmethoden- veroorzaakt deze behandelingsmethode geen pijn, terwijl de tumor toch wordt bestreden.

Nadeel:
De stukjes nanorobot zijn heel klein, en zijn niet biologisch afbreekbaar.

Dit betekent dat de robotdeeltjes kunnen ophopen in bijvoorbeeld de drinkwater voorziening.

Condition 1: Only affective descriptions

Voordeel:
Doordat de nano-kankerbehandeling geen gezonde cellen doodt

-in tegenstelling tot de huidige behandelingsmethoden-
veroorzaakt deze behandelingsmethode geen pijn, terwijl het kankergezwellen toch wordt bestreden.

Nadeel:
De stukjes nanorobot zijn heel klein, en kunnen niet op een natuurlijke manier verteren.

Dit betekent dat de robotdeeltjes kunnen ophopen in bijvoorbeeld het kraanwater.

Voordeel:
We kunnen op een veel goedkopere manier genieten van elektronische producten,
daarnaast kan het gebruik van fossiele brandstoffen drastisch verminderd worden.

Nadeel:
Wanneer zonnepanelen kapot gaan, kunnen quantum dots in de leefomgeving verspreid worden.

Hier kunnen ze tot bloedpropjes in de longen en lever van muizen leiden.

Er is nog niet bekend wat de gevolgen zijn voor de mens.

Voordeel:
Een groot deel van het dikmakende vet kan vervangen worden door water,
terwijl de lekkere smaak en romigheid hetzelfde blijven.

Nadeel:
De giftigheid van het vet kan veranderen.

Dit kan negatieve gevolgen hebben voor zowel mensen als dieren.

Appendix II General parts of the survey

Q2 Beste respondent, Bedankt voor je medewerking aan dit experiment. Dit experiment zal ongeveer 5 tot 10 minuten duren. We beginnen dit experiment met wat vragen over jouw kennis van Nanotechnologie. Daarna zul je wat informatie over Nanotechnologie in het algemeen en informatie over drie toepassingen van Nanotechnologie krijgen. Het is belangrijk dat je de vragen goed leest en waarheidsgetrouw beantwoordt. Het antwoord op de gesloten vragen moet je aankruisen op de schaal. Kruis hierbij steeds maar één hokje aan, tenzij anders wordt aangegeven. Het gaat steeds om je eigen mening, er zijn dus geen goede of foute antwoorden. Alle resultaten worden anoniem verwerkt. Neem zoveel tijd als je denkt nodig te hebben. De knop rechts onder in beeld brengt je naar de volgende pagina van het experiment. Eventuele vragen kun je stellen aan de begeleider van dit experiment.

Q4 Vragen: Heb je ooit gehoord van Nanotechnologie?

- Ja (7)
- Nee (0)

Q6 Weet je wat Nanotechnologie betekent?

- Ja (7)
- Nee (0)

Q8 Hoeveel weet je over nanotechnologie in het algemeen?

- Ik weet niets over Nanotechnologie (1)
- (2)
- (3)
- (4)
- (5)
- Ik ben een expert op het gebied van Nanotechnologie (6)

Q10 Weet je in welke sectoren Nanotechnologie wordt gebruikt?

- Ja, ik ken één of meerdere sectoren waarin Nanotechnologie wordt gebruikt (1)
- Nee, ik ken geen sector waarin Nanotechnologie wordt gebruikt (2)

Q12 In welke sector(en) wordt Nanotechnologie gebruikt? (je mag meer dan een antwoord geven)

- Voedingsindustrie (1)
- Mode (2)
- Water (3)
- Cosmetica (4)
- It/Telecommunicatie (5)
- Auto (6)
- Agrarische sector (7)
- Verkeer (8)
- Energie (9)
- Bouw (10)
- Defensie (11)
- Geen van de bovenstaande sectoren (12)

Q14 Ken je één of meerdere producten waarin nanotechnologie wordt gebruikt?

