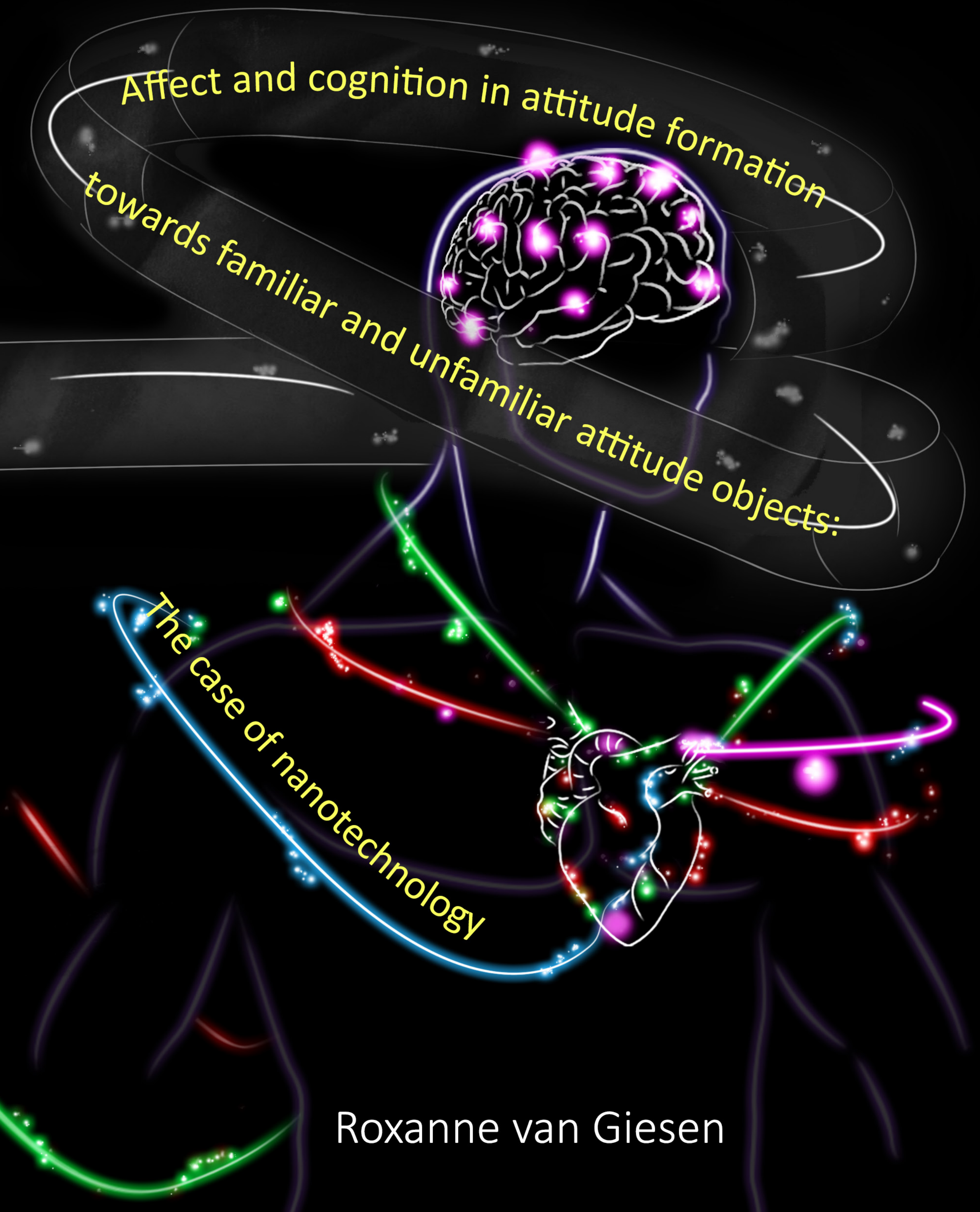
Affect and cognition in attitude formation towards familiar and unfamiliar attitude objects: The case of nanotechnology



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This research was conducted under the auspices of the Wageningen School of Social Sciences (WASS)

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Thesis
submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Academic Board,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Tuesday 30 June 2015
at 4 p.m. in the Aula.

Roxanne van Giesen
Affect and cognition in attitude formation towards familiar and unfamiliar attitude objects: The case of nanotechnology
188 pages.

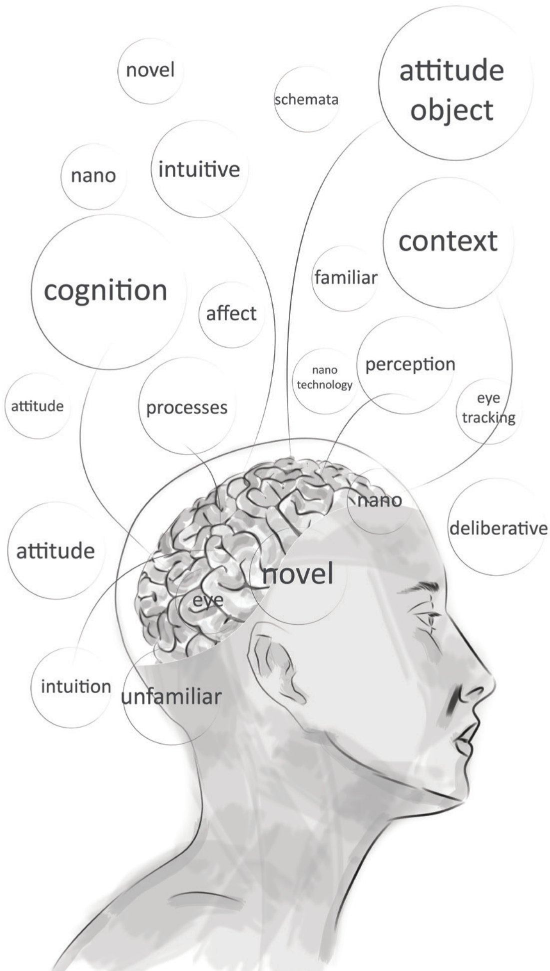
PhD thesis, Wageningen University, Wageningen, NL (2015)
With references, with summaries in English and Dutch.

ISBN: 978-94-6257-339-0

Contents

Chapter 1

General introduction



In everyday life attitudes play a major role in helping us to make sense of the environment, helping us to determine how we think and feel about things, and influencing the decisions we make. For instance, our attitudes influence which political party we vote for, which car we buy, and whether or not we accept a new technology. Attitudes are of great interest to psychologists and decision researchers because they provide information on how people make evaluative judgements and contribute to better understanding of judgement and decision making processes. Although central to research on judgement and decision making and to social psychology, attitudes are still a poorly understood concept deserving further exploration (Gawronski, 2007).

To a large extent, attitudes are memory traces from the past built on earlier experiences and further refined after repeatedly encountering the attitude object in the environment (Eiser, Fazio, Stafford, & Prescott, 2003; Fazio, 2007). Consequently, most commonly used attitudinal models apply very well to situations where people have experience with the attitude object (Plessner & Czenna, 2008). If such earlier experiences are not available, such as in the case of new technologies, people are still somehow able to construct attitudes on the spot (Schwarz, 2007). How this is done and which factors are important in the process of attitude formation towards unfamiliar attitude objects will be investigated in this thesis. Therefore, the central question in this thesis is:

How do people form attitudes towards unfamiliar attitude objects?

What is an attitude?

The starting point in understanding attitudes is defining what an attitude is and where attitudes stem from. It is generally accepted that attitudes represent summary evaluations and can be viewed as “associations between a given object and one’s evaluation of that object” (Ajzen, 2001; Fazio, 2007). A dominant approach within the attitude research tradition is that of the expectancy-value model (Fishbein & Ajzen, 1975), which states that a person’s overall attitude is determined by the sum of subjective values of the attributes related to the object, in combination with the strength of these values.