- Ja (1)
- Nee (2)

Q16 In welk(e) van de volgende producten wordt Nanotechnologie gebruikt? (je mag meerdere antwoorden geven)

- Computer (1)
- Radio (2)
- Zonnepaneel (3)
- Telefoon (4)
- Televisie (5)
- Wasmachine (6)
- Mp3 speler (7)
- Navigatie systeem (8)
- Geen van de bovenstaande producten (9)

Q18 Dit waren de vragen over jouw kennis van Nanotechnologie. Op de volgende pagina's zal je algemene informatie over Nanotechnologie en informatie over drie toepassingen van Nanotechnologie krijgen. Neem de informatie goed in je op en beantwoord de vragen waarheidsgetrouw. De informatie wordt telkens gevolgd door enkele vragen over jouw mening betreffende deze toepassingen. Nogmaals: Het gaat steeds om jouw mening, er zijn dus geen goede of foute antwoorden.

Q20 Lees nu de volgende informatie: Nanotechnologie is een verzamelnaam van technieken die het mogelijk maken te werken met deeltjes die een omvang hebben van nanometers. Een

nanometer is een miljoenste millimeter. Om dit in perspectief te brengen; één mensenhaar is maar liefst 80.000 nanometer (nm.).

Q22 Informatie (vervolg) Binnen de nanotechnologie wordt onderscheid gemaakt tussen het gebruik van nanodeeltjes in allerlei toepassingen (als product) en het gebruik van nanotechnologie in het productieproces (als proces). Door op nanoschaal te werken, wordt het mogelijk om zowel organisch als niet-organisch materiaal aan te passen of zelfs nieuwe materialen te creëren. We hebben een aantal toepassingen in verschillende branches uitgekozen om je een beter beeld te geven van nanotechnologie.

Q24 Informatie over de toepassing van Nanotechnologie: Nanonaise In de voedingsbranche wordt gewerkt aan de ontwikkeling van mayonaise met behulp van nanotechnologie. Zo is er bijvoorbeeld een 'Nanonaise' ontwikkeld die 70% minder vet bevat doordat deze dubbel is geëmulgeerd. Dit betekent dat er in een 'vet-in-water-oplossing' in elk druppeltje vet een klein druppeltje water zit. Dus met dezelfde ingrediënten en dezelfde vorm vetbolletjes wordt nu een minder vette mayonaise gemaakt.

Q26 [At this point of the survey, stimulus material is presented.]

Q30 Vragen: Hoe positief is jouw gevoel tegenover het toepassen van Nanotechnologie in Nanonaise?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q65 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q32 Hoe negatief is jouw gevoel tegenover het toepassen van Nanotechnologie in Nanonaise?

- helemaal niet negatief (1)
- (2)
- (3)
- heel erg negatief (4)

Q66 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q34 Hoe positief denk jij over het toepassen van Nanotechnologie in Nanonaise?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q67 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q36 Hoe negatief denk jij over het toepassen van Nanotechnologie in Nanonaise?

- helemaal niet negatief (1)
- (2)
- (3)
- extreem negatief (4)

Q69 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q38 Hoe vond je het om de informatie over het voor- en nadeel van deze toepassing te verwerken?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
heel lastig te begrijpen:heel makkelijk te begrijpen (1)	<input type="radio"/>						
heel moeilijk te verwerken:heel makkelijk te verwerken (2)	<input type="radio"/>						
het ging helemaal niet vloeiend:het ging heel vloeiend (3)	<input type="radio"/>						

Q40 In welke mate was je betrokken bij het verwerken van de informatie?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
ik was helemaal niet betrokken:ik was heel erg betrokken (1)	<input type="radio"/>						
ik heb er heel weinig aandacht aan besteed:Ik heb er heel veel aandacht aan besteed (2)	<input type="radio"/>						
Ik heb de informatie snel gescand:Ik heb de tekst zorgvuldig bekeken (3)	<input type="radio"/>						
Ik was totaal niet geïnteresseerd:Ik was heel geïnteresseerd (4)	<input type="radio"/>						

Q42 Informatie over de toepassing van Nanotechnologie: Zonnecellen In de energiebranche wordt gewerkt aan de ontwikkeling van zonnecellen met behulp van nanotechnologie. Zo zijn er bijvoorbeeld zonnepanelen ontwikkeld die goedkoper zijn doordat er 'quantum dots' (een deeltje dat met nanodeeltjes wordt gemaakt) in worden gebruikt. Dit betekent dat het dure Silicium wordt vervangen door goedkope quantum dots. Dus met goedkopere materialen kan nu dezelfde duurzame zonnecel geproduceerd worden.

Q44 [At this point of the survey, stimulus material is presented.]