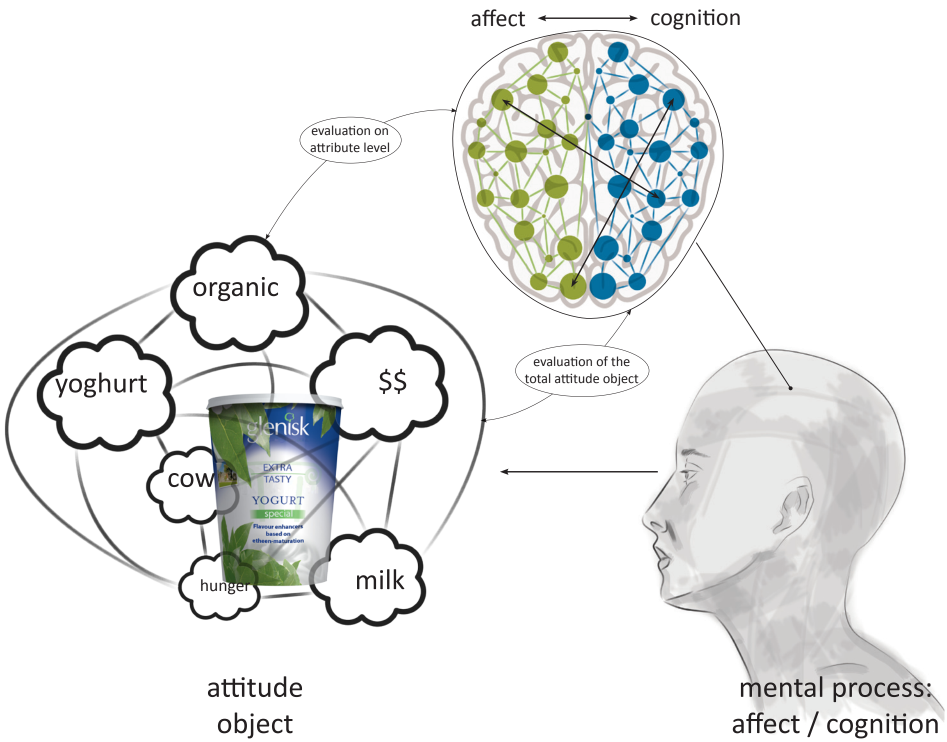


Figure 1.1 from perception to evaluation of an attitude object

Attitudes are multi-faceted with a complex layered structure consisting of multiple object-associated attributes, attribute-evaluations, and object-evaluation linkages (van Overwalle & Siebler, 2005). Object-associated attributes are specific characteristics of the attitude object that become salient when the attitude object is perceived. For example, encountering a yogurt, might activate attributes like: “organic”, “milk”, “cow” (see figure 1.1). These attributes can be evaluated individually (e.g. the attribute-evaluation: “I don’t like milk”), or all attribute-evaluations can be integrated into a single evaluation towards the attitude object (e.g. “I don’t like milk-based yogurt”). At the higher-order level, attitude objects are represented as a collection of integrated attribute-evaluations that are summarized into an overall attitude towards the object. At the lower-order level, attitude objects are represented as evaluations of attributes related to the attitude object (Ajzen, 2001). Depending on the familiarity with the attitude object the attitude structure can be extensive and well-developed, or it can have a superficial structure (fewer linkages and associations) when less is known about the attitude object. When the attitude object is familiar, attitudes can be retrieved from memory, whereas when the attitude object is unfamiliar the attitude needs to be created on the spot (Olson & Zanna, 1993; Wood, 1982).

Attitude evaluations can stem from a combination of affective reactions that the object evokes and cognitive beliefs that characterize the attitude object (Breckler & Wiggins, 1989; Fazio, 2007). Affect has been used to describe the positive and negative feelings that one holds towards an attitude object (Eagly & Chaiken, 2007). Cognition refers to the positive or negative beliefs one holds about the attitude object (Eagly & Chaiken, 2007). Eventually, evaluations are summarized as affective and cognitive attitude components of the overall attitude (Edwards, 1990; Giner-Sorolla, 2004). At the lower-order level the underlying attitude structure is composed of different affective object-association linkages and cognitive object-association linkages related to the attitude object (Breckler & Wiggins, 1989; Chang & Pham, 2013; Crites, Fabrigar, & Petty, 1994; Verplanken, Hofstee, & Janssen, 1998). In attitude expression, both individual attributes of the attitude object can be evaluated in a more cognitive or affective way, as well as the attitude object in its entirety.

In most situations no pure affect-based or cognition-based attitudes will be formed but the attitude will jointly be determined by affect and cognition (Edwards, 1990). However, depending on the context within which judgements are made, the focus in attitude expressions may shift either to a stronger focus on cognitive or on affective factors.

Underlying processes

Besides understanding what attitudes are and where they stem from, it is also necessary to understand the underlying processes leading to the attitude formation and expression, because different underlying processes might lead to different attitude outcomes. This is, for instance, dependent on the amount of accessible information that is taken into account to express the attitude (Hogarth, 2002). In terms of underlying processes, attitudes can be the outcome of a retrieval process or a more active integration process (Gawronski & Bodenhausen, 2006). Attitudes that are well-learned and easily retrieved from memory arise spontaneously. Such attitudes can be expressed without conscious effort and awareness, and they are based on accessible cognitive beliefs or affect. Attitudes can also be a result of a more elaborate and analytic process, which requires integration of several associations.

All dual-process models share the common distinction between the processing modes, but use different names for these processes and ascribe some specific characteristics to these processes (Evans, 2008). Within this thesis, a distinction is made between intuitive versus deliberative processes. Deliberative reasoning is described as a conscious, controlled, and analytic process. Intuition is described as the automatic, unconscious, and fast process. The intuitive process relies heavily on prior experience and requires less processing time, whereas the deliberate process consumes processing time (Smith & DeCoster, 2000). People usually rely on a combination of intuition and deliberative reasoning, each of which may have precedence in specific situations (Hogarth, 2002).

Intuitive processes hold a sense of 'knowing without knowing how one knows', based on unconscious information processing (Epstein, 2010; Evans, 2010). Intuitive processes help people to structure information from the environment and rapidly come to reasonable interpretations which can constitute an adequate basis for judgements and decisions (Glöckner & Betsch, 2008). It is generally accepted that intuition is acquired through learning (Chaiken, 1980). Intuition can thus be seen as a process that somehow produces a learned answer, solution, or idea without the use of a conscious, logically defensible step-by-step process (Slovic, Finucane, Peters, & MacGregor, 2002).

Deliberative processing allows people to think at high and complex levels of abstraction (Epstein, 2010). This process is based on experiential cues signalling that more deliberate processes are required to arrive at a more accurate evaluation (Alter, Oppenheimer, Epley, & Eyre, 2007). People will constitute a more deliberate process when the attitude object is personally relevant or when their judgements and decisions have important consequences to themselves or for others (Chaiken, 1980).

To summarize, the attitude process can be the result of a more intuitive or deliberative process, whereas the attitude itself can stem from more affective or cognitive evaluations. This results in a multidimensional view on attitudes (see figure 1.2), with one axis representing the affective-cognitive dimension and the other axis the depth of processing dimension. Combination of the intuitive-deliberative and affective-cognitive dimensions results in different strategies to arrive at attitudes. People can use relatively more cognitive or affective input strategies in evaluation, while their processing mode can be relatively more intuitive or deliberate, where the deliberate process requires more elaboration.

Affect ranges across a continuum from an immediate, intuitive process, and a deliberate process, arising in a relatively controlled manner as a result of higher order-processing (Giner-Sorolla, 2001; Shiv & Fedorikhin, 1999). Affective feelings are often seen as automatic and primary, and more rapidly activated than non-emotional associations (Hansen & Wänke, 2009; Zajonc, 1980). The affective system is fast and might be characterized as the default source underpinning attitudes (Zajonc & Markus, 1982). Affect can however occur in the forms of both primary

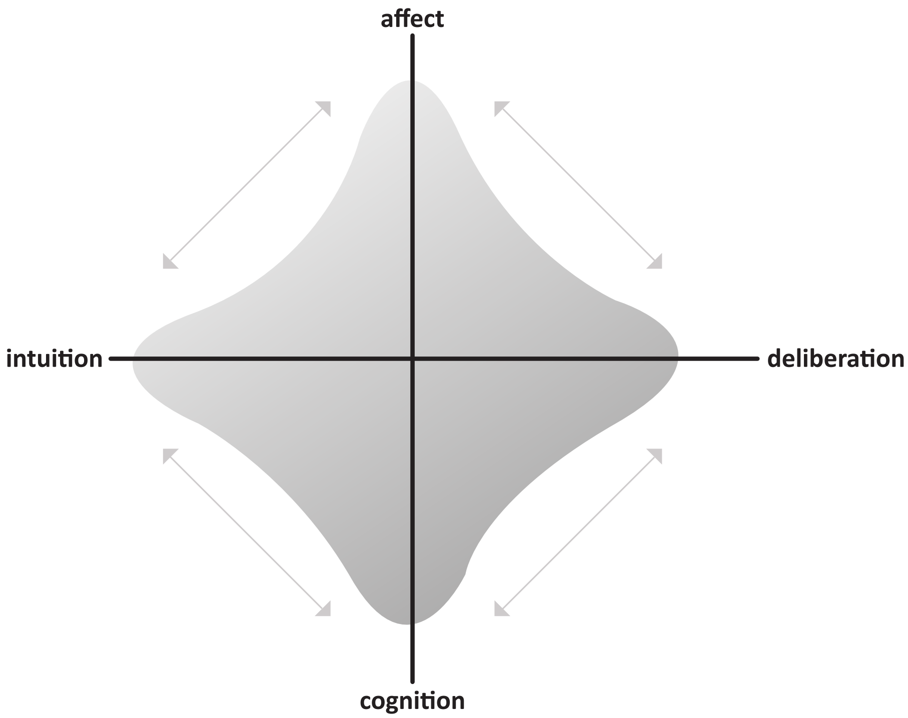


Figure. 1.2 Underlying processes in attitude formation

affect and more elaborated affect. Primary affect constitutes the “gut” feelings which comprise a valence component (positive / negative) that serves as information in the further decision process (affect as information). A more elaborate affect, in the form of emotions, is however broader and reflects conscious anticipated emotional associations with the object. This more developed form of affect reflects deliberation and insight, especially when it comes to evaluative judgements (Frijda, 1986).

Cognition can be placed on a similar continuum ranging from intuitive cognition to deliberate cognition (Hannond, Hamm, Grassia, & Pearson, 1987). On one end of the continuum are the cognitive heuristics, which often seem to be simplifications of analytic thought (Betsch & Glöckner, 2010). Cognitive heuristics reflect solutions which are not guaranteed to be optimal, but good enough for a given set of goals (Gigerenzer & Gaissmaier, 2011). On the other end of the continuum are cognitive thoughts based on an elaborate process, which rely heavily on in-depth researched and weighted information, and are related to elaborate thinking and memory processes (Gigerenzer, 2007).

Cognition and affect can thus both be relatively more intuitive or more elaborate. People are flexible in their thinking and can switch between the intuitive- deliberate processing modes depending on contextual factors (such as message framing) and motivational factors (such as motivation and personal relevance) (Petty, Wegener, & Fabrigar, 1997). In addition, people have strong individual preferences for certain ways of thinking. Some people have an urge to understand how things exactly work and like to think about this. The tendency to rely more on cognitive and analytic information indicates that those people have a high Need for Cognition (Cacioppo & Petty, 1982; Epstein, Pacini, DenesRaj, & Heier, 1996). Others trust their gut feelings most and tend to rely more on affective intuitive information, which indicates a high Faith in Intuition (Cacioppo & Petty, 1982; Epstein et al., 1996). In this thesis individual differences in thinking styles on attitude formation will also be taken into account.

Familiarity with the attitude object

The influence of affect and cognition on overall attitude and processing strategies also varies with the type of attitude object being evaluated and the familiarity with the attitude object. As an object-evaluation association, attitude represents a knowledge structure, which can be retrieved from memory when the attitude object is familiar or created at the time of judgement when the attitude object is unfamiliar. Attitudes are part of a larger set of knowledge structures which are organized into categories, represented by schemata in the brain (Eagly & Chaiken, 1995; Pavelchak, 1989). Schemata represent organized experiences with attitude objects, ranging from separate attributes to general attitude categories, and are built up in the course of interaction with the attitude object (Mandler, 1982). With repeated exposure to and experience with attitude objects, the strength of attribute-evaluation and object-evaluation linkages is affected. Evidence that is consistent with prior knowledge will strengthen the associations through a process of conditioning (de Houwer, Thomas, & Baeyens, 2001; Hofmann, de Houwer, Perugini, Baeyens, & Crombez, 2010).

Expressing attitudes is relatively straightforward when people are familiar with and have knowledge about the attitude object. People automatically recognize and categorize the attitude object as familiar, as it will only be meaningful to them if it evokes associations known to them. This also means that while expressing their attitudes towards familiar attitude objects, people can draw upon these established knowledge structures and schemata that are already build up over the course of time (Tourangeau, Rasinski, D'Andrade, 1991). For familiar attitude objects, the associated knowledge structures can easily be activated, and individuals can effortlessly infer self-relevant benefits, producing an overall positive or negative attitude (Ajzen, 2001). Having an established knowledge base also means that relevant affective and cognitive information and experiences are available, which allows the recollection of attitudes based on both cognitions and affect (Edwards, 1990; Plessner & Czenna, 2008). When a fit between the perceived attitude object and the existing knowledge structure is experienced, the stage is set for a fast and easy evaluation (Fiske, Neuberg, Beattie, & Milberg, 1987; Mandler, 1982). This type of fast evaluation can be along the intuitive-affective or intuitive-cognitive dimension (left part of figure 1.2). It should be kept in mind that although

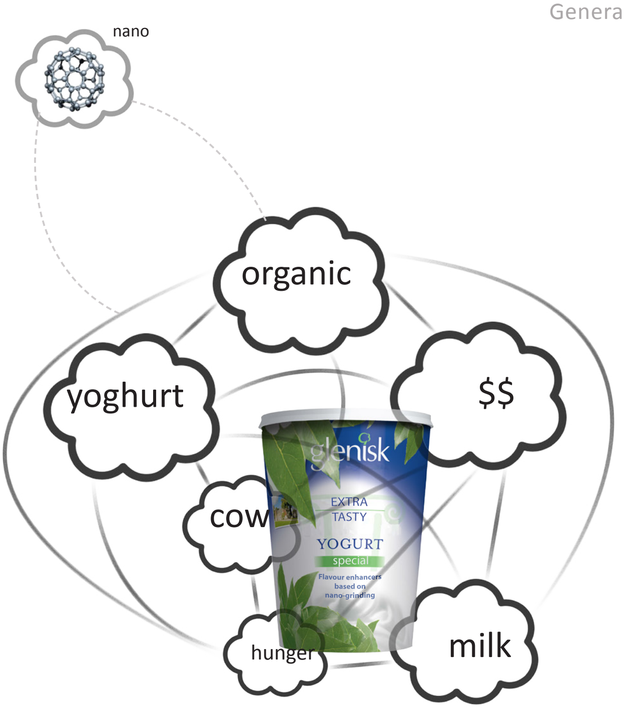


Figure 1.3. An unfamiliar nanotechnology attribute (buckyball) added to a familiar attitude object.

evaluation might be fast and easy and therefore more intuitive, people are also able to reconstruct inferences when required or forced to do so. People can thus shift to a more deliberative approach when asked to do so.

Attitude expression becomes more challenging when the attitude object is completely unfamiliar to people or when it contains attributes that are unfamiliar. This is for instance the case when asked to evaluate a new technology or a product containing an unfamiliar technology. For instance, when an unfamiliar nano-attribute (the buckyball[1]) is added to a yogurt, it is not part of the existing knowledge structure (figure 1.3). In this case the attitude object is not recognized as a prototypical category member as people do not expect nano-particles in their yogurt and might wonder: "Is this still a natural yogurt?" For individuals confronted with unfamiliar attitude objects or attributes their current knowledge structures will fall short. As a consequence, no directly relevant representations are available in memory as evaluation-linkages are not established yet, and no fully-fledged evaluation is stored in memory.

1 The discovery of the buckyball (a fullerene structure) gave rise to much of nanotechnology's foundation. The buckyball is often used to depict nanotechnology. This is why a buckyball is used to represent a nano attribute in the picture.

People might be motivated to evaluate the unfamiliar attitude object, but they often lack the ability to do so because of their incomplete information about the attitude object. Nevertheless, people are somehow able to express attitudes towards the unfamiliar attitude object, although this requires a more active integrative process as new connections between the unfamiliar attitude object and existing knowledge structures need to be created (Fazio, 2007; Fazio, Eiser, & Shook, 2004; Schwarz, 2007; Zajonc, 1980). When constructing an evaluation of an unfamiliar object, usually some resemblances can be drawn with existing attitude objects. Individuals may try to fit the unfamiliar attribute within the knowledge structure of a familiar attitude object to reach a better understanding of the unfamiliar attitude object (Peracchio & Tybout, 1996). In this case, a process of accommodation takes place by stretching the existing knowledge structure, which requires a more deliberate process (Mandler, 1982). The constructed evaluation is then based on resemblance to schema for which one already has attitudes represented in memory (e.g. Duckworth, Bargh, Garcia, & Chaiken, 2002; Fazio, Jackson, Dunton, & Williams, 1995). Eventually, over time, the newly developed object-attribute-evaluation chains can evolve to immediate object-evaluation linkages (van Overwalle & Siebler, 2005). Linkages are then further updated and incorporated in the schema (Smith & DeCoster, 2000), until a new schema is formed that represents the now no longer unfamiliar attitude object. When this new schema is established evaluation will be fast and easy.

Adjustment of existing schemata into new schemata can be based on feelings that are used as information inputs in the judgement (Clore & Huntsinger, 2007), or from mere exposure where repeated stimulus exposure leads to incorporation of the unfamiliar attributes in the knowledge structure and increased liking (Zajonc, 1980). People can easily access the broader range of feelings (Clore & Huntsinger, 2007; Clore & Schnall, 2005). Affective responses do not necessarily require conscious elaboration and can therefore be created more quickly (Bornstein, 1989; Hansen & Wänke, 2009; Zajonc, 1980). By serving as information regarding how one feels about the attitude object, a decision based on affect is often more informative than one based on cognition, as people can more easily access the broader range of feelings than the few available cognitive associations (Clore & Schnall, 2005). Information that fosters cognitive connections can, for instance, be derived from imagined experience with the attitude object or attribute, or from analogical reasoning (Cohen & Reed II, 2006).

In this thesis both affective and cognitive processes in attitude formation and expression, and underlying mental processing strategies are investigated and compared for familiar and unfamiliar attitude objects. By comparing attitude formation for familiar and unfamiliar attitude-objects this research contributes to understanding situations in which affect or cognition is the better predictor of overall attitudes. Moreover, by taking into account personality differences, and by changing the amount of available context information, it is investigated how the relative influence of affect and cognition changes between a more affect-driven process or a more cognitive-driven process. In addition, changes in the relative influence of affect and cognition over time are investigated when more context information becomes available to people. In this way a better understanding is reached of how attitudes towards unfamiliar attitude objects evolve.

By connecting the affective-cognitive and the intuitive-deliberative dimension, this thesis brings new insights about underlying attitude formation processes. By exposing people to attitude-objects with different strengths, differences in the elaborateness of affective and cognitive processing can be investigated. In this way it can be investigated whether the component which is decisive in the attitude formation process requires the least elaborate process, as this could explain why people prefer to rely more on one of the attitude components in attitude expression.