Q46 Vragen: Hoe positief is jouw gevoel tegenover het toepassen van Nanotechnologie in zonnecellen?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q72 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q50 Hoe positief denk jij over het toepassen van Nanotechnologie in Zonnecellen?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q71 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q52 Hoe negatief denk jij over het toepassen van Nanotechnologie in Zonnecellen?

- helemaal niet negatief (1)
- (2)
- (3)
- extreem negatief (4)

Q73 Timing

- First Click (1)
- Last Click (2)
- Page Submit (3)
- Click Count (4)

Q54 Hoe vond je het om de informatie over het voor- en nadeel van deze toepassing te verwerken?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
heel lastig te begrijpen:heel	<input type="radio"/>						

makkelijk te begrijpen (1)							
heel moeilijk te verwerken:heel makkelijk te verwerken (2)	<input type="radio"/>						
het ging helemaal niet vloeiend:het ging heel vloeiend (3)	<input type="radio"/>						

Q56 In welke mate was je betrokken bij het verwerken van de informatie?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
ik was helemaal niet betrokken:ik was heel erg betrokken (1)	<input type="radio"/>						
ik heb er heel weinig aandacht aan besteed:ik heb er heel veel aandacht aan besteed (2)	<input type="radio"/>						
Ik heb de informatie snel gescand:ik heb de tekst zorgvuldig bekeken (3)	<input type="radio"/>						
Ik was totaal niet geïnteresseerd:Ik was heel geïnteresseerd (4)	<input type="radio"/>						

Q48 Informatie over de toepassing van Nanotechnologie: Kankerbehandeling In de gezondheidsbranche wordt gewerkt aan de ontwikkeling van een nieuwe behandelingsmethode van kanker met behulp van nanotechnologie. Zo is er bijvoorbeeld een behandelingsmethode ontwikkeld tegen kanker die met behulp van nanorobotjes kankergenen uitschakelt. Dit betekent dat er kleine (70 nm.) nanorobotjes worden ingebracht. Deze nano-robotjes dragen een eiwit dat reageert met specifieke genen in kanker cellen, waardoor bepaalde stoffen niet meer door de cel aangemaakt kunnen worden, en de cellen sterven.

Q28 [At this point of the survey, stimulus material is presented.]

Q50 Vragen: Hoe positief is jouw gevoel tegenover het toepassen van Nanotechnologie bij de behandeling van kanker?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q74 Timing

First Click (1)

Last Click (2)

Page Submit (3)

Click Count (4)

Q48 Hoe negatief is jouw gevoel tegenover het toepassen van Nanotechnologie in zonnecellen?

- helemaal niet negatief (1)
- (2)
- (3)
- extreem negatief (4)

Q75 Timing

First Click (1)

Last Click (2)

Page Submit (3)

Click Count (4)

Q58 Hoe positief denk jij over het toepassen van Nanotechnologie bij de behandeling van kanker?

- helemaal niet positief (1)
- (2)
- (3)
- extreem positief (4)

Q52 Timing

First Click (1)

Last Click (2)

Page Submit (3)

Click Count (4)

Q60 Hoe negatief denk jij over het toepassen van Nanotechnologie bij de behandeling van kanker?

- helemaal niet negatief (1)
- (2)
- (3)

extreem negatief (4)

Q76 Timing

First Click (1)

Last Click (2)

Page Submit (3)

Click Count (4)

Q76 Wat vind je van het toepassen van Nanotechnologie in het algemeen?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
heel negatief:heel positief (1)	<input type="radio"/>						

Q78 Hoe zeker ben je over dit oordeel?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Onzeker:heel zeker (1)	<input type="radio"/>						

Q80 Geef aan in welke mate je het (on)eens bent met de volgende statements:

	heel erg oneens (1)	(2)	niet eens noch oneens (3)	(4)	helemaal mee eens (5)
Als ik moet kiezen heb ik liever een ingewikkeld dan een simpel probleem (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik ben graag verantwoordelijk voor een situatie waarin veel nagedacht moet worden. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Denken is niet precies mijn idee van plezier hebben. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik doe liever iets waarbij weinig nagedacht hoeft te worden dan iets waarbij mijn denkvermogen zeker op de proef wordt gesteld. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Iets langdurig en precies afwegen geeft me voldoening. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik denk alleen zoveel als nodig is. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik denk liever over kleine dagelijkse dan over lange-termijn projecten na. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik hou van taken waarbij weinig nagedacht hoeft te worden wanneer ik ze eenmaal geleerd heb. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Het idee om op mijn verstand te vertrouwen vind ik aantrekkelijk. (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik geniet echt van een taak waarin men met nieuwe oplossingen voor problemen moet komen. (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nieuwe manieren leren om te denken trekt me niet bijzonder aan. (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Het idee om abstract te denken vind ik aantrekkelijk. (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik heb liever een taak die intellectueel, moeilijk en belangrijk is dan een taak die enigszins belangrijk is, maar waarbij je niet veel na hoeft te denken. (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik vind het voldoende wanneer iets blijkt te werken: hoe of waarom het precies werkt interesseert me niet. (14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gewoonlijk maak ik zelfs uitgebreid afwegingen over zaken die niet persoonlijk op mijzelf betrekking hebben. (15)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q82 Wat is je leeftijd (in jaren)?

Q84 Op welk niveau volg je momenteel een opleiding?

- Bachelor (1)
- Master (2)

Q86 Binnen welk onderdeel van de Wageningen Universiteit valt deze opleiding?

- Maatschapijwetenschappen (1)
- Omgevingswetenschappen (2)
- Life Sciences (3)
- geen idee (4)

Q90 Wat is je geslacht?

- Vrouw (1)
- Man (2)

Q46 Dit was het einde van de vragenlijst. Hartelijk bedankt voor je medewerking! Ten slotte: De toepassingen die beschreven zijn in deze vragenlijst zijn deels fictief. Dat wil zeggen sommige toepassingen bestaan nog niet, en zullen in de toekomst helemaal niet op de markt gebracht worden. Mocht je vragen hebben over dit onderzoek dan kun je contact opnemen met Josien Drenten: josien.drenten@wur.nl

Appendix III Results pretest

	#	Nanonai average	mod us	Solar Cells average	mod us	Cancer- Hairrelease averag e	modus	Cancer – Pain average	mod us
		Depictions							
Affective Advantage	1	4,33	5	3,83	4	5,33	6	3,33	3
	2	3,00	3	3,33	3	2,50	2	2,83	4
	3	4,17	6	3,17	3	5,00	7	5,00	6
	4	4,00	3	4,00	5	2,83	2	3,83	4
		Descriptions							
	1	3,00	4	4,67	6	4,50	5	4,17	4
	2	2,00	2	2,33	1	2,00	2	2,83	4
	3	5,67	5	5,67	6	5,33	6	5,83	6
	4	4,50	6	3,50	4	3,00	3	3,50	3
		Depictions							
Cognitive Advantage	1	5,20	5	4,67	4	4,83	5	4,67	6
	2	3,60	4	2,50	2	2,33	2	3,33	4
	3	6,20	6	5,67	5	5,33	6	4,67	6
	4	4,20	5	3,17	2	3,33	2	4,17	4
		Descriptions							
	1	5,60	5	3,50	3	5,00	4	4,50	6
	2	3,20	3	2,17	2	2,67	1	2,83	3
	3	4,00	5	5,83	7	5,83	7	4,67	5
	4	4,40	6	3,83	3	3,00	5	2,83	3
		Depictions							
Affective Disadvantage	1	4,60	5	4,00	4	5,00	7		
	2	4,80	6	4,83	5	4,17	4		
	3	4,00	5	3,50	4	1,83	2		
	4	4,60	5	4,00	5	3,50	4		
		Descriptions							
	1	4,17	4	4,33	3	3,33	3		
	2	5,17	6	5,67	5	5,33	6		
	3	4,67	6	5,33	7	5,17	6		
	4	3,50	4	3,17	3	3,33	3		
		Depictions							
Cognitive	1	5,00	5	4,17	5	5,17	6		

Disadvantage

2	4,17	4	5,33	5	4,50	4
3	4,50	6	4,33	5	3,50	-
4	3,67	2	3,33	2	3,67	3
Descriptions						
1	4,60	5	4,00	2	4,00	4
2	4,80	5	5,50	5	5,17	6
3	5,00	5	5,33	5	5,00	6
4	3,20	3	4,00	5	2,67	2

Measure	Rating	Rating
1. Feelings	1	Thoughts 7
2. Positive	1	Negative 7
3. Dont understand	1	Do understand 7
4. Credible	1	Not credible 7