Measuring attitudes

Insight into attitudes is traditionally inferred from self-report measures reflecting positive or negative evaluations of the attitude object. Most often attitudes have been represented by a single numerical index, reflecting the position of an attitude object on an evaluative continuum (Fabrigar, MacDonald, & Wegener, 2005). Frequently, a distinction is made between overall attitudes and affective and cognitive attitudes (Crites et al., 1994). In this way also, differences in the relative importance of affect and cognition on overall attitudes can be identified (Pham, 2007).

Attitudes derived from associative networks in memory constitute a dynamic phenomenon where both object-evaluations and attribute-evaluation linkages can be constructed on the spot. These linkages can either be instrumental in attitude expression, or can be post-hoc rationalizations of how the attitude came about. A focus on attitude outcomes by means of a single numerical index cannot explain the underlying structures and processes. For a fuller understanding, it is therefore necessary, in addition to outcome-based research, to focus directly on the psychological processes underlying the attitudes and the extensiveness of these processes for different attitude objects. (Schulte-Mecklenbeck, Kuehberger, & Ranyard, 2011; Topolinski, 2011). Understanding when and why a task elicits a particular process to arrive at an evaluation will be facilitated by data that reflect the process and not just the outcomes of the process (Payne, 2010).

Previous research has usually focused on either the intuitive or deliberative process, typically by constraining the other process. For instance, putting respondents under time pressure or providing them with a distracting task, are research approaches applied to the study of intuitive processes as these make deliberate thinking difficult, given that our conscious attention can only focus at one thing at a time (Glöckner & Witteman, 2010b). People then can only switch to a more intuitive processing style. On the contrary, asking for justifications or increasing the incentives to arrive at an accurate answer may elicit more deliberative thinking (Shafir & LeBoeuf, 2002). In practice, however, these processes almost always work together and rely on the same principles (Kruglanski & Gigerenzer, 2011; Smith & DeCoster, 2000). By constraining one of the processes, boundary conditions are imposed on how the attitude process naturally evolves, so then only partial insight in underlying process can be derived.

When it comes to studying unfamiliar (hypothesized) attitude objects in particular, more insight is needed about how evaluations arise. When the attitude object under study is unfamiliar, it is also unclear which of the processes should be constrained. For instance, it can be assumed that for unfamiliar attitude objects affective information is more helpful than cognitive information in the judgement process as affect can reach a judgement with far less information (Clore & Schnall, 2005). At the same time, it is often assumed that affective processes equate to intuitive processes (Hansen & Wänke, 2009). This would imply that for unfamiliar attitude objects, affect is relatively more important, and the process would be an intuitive process. Intuition is however acquired through learning, which requires some form of internalized knowledge about the attitude object (Chaiken, 1980), which is not likely when it comes to unfamiliar attitude objects. Thus, to further investigate these underlying processes, it is important that both intuitive-deliberative and affective-cognitive processes can be simultaneously investigated. Therefore, there is a need to map better the underlying process without putting constraints, so that both attitude dimensions can simultaneously be addressed.

Eye-tracking is one of the promising tools which provide insights into underlying psychological processes, in conjunction with outcome measures and, without constraining any of the involved processes (Glöckner & Witteman, 2010b). An eye-tracker is a device for measuring eye positions and eye movements (eye-gazes). Eye-gaze is an unobtrusive measure, allowing for more information about the processes that are at work while making (affective and cognitive) judgements and decisions, and without interfering in the research context. From fixation durations and the total number of fixations that respondents make prior to their attitude judgement, the extensiveness of processing prior to making a judgement or decision can be derived. Fixation duration and number of fixations increase with increasing levels of processing and should go along with longer fixations (Horstmann, Ahlgrimm, & Glöckner, 2009).

In the current thesis, both outcome measures and process measures will be used to understand more about the affective-cognitive and the intuitive-deliberative dimension. Outcome measures will be used to understand, whether compared with familiar attitude objects, attitudes towards unfamiliar attitude objects are based more in affect or cognition. In addition, by means of a novel eye-tracking approach the underlying intuitive and deliberative processes in conjunction with affect and cognition will be studied.

Nanotechnology applications

In this thesis the attitude formation process towards nanotechnology applications is studied whilst comparing this with similar conventional technology applications. Nanotechnology is an existing yet little known novel technology. It provides a good example of unfamiliar attitude objects, because at the beginning of this project, people had limited knowledge about nanotechnology and its applications

(Stijnen et al., 2011). Nanotechnology concerns the manipulation of materials at the smallest possible physical levels (i.e. molecular or atomic levels). It enables the creation of completely new products, as well as the substantial improvement of properties of existing products (Borisenko & Ossicini, 2012). In this way, a new generation of technological applications is formed, opening up new possibilities in a wide range of fields, varying from health care and food to environment and agriculture (RIVM, 2012). By focussing on nanotechnology-facilitated improvement of existing products, nanotechnology does not only provide a good research context to investigate realistic unfamiliar attitude objects but also allows for comparison between similar unfamiliar and familiar attitude objects as many nanotechnology applications have conventional counterparts. Nanotechnology also allows selection from a broad range of applications, which may be associated with different potential advantages and disadvantages, helping to show robustness of results.

With a variety of potential applications, nanotechnology is a key technology for the future and governments have invested billions of dollars in its research. Nanotechnology raises concerns about the toxicity and environmental impact of nanomaterials (Borm et al., 2006; O'Brien & Cummins, 2008). Nanotechnology also leads to speculations about various doomsday scenarios, such as the grey goo (where a large mass of self-replicating nanomachines covers the earth, for instance in the novel 'Prey', by Michael Crichton (2002)). In some cases, negative public opinion caused by such concerns has led to failure or at least considerable cost and delay to the introduction of a technology. Previous technologies, such as genetic modification, biotechnology and nuclear energy have met with considerable resistance from the public, leading to categorical rejection of these technologies (Currall, King, Lane, Madera, & Turner, 2006; Einsiedel & Goldenberg, 2004). Nanotechnology may face similar issues (Frewer, Fischer, & van Trijp, 2011; Gupta, Fischer, & Frewer, 2012). Prior to developing strategies for gaining acceptance of new technologies, it is therefore essential to understand attitudes towards the new technology, how such attitudes are established, and how such attitudes develop over the time while technology matures. Thus, the ideas developed in this thesis are both relevant to understanding public response to nanotechnology and can be validated for broader applications using nanotechnology as a case study.

Overview of the studies

The central research question in this thesis is:

How do people form attitudes towards unfamiliar attitude objects?

As people have limited knowledge available in evaluating unfamiliar attitude objects such as nanotechnologies, a better understanding of the factors and processes leading to attitude evaluation is necessary. In order to achieve this, both outcome measures and process measures will be used to capture both the affective-cognitive and the intuitive-deliberative dimension.

The affective-cognitive dimension is studied by means of survey data to answer the specific research question:

RQ1: How does attitude formation towards familiar and unfamiliar attitude objects differ in terms of the relative influence of affect and cognition on overall attitudes?

Chapter 2 provides insight into this research question based on the results of a survey study with a cross-section of Dutch consumers. Consumers judged different applications of nanotechnology and conventional technology. From these evaluations it is investigated whether compared with familiar attitude objects, for unfamiliar attitude objects (e.g. nanotechnologies) people rely more on affect than cognition. Individual differences are taken into account to investigate whether differences in thinking style are also applicable to situations in which unfamiliar attitude objects are being evaluated.

By taking into account the affective-cognitive and intuitive-deliberative dimensions, the underlying process mechanisms in attitude formation were explored. This part of the thesis answers the specific research question:

RQ2: In terms of elaborateness of processing of affective and cognitive attitudes, to what extent are underlying processes different for attitude objects with varying strength of object-evaluations?

Chapter 3 starts answering this research question by taking a process-approach to the exploration of underlying affective and cognitive processes in attitude expression, while at the same time studying how much elaboration was necessary to arrive at the attitude judgement. A novel eye-tracking procedure was developed which allows monitoring of attitude formation processes during attitude response formation, thereby circumventing limitations to which self-reported outcome measures are prone. In chapter 3, familiar attitude objects differing in strength of object-evaluations (i.e. univalent, neutral, ambivalent) were evaluated on affective and cognitive scales while at the same time the eye-tracker recorded the extensiveness of this process.

Chapter 4 combines insights from chapter 2 and chapter 3. Chapter 4 extends chapter 2 by varying the amount of available context information to investigate how the attitude formation process changes when people have more or less context information available, as it might be easier to integrate an unfamiliar attribute into existing knowledge structures when more cues are available. Chapter 4 also adopts the methods from chapter 3 by investigating the underlying processes for attitude objects with weak object-evaluations, in this case nanotechnology compared with conventional technology.

Chapter 2-4 compared unfamiliar with familiar attitude objects, but this does not say anything about changes over time for the unfamiliar attitude objects. When people become more familiar with an unfamiliar attitude object over time, they are more and more able to integrate unfamiliar attitude objects and associated attributes in their existing knowledge structures. This means that the influence of affect on overall attitude might change over time as cognitive inferences are more and more available. This part of the thesis follows on the first research question and studies changes in the affective-cognitive dimension over time, by means of self-reported data:

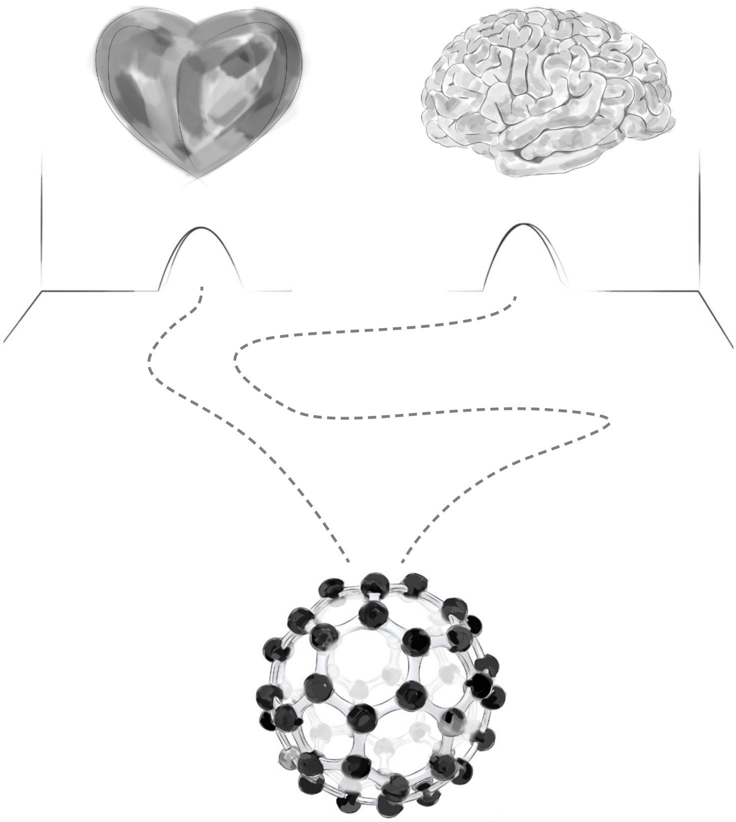
RQ3: How do affect and cognition in attitude formation towards unfamiliar attitude objects evolve over time as a function of growing familiarity with the attitude object and knowledge growth of consumers?

Chapter 5 reports on a longitudinal survey study in which consumers judged at three different time points (with 10-11 months in between) the same applications of nanotechnology and conventional technology as in chapter 2. From these evaluations it is investigated whether there are changes over time in reliance on affect or cognition.

Chapter 6 concludes the thesis and reflects on the question of how people form attitudes towards unfamiliar attitude objects. Chapter 6 also provides theoretical implications on process tracing research, and practical implications on communication about new technologies, and nanotechnology in particular. It is concluded that although the default is to rely on affect, in attitude formation toward unfamiliar attitude objects, people are able to draw on cognitive inferences provided that there are enough cues available (e.g. product context, high need for cognition, or being more often exposed). Whether people rely on affect or cognition also depends on which process is the easiest. The attitude component which is decisive in the attitude formation process requires the least elaborate process. This thesis contributes in a better process understanding as both affective-cognitive and deliberative-intuitive dimensions were simultaneously studied. Finally, it is concluded that attitudes toward unfamiliar attitude objects are still subject to change. This has implications for communication about new technologies, as it is important to address both affective and cognitive aspects.

Chapter 2

Affect and cognition in attitude formation towards familiar and unfamiliar attitude objects



This chapter is based on: Giesen, R.I. van, Fischer, A.R.H., Dijk, H. van, & Trijp, J.C.M. van. Affect and cognition in attitude formation towards familiar and unfamiliar attitude objects. Manuscript under review

Abstract

Attitudes are built on earlier experiences with the attitude object. If earlier experiences are not available, as is the case for unfamiliar attitude objects such as new technologies, no stored evaluations exist. Yet, people are still somehow able to construct attitudes on the spot. Depending on the familiarity of the attitude object, attitudes may find their basis more in affect or cognition. In the current chapter differences in reliance on affect or cognition in attitude formation towards familiar and unfamiliar realistic attitude objects are investigated. In addition, individual differences in reliance on affect (high faith in intuition) or cognition (high need for cognition) are taken into account. In an experimental survey among Dutch consumers (N = 1870), it is shown that, for unfamiliar realistic attitude objects, people rely more on affect than cognition. For familiar attitude objects where both affective and cognitive evaluations are available, high need for cognition leads to more reliance on cognition, and high faith in intuition leads to more reliance on affect, reflecting the influence of individually preferred thinking style. For people with high need for cognition, cognition has a higher influence on overall attitude for both familiar and unfamiliar realistic attitude objects. On the other hand, affect is important for people with high faith in intuition for both familiar and unfamiliar attitude objects and for people with low faith in intuition for unfamiliar attitude objects; this shows that preferred thinking style is less influential for unfamiliar objects. By comparing attitude formation for familiar and unfamiliar realistic attitude objects, this research contributes to understanding situations in which affect or cognition is the better predictor of overall attitudes.

Affect and cognition in attitude formation towards familiar and unfamiliar attitude objects

Attitudes are built on earlier experience and help people to make sense of their environment (Fazio, 2007). As such, attitudes play a central role in life, and make up a large part of our daily thoughts, emotions, and behavioural processes (Eagly & Chaiken, 2007). If earlier experiences are not available, as is the case for unfamiliar attitude objects, people still construct attitudes on the spot in order to respond to unfamiliar situations or attitude objects (Schwarz, 2007). While attitudes are formed for both familiar and unfamiliar objects, the way in which these attitudes are formed can be different. In the current chapter differences between attitude formation towards familiar and unfamiliar realistic attitude objects are investigated.

Individuals confronted with familiar attitude objects, have stored evaluations in memory. If we consider attitudes as summary object-evaluation linkages and/or object-attribute-evaluation linkages (van Overwalle & Siebler, 2005) that find their basis in cognitive and affective associations in memory (Ajzen, 2001; Chaiken, Duckworth, & Darke, 1999; Fazio, 2007), there are extensive object-evaluation linkages available for familiar objects. After individuals have been repeatedly exposed to attitude objects additional exposures have reinforced such associations through a process of conditioning, especially if accumulating evidence has been consistent with prior knowledge (de Houwer et al., 2001; Hofmann et al., 2010). This results in a stable, crystallised attitude (Schwarz, 2007) that can draw upon learned cognitions such as facts and statements (Edwards, 1990) but also in learned emotional responses such as somatic markers that are associated with past outcomes (Damasio, Everitt, & Bishop, 1996) and learned regulation of emotion (Gross, 2002). Having an established knowledge base, consisting of relevant affective and cognitive information and experience, allows the formation of attitudes based on both cognition and affect (Edwards, 1990; Plessner & Czenna, 2008).

Individuals confronted with unfamiliar attitude objects, however, do not have a fully-fledged evaluation of that object stored in memory. People are, nevertheless, somehow able to construct attitudes towards unfamiliar attitudes on the spot, based on whatever relevant associations are available in the current context (Fazio, 2007; Fazio et al., 2004; Schwarz, 2007; Zajonc, 1980). This raises the question what object-attribute linkages will become available while constructing attitudes towards unfamiliar attitude objects. It is consistently found that, after repeated exposure to a stimulus, people will begin to react more positively to a once-novel attitude object, even without conscious evaluation (Bornstein, 1989; Hansen & Wänke, 2009; Zajonc, 1980). This provides evidence that affective responses happen more quickly and possibly do not even require cognitive evaluations of attitude objects. In this way, affective object-attribute linkages towards unfamiliar attitude objects can rapidly emerge.

In realistic contexts, new attitude objects will rarely exist in complete isolation from anything encountered before, since attitude objects generally do not exist independently of social processes and other contextual factors (Stern, Kalof, Dietz, & Guagnano, 1995). Hence, in a realistic context, people will have been exposed (unconsciously or otherwise) to some features around the unfamiliar attitude object and can infer meaning from existing knowledge about related familiar attitude objects (Loken, 2006). Therefore, some object-attribute linkages for unfamiliar attitude-objects will become activated, even if no cognitive elaboration on the new object has ever taken place. In such cases, where no cognitive inferences have yet been developed, affective responses can already be mobilised (Bechara & Damasio, 2005; Zajonc, 1980). This could explain why affect consistently contributes to attitude formation of unfamiliar realistic attitude objects such as, for example, carbon dioxide storage, genetic modification of food products and nanotechnology (e.g. Midden & Huijts, 2009; Scheufele & Lewenstein, 2005). Supporting this line of reasoning is previous research which has shown that attitudes in cases characterized by a lack of concrete factual information are often based on affect (Lee, Scheufele, & Lewenstein, 2005; Slovic, Finucane, Peters, & MacGregor, 2004), which, compared with cognitive weighing of pros and cons, requires less formal information in decision making (Slovic et al., 2002). By serving as information regarding how one feels about the attitude object, these affective associations are able to influence judgements even in the absense of crystallised cognitive or affective object-attribute-evaluation linkages. In the absensce of clear object-evaluation linkages, a decision based on affect is often more informative than one based on cognition, as people can more easily access the broader range of affective feelings than the few available cognitive associations (Clore & Huntsinger, 2007; Clore & Schnall, 2005). Hence, in situations of limited knowledge, it is more likely that people will access affective assocations

towards an unfamiliar object than construct cognitive object linkages.
In this way, depending on familiarity, attitudes may find their basis in more or less elaborate affective object-linkages (feelings and emotions) and/or cognitive object-linkages (beliefs and thoughts) (Breckler & Wiggins, 1989; Verplanken et al., 1998), which represent the affective and cognitive attitude components of the overall attitude (Edwards, 1990; Giner-Sorolla, 2004).

Therefore the first hypothesis is:

- H1: Affect will have a relatively stronger association with overall attitude for unfamiliar than for familiar attitude objects, whereas cognition will have a relatively weaker association with overall attitude for unfamiliar than for familiar attitude objects.

Although, in the process of attitude formation, people in principle have access to a rich network of cognitive and affective attribute-evaluations, in most daily decisions they are unlikely to access all of that information. If the object is familiar, that is in cases where both cognitive and affective object-evaluation linkages are available, individuals are at liberty to use any combination of affective object-evaluation linkages or cognitive object-evaluation linkages, that leads to a clear evaluation. Differences in individual preferences for affect or cognition will play an important role in determining to what extent people rely more on affect or cognition in attitude formation in this type of situation. People with a high need for cognition rely on the cognitive system, making cognitive beliefs important in forming judgements (Cacioppo & Petty, 1982; Epstein, 2010; Epstein et al., 1996). People with a high faith in intuition om the other hand rely on the intuitive system and show a strong reliance on feelings in their judgements (Epstein, 2010; Epstein et al., 1996; Keller & Bless, 2009). People with a clear preferred thinking style (high need for cognition and low faith in intuition or vice versa) will rely on either cognition or on affect, depending on their preference.

If the object is unfamiliar, cognitive object-evaluation linkages are hardly available, while affective-evaluation linkages remain to a larger extent available. For unfamiliar attitude objects, individuals are restricted in relying on cognitive evaluations and therefore can only fall back on more intuitive and affective processes. Thus, even when individuals have a high need for cognition, an analytical approach to information processing might fall short for unfamiliar objects (Pretz & Totz, 2007). It is therefore expected that, for unfamiliar attitude objects, a preference for a cognitive thinking style will not relevantly shift the process to a more cognition-driven process. As affect is less dependent on information, affect will have a similarly high influence on the overall attitude for both familiar and unfamiliar attitude objects, for people having a high faith in intuition. A high influence of affect on overall attitude is expected even in the case of low faith in intuition for unfamiliar attitude objects.

Hence, it is hypothesized that:

- H2a: For familiar attitude objects cognition will have a relatively stronger association with overall attitude for individuals with high need for cognition, compared with low need for cognition.
- H2b: For unfamiliar attitude objects, cognition will *not* have a relatively stronger association with overall attitude for individuals with high need for cognition, compared with low need for cognition.
- H3a: For familiar attitude objects affect will have a relatively stronger association with overall attitude for individuals with high faith in intuition, compared with low faith in intuition.
- H3b: For unfamiliar attitude objects affect will have a relatively stronger association with overall attitude for individuals with *both* high and low faith in intuition.

Study

The hypotheses were tested in an experimental survey in the Netherlands in the context of technological applications. Nanotechnology, an existing yet little known novel technology, was used to study a range of unfamiliar attitude objects. The range of unfamiliar nanotechnology attitude objects was compared with a similar range of familiar variants. Nanotechnology provides a good research context to operationalise unfamiliar realistic attitude objects as, at the time of the study, people had limited knowledge about nanotechnology and its applications (Stijnen et al., 2011). Nanotechnology is involved with the manipulation of materials at the smallest possible physical levels (i.e. molecular or atomic levels). It enables the creation of completely new products, as well as the substantial improvement of properties of existing products (Borisenko & Ossicini, 2012). By focusing on nanotechnology-facilitated improvement of existing products, nanotechnology not only provides a good research context to operationalise realistic unfamiliar attitude objects but also allows for comparison between similar unfamiliar and familiar attitude objects. Nanotechnology also allows to select from a broad range of applications, which may be associated with different potential advantages and disadvantages, helping to show robustness of results.

Method

Respondents

Data were collected by a commercial market research agency (GfK; see www.gfk.com), as the first wave in a longitudinal study. Respondents were drawn from an existing panel for which respondents voluntarily registered. The research complies with the Netherlands Code of Conduct for Scientific Practice and the Social Sciences Ethics Committee of Wageningen University waived the need for ethical consent. There were no misleading questions in the survey, and the questions did not cause discomfort to respondents. GfK anonymized and de-identified all data prior to author access, so there was no access to any identifying information about the participants.

As the socio-demographic information of panel members is known, the panel allows for stratified random sampling of a nationally representative sample on gender, age, and education level of the Netherlands. The panel consists of approximately 12,000 respondents, who are repeatedly invited to participate in studies. The panel is maintained through a range of sampling techniques, taking care that the panel remains representative for the population. Agreement to join the panel is between 10% and 35% among those invited; about 20% of panel members are replaced each year. Data were collected in the Netherlands between 16 October and 6 November 2012. The research agency approached a gross sample of 2500 respondents from their panel, of whom 1907 participated (response rate of 76%). Of these 51% were male, 28% have a low education level (primary school, vocational education), 45% have an intermediate (secondary vocational education), and 27% have a high education level (university of applied sciences, or university). The mean age of respondents was 43 years (*SD* = 13.2 years, age range 18-65 years).

Inspection of responses on all variables showed highly unlikely response patterns for 37 respondents, who had zero variance on all variables. These 37 respondents were removed prior to analyses (valid $N = 1870$). After removing these respondents, no further univariate and multivariate outliers were detected.

Design

Respondents judged a total of four applications. Each respondent was asked to rate both familiar (non-nanotechnology) applications and the related unfamiliar (nanotechnology) applications. In addition, each respondent was asked to judge applications from two out of four application domains (either water and energy, or medicine and food). Within each application domain, two different applications were specified. Each respondent judged in total four of the sixteen available applications, as an incomplete repeated measures factor across four domains. The combinations of stimuli as presented to groups of respondents can be found in table 2.1.

Stimuli

Technological applications

Stimuli were 16 vignettes of technological applications. These consisted of a set of eight familiar and eight unfamiliar (nano) applications with the same purpose, to operationalise different levels of familiarity. For example, a conventional solar panel was included as a familiar attitude object and a nano-based solar panel was included as an unfamiliar attitude object. Four application domains were included that cover the key areas of nanotechnology research and development: food, water, medicine, and energy (NWO. EC/TKI, 2012). For each domain, two different applications were selected – food additives and food supplements, water purification and water quality monitoring, medical home tests and drugs, solar energy and batteries – to provide replications, allowing to control for specific application and domain associations.

Respondents received a short description of an application, consisting of some information about the technology behind the application, examples in which the application can be used, and some advantages and disadvantages of the application.

Table 2.1
Design of the study

		Application		Application		Application		Application	
Group	N	Nano	Conventional	Nano	Conventional	Nano	Conventional	Nano	Conventional
1	449	Water purification nano-membrane	Water purification sand filtration	Nano-solarcel	Solarcel				
2	471	Water monitoring nano sensor	Water monitoring	Nano battery	Battery				
3	495					Lab-on-a-chip	Medical home test	Nano food additives	Food additives
4	492					Nano medicine	Medicine	Nano supplements	Supplements

Note. This is the first study in a longitudinal series (see Chapter 5).

2

The order of the information on advantages and disadvantages was randomised. Descriptions were checked by an expert on nanotechnology for realism of content. Scenarios of pairs of applications (familiar versus unfamiliar) were matched as much as possible in content and length. An example of a scenario is provided in appendix 2.1 (translated from Dutch).

Four sequential pilot studies were conducted to improve the materials iteratively. The first three pilot studies were conducted with students from Wageningen University, and the final pilot study was conducted on a more diversified sample. Scenarios were adapted until comprehensibility, credibility, and emotional neutrality, as well as the purpose, advantage, and disadvantage of the familiar and unfamiliar applications, were comparable; at the same time, the nano-applications remained less familiar compared with corresponding alternatives (see Appendix 2.2 for details).

Measures

Data were collected as part of a larger study. Respondents were asked whether they had heard of nanotechnology ('yes/no') and whether they knew what nanotechnology means ('yes/no'). To assess whether familiarity with the selected applications differed between the nano and the conventional applications, respondents were asked to indicate for each application whether they had heard of the application.

Affective attitude

The affective attitude component was measured with an affective judgement scale, consisting of four items measuring positive emotions (joy, desire, fascination, satisfaction) and four items measuring negative emotions (fear, boredom, sadness, and disgust) (see Desmet, 2003; Russell, 1980). Respondents were asked to indicate to what degree they experienced each of the emotions when reading about the application, on a seven-point Likert scale (1 = 'not at all', 7 = 'very much').

Cognitive attitude

The cognitive attitude component was measured with a cognitive judgement scale, consisting of four items measuring positive cognition (useful, functional, beneficial, nice) and four items measuring negative cognition (useless, harmful, disadvantageous, unusable) (based on Crites et al., 1994). Respondents were asked to indicate to what degree they think each of the cognitions applied when reading about the application on a seven-point Likert scale (ranging from 'not at all' to 'very much').

Scale dimensions

In order to verify that the cognitive and affective items tapped into different attitude components, a hierarchical confirmatory factor analysis (CFA) was conducted with maximum likelihood in SPSS AMOS. Goodness of fit index (GFI) and comparative fit index (CFI) values above .90 and root mean square error of estimation (RMSEA) below .10 were adopted as indication of good fit. χ^2 is reported as customary, but not indicative of model fit with large samples (Kline, 2005). Affective and cognitive items were loaded on cognitive positive, cognitive negative, affective positive, and affective negative factors. After removal of the 'boredom' (affective negative) and 'nice' (cognitive positive) items, which did not load onto their respective factor, and allowing error-term correlation within subscales (between affective positive: 'joy' and 'desire'; cognitive negative: 'unusable' and 'useless'; and 'harmful' and 'disadvantageous'), the hierarchical CFA resulted in an acceptable fit confirming that affective and cognitive items tapped distinct underlying constructs: χ^2 (69) = 4510.66, p < . 001; GFI = .92; CFI = .93; and RMSEA= .093 [.090 to .095]. Remaining items were then recoded where needed and averaged to form reliable affective (Cronbach's alpha = .78; M = 4.83, SD = 1.07) and cognitive (Cronbach's alpha = .86; M = 4.45, SD = 1.01) attitude scales.

Overall attitude[1]

Overall attitude was measured with one item: 'What is your overall opinion towards the application?', measured on a seven-point scale (1 = 'very negative' and 7 = 'very positive').

1 In this chapter a single item construct was used to measure overall attitude. A single item construct can be considered a relevant alternative for multi-item constructs in many cases (Bergkvist & Rossiter, 2007; Rossiter, 2002). In chapter 5 a multiple-item construct is used, showing similar results as when only the single-item construct is used.

Need for cognition and faith in intuition

Respondents' need for cognition and faith in intuition were measured using a Dutch translation of the short version of the Cognitive-Experiential Inventory (for the REI see Epstein et al., 1996). After recoding negative items, internal scale reliability of the need for cognition scale and faith in intuition scale were high (Cronbach's alpha = .77 and .88, respectively). There is a negligible correlation between need for cognition and faith in intuition, r (1873) = .046, $p < .001$, and a moderate correlation between education level and need for cognition, r (1873) = .328, $p < .001$.

Procedure

Respondents started the online-survey in their own home at their own time and were presented with an introduction to the study. Next, all respondents answered two questions about their knowledge about nanotechnology in general, before reading a general description of nanotechnology in order to create a basic understanding about nanotechnology. Respondents were then randomly assigned to one of four conditions (see table 2.1). After reading the general description respondents were asked to carefully read an information scenario of one of the four applications. After they read the information, respondents' affective attitude, cognitive attitude, overall attitude, and familiarity with the application were measured. This process was repeated for all four applications in randomised order. At the end of the survey, respondents were asked to complete the REI questionnaire and to provide some other background variables. Respondents were thanked for their participation and debriefed. In the debriefing, the respondents were told that the majority of nanotechnology applications used for the survey are still under development and therefore non-existent at this time. Following their participation, the respondents received credits from the research agency that could be accumulated towards a gift voucher. On average, it took about 22 minutes to complete the questionnaire.

Data analysis

To assess the impact of *affect* and *cognition*, *familiarity* of the technology/application, and *need for cognition* and *faith in intuition* on *overall attitude*, attitude scores were subjected to a repeated-measures mixed linear model using SPSS 19. Mixed linear models can deal with incomplete repeated measures (respondents rated four out of sixteen applications). *Application* was entered as a repeated variable in the model. A simple-structure variance–covariance matrix was set. Familiarity was operationalised as comparison between nano applications (unfamiliar) and conventional applications (familiar). Familiarity with the technology was effect coded (familiar = –1; unfamiliar = 1). In addition to the variables of interest, the eight application types were included in the model as effect-coded covariates to control for associations with the specific application. Scores on the continuous independent variables (affective and cognitive attitude, need for cognition and faith in intuition) were grand mean centred to control for collinearity between main effects and interaction effects (Snijders & Bosker, 1999).

A model was estimated with all main effects, and the two- and three-way interactions of interest. Unstandardized betas are reported in the results. To interpret three-way interaction effects, simple slope analysis was used[2] (see Aiken, West, & Reno, 1991).

Results

While 71.9% of respondents recalled having heard of the term nanotechnology only 39% of respondents reported knowing its meaning. Thus, in general knowledge about nanotechnology is low. In addition, the proportion of respondents indicating knowledge about the selected nanotechnology applications was lower (27%) than the proportion of respondents indicating knowledge about their conventional counterpart (55%), χ^2 (7) = 93.71, p < . 05, Cramer's V = .12. This confirmed the successful operationalization of familiarity by presenting respondents with conventional versus nano-based applications.

Model tests

Affect, cognition, familiarity

The results show that affect and cognition both have a positive main effect on the overall attitude, F_{affect} (1, 7473) = 1594.73, p < .001; $F_{cognition}$ (1, 7473) = 1359.27, p < .001 (see table 2.2 for details). The regression coefficient of affect is .59 and of cognition .52. Familiarity has a positive main effect on overall attitude,

2 Simple slope analyses are used to illustrate the interaction effect, with one standard deviation below the mean, and above the mean of the predictor. Effect size measures for mixed linear models were not readily available at the time of writing.

Table 2.2
Results General Linear Mixed Model Analysis

	Variable	*t*	*b*	*p*	*CI95 lower*	*CI95 upper*
H1	Affect	39.93	.585	<.001***	.557	.614
	Cognition	36.87	.518	<.001***	.490	.545
	Familiarity (familiar = -1; unfamiliar =1)	-3.11	-.035	.002**	-.057	-.013
	Familiarity*affect	3.08	.045	.002**	.016	.073
	Familiarity*cognition	-2.65	-.037	.008**	-.064	-.010
H2	Need for cognition (nCog)	-4.42	-.048	<.001***	-.068	-.027
	nCog*affect	-1.01	-.015	.31	-.043	.014
	nCog*cognition	4.70	.065	<.001***	.038	.093
	nCog*familiarity	0.75	.008	.46	-.013	.029
	nCog* familiarity*affect	1.25	.018	.21	-.010	.047
	nCog*familiarity*cognition	-1.51	-.021	.13	-.048	.006
H3	Faith in intuition (FI)	4.09	.034	<.001***	.018	.051
	FI*affect	2.37	.026	.02*	.005	.048
	FI*cognition	-3.25	-.035	.001**	-.056	-.014
	FI*familiarity	0.43	.004	.67	-.013	.020
	FI*familiarity*affect	-2.15	-.024	.03*	-.046	-.002
	FI* familiarity*cognition	2.51	.027	.01*	.006	.048

Note. * <.05; ** <.01; *** <.001. Application type was controlled for and entered as covariate, F (7, 7466) = 21.27, p < .001. nCog is the abbreviation of need for cognition; FI for faith in intuition.

F (1, 7473) = 9.65, *p* = .002. The interaction between familiarity and affect has an effect on the overall attitude, *F* (1, 7473) = 9.47, *p* = .002, in such a way that affect has a higher association with overall attitude towards unfamiliar technologies than familiar technologies. The interaction between familiarity and cognition has an effect on overall attitude, *F* (1, 7473) = 7.02, *p* = .008, showing that cognition has a higher association with overall attitude towards familiar technologies than unfamiliar technologies. Thus, as predicted in hypothesis 1, there is a relatively stronger association between affect and overall attitude for unfamiliar attitude objects and a relatively stronger association between cognition and overall attitude for familiar attitude objects.

Need for cognition

Need for cognition had a negative main effect on overall attitude, *F* (1, 7473) = 19.56, *p* < .001. In addition, the significant two-way interaction between need for cognition and cognition shows that higher need for cognition has stronger associations with cognition on overall attitudes, *F* (1, 7473) = 22.11, *p* = .006. The non-significant three-way interaction of need for cognition, cognition, and familiarity shows that this effect is similar for familiar and unfamiliar attitude objects (see table 2.2). These results confirm that there are stronger associations between cognition and overall attitude for high need for cognition for familiar attitude objects, which is in line with H2a. However, this is also the case for unfamiliar attitude objects, and not only for familiar objects, which does not confirm H2b. The same pattern is also reflected in the simple slope analyses, which show that cognition has a stronger association with the overall attitude for high need for cognition compared with low need for cognition, for familiar and unfamiliar attitude objects (see table 2.3).

The influence of need for cognition on affect was investigated and showed no significant interaction between need for cognition and affect. In addition, there is no significant three-way interaction between familiarity, need for cognition and affect. Thus, as expected, need for cognition does not influence the role of affect in overall attitude.

Table 2.3
Regression coefficients for nCog and FI[1] (H2; H3) for familiar and unfamiliar applications

Variable	Familiar[2]		Unfamiliar[3]	
	Affect	Cognition	Affect	Cognition
High nCog[1]	.51	.63	.62	.52
Low nCog	.57	.47	.62	.43
High FI	.60	.48	.63	.46
Low FI	.48	.62	.62	.48

Note. [1] nCog is the abbreviation of need for cognition; FI for faith in intuition. [2]Baseline for familiar: regression coefficient affect = .54; regression coefficient cognition = .55; [3] Baseline for unfamiliar: regression coefficient affect = .63; regression coefficient cognition = .47. High and low relate to simple slope analyses centring that variable at one SD above the mean and one SD below the mean, for significance levels see table 2.2.

Faith in intuition

Faith in intuition has a positive effect on overall attitude, F (1, 7473) = 16.75, p < .001. In addition, the interaction between faith in intuition and affect shows that higher faith in intuition creates stronger associations between affect and overall attitude, F (1, 7473) = 5.62, p = .018. More importantly, the interaction between familiarity, faith in intuition, and affect on overall attitude is significant, F (1, 7473) = 4.64, p = .031. Simple slope analyses show that affect has a stronger association with the overall attitude with high faith in intuition compared with low faith in intuition for familiar attitude objects, which is in line with H3a. In addition, it is shown that high and low faith in intuition do not influence the importance of affect for unfamiliar attitude objects, which is in line with H3b (see table 2.3).

The influence of faith in intuition on cognition shows a significant interaction between faith in intuition and cognition, F (1, 7473) = 10.57, p < .001. In addition, there was a significant three-way interaction between familiarity, faith in intuition and cognition on overall attitude, F (1, 7473) = 6.30, p = .012. Simple slope analyses show that cognition has a stronger association on the overall attitude for people with low faith in intuition compared with high faith in intuition for familiar attitude objects (see table 2.3). Faith in intuition does not alter the influence of cognition for unfamiliar attitude objects. Thus, for familiar attitude objects only, for people with high faith in intuition affect has a stronger association with the overall attitude and at the same time the association of cognition with the overall attitude is reduced.

General discussion

This study showed that attitude formation processes for realistic unfamiliar attitude objects rely more on affect than is the case for realistic familiar attitude objects. By focusing on unfamiliar realistic attitude objects, where some knowledge in the context can be expected, the current study addresses the gap between attitude research that either focused on attitude objects where a meaningful reference point is lacking (e.g. fictitious attitude objects) or focused on familiar attitude objects. The present study achieved this by presenting similar applications with and without the use of a new unfamiliar technology: nanotechnology.

The results showed that, for the more familiar attitude objects, cognition is more predictive for the overall attitude. On the other hand, for realistic unfamiliar attitude objects, affect is more predictive for the overall attitude. This supports the proposition that, in attitude formation towards familiar attitude objects, people in principle have access to a rich network of affective and cognitive associations and attribute-evaluations. For familiar attitude objects, evaluation (the extent to which people rely on affect or cognition) is guided by people's preferred thinking style. Consistent with previous research in attitude formation, people with high need for cognition rely more on cognition and people with high faith in intuition rely more on affect (Epstein et al., 1996).

It is shown that people with high need for cognition rely more on cognition when expressing overall attitude, both for familiar and (contrary to the expectations) also for unfamiliar attitude objects. Previous research showed that, for unfamiliar attitude objects without meaningful reference points, repeated exposure leads to positive affective feelings in the lack of a solid knowledge base (Hansen & Wänke, 2009; Zajonc, 1980). This study shows that, with realistic unfamiliar attitude objects, cognitions can be constructed or derived from the realistic context if individuals have a high need for cognition. Thus, cognitions can be used to some extent towards unfamiliar attitude objects. The current study extends previous research on faith in intuition in relation to affective focus for unfamiliar attitude objects. For unfamiliar attitude objects, both high- and low-intuitive people rely on affect, while for familiar attitude objects in particular, people with high faith in intuition rely on affect. This implies that, for people with low faith in intuition, affect can still be considered as a default heuristic (Slovic, Finucane, Peters, & MacGregor, 2007), making best sense of unfamiliar realistic attitude objects.

Respondents were presented with unfamiliar realistic attitude objects delivering potential benefits in an unfamiliar way (based on nanotechnology). As the selected attitude object is a technology application, and the unfamiliar variant is a similar application based on a novel technology, technophobia or consumer resistance against technology may play a role (Mukherjee & Hoyer, 2001). Specifically, with new technologies, ‘unknown’ can quickly turn into ‘unloved’, as happened for instance in the case of genetically modified food (Frewer, Bergmann, et al., 2011). Yet, as the technology context brings in specific characteristics for nanotechnology, most will also be applicable for their conventional alternatives. Nevertheless, future research should focus on other unfamiliar attitude objects that deliver familiar benefits in an unfamiliar way (for instance when smartphones just came onto the market). Hence, research should be extended to include different unfamiliar objects to generalise these findings and to control for specific context-dependent effects.

Respondents were provided descriptions about the attitude objects in order to make any sense of the stimuli. Careful pilot testing confirmed that the scenarios were emotionally neutral. The elaborateness of information of the scenarios may however have contributed to a factual basis, necessary to construct cognitive attitudes, and thus may have reduced hypothesised effects that were nevertheless observed. Providing a short scenario only once will do little to support the creation of lasting cognitive or affective associations. Research following longitudinal exposure to the technology in real-life context would be a more relevant way to study familiarisation with the new technology. In addition, in future research it is also important to investigate whether the relative influence of affect and cognition on overall attitudes hold when the available context information changes. For instance when there is little or no information about unfamiliar objects presented, as is often the case in real life.

Attitudes were assessed in a representative adult sample of the Netherlands (i.e. as opposed to a student sample), less familiar with technological innovations. This supports the predictive and explanatory value of the cognitive–affective attitude structure for the general population. A disadvantage of survey research is however that it is not possible to disentangle the underlying processes in attitude formation (Neys, 2006) or biases observed with self-report measures (Glöckner & Herbold, 2008). In order to get a deeper understanding of how affective and cognitive processes influence the attitude formation process, additional methods that do not rely (completely or partially) on self-reports should be used in future research. Techniques such as time-pressured answering or psychophysiological measures, such as heart rate variability, galvanic skin response, eye-tracking, or fMRI, extend the possibility to study the actual processes without interfering in the research context, and provide deeper insights about underlying processes (Glöckner & Witteman, 2010b). It is pragmatically impossible to apply these to large representative samples; hence, a combination of large-scale population-based surveys, with focused experiments to further understand the underlying processes, is recommended for future research.

As a final remark, it should be emphasised that communication towards the general public is often cognitive in nature, with a focus explaining and rationalising new things and innovations (Dudo, 2013). The present study shows that it is important (or even essential) to anticipate emotions and address people's affect in communication towards the general public. This study shows that, in order to understand how the public will respond to real-life innovations, in-depth understanding of the formation of attitudes and of the balance of affect and cognition towards unfamiliar but realistic attitude objects is necessary. While cognition plays a role in attitude formation towards unfamiliar realistic attitude objects when people have a high need for cognition, in general, affect is the more influential predictor of attitudes towards unfamiliar realistic objects.

Appendix 2.1. Example scenarios (translated from Dutch)

Scenario 1: Water filtration using a nano-membrane

Water purification and desalination by means of ultra-fine nano-membranes
The water industry is working on the development of ultra-fine membranes with nano-materials for water purification. This membrane acts like a coffee filter for molecules, ensuring that water is purified for drinking. Certain substances can pass through the membrane and other substances are stopped. An example is the desalination and disinfection of water for drinking.
Because the nanoparticles in the membrane change the properties of the membrane, they ensure that the membrane draws in water. As a result, the water can easily go through the membrane. With the same amount of pressure, twice as much water can be purified. The nano-membranes can therefore increase the efficiency of purification and desalination of water for drinking.
People use water and can therefore be exposed to released nanoparticles. For instance, some of the nanoparticles can penetrate into the brain and into cells, where larger particles cannot pervade. It is not yet known what the consequences are to humans. The nanoparticles could potentially cause damage.

Scenario 2: Water filtration using sand filtration

Water purification by means of sand filtration
In the water sector, sand filtration is used for water purification. With sand filtration, the water flows through a bed of fine sand and/or gravel. When water flows through this filter, dirty particles in the water are retained. Water itself can flow through the filter. An example is removing waste from water for drinking or deferrisation of groundwater by sand filtration.
Because a sand filter is easy to install, sand filtration can be easily used in many places in water-management systems. Sand filters can be used as pre-treatment and post-treatment methods. Thus, water can be purified efficiently and cheaply.
People use water for instance for showering and drinking. Sand filtration is not a total disinfection method. Thus, nematodes and viruses are in some cases insufficiently filtered, so that they can enter the body. People could be exposed to these nematodes and viruses and consequently become ill.

Appendix 2.2
Description of pilot studies

	Pilot study 1	Pilot study 2
Aim	Investigate comprehensibility, credibility, completeness.	Compare familiar and unfamiliar applications on the comparability of the purpose of the technology, advantage, and disadvantage. Feedback from respondents to improve scenarios.
Sample	Wageningen University students (N = 18, M_{age} = 23.67 years, SD_{age} = 2.61).	Wageningen University students and staff (N = 20; $N_{per\ application}$ = 10).
Stimulus material	Short description of purpose of application.	Adjusted scenarios with description of purpose, advantage, and disadvantage of the technology. One for the familiar technology and one for unfamiliar technology, which needed to be compared.
Measures	Seven-point Likert scales (not at all – very much): *Comprehensibility *Credibility *Completeness	(1) Seven-point Likert scales (not at all – very much): *Comparability of purpose *Comparability of advantage *Comparability of disadvantage (2) Remarks of respondents
Results	Since this is the first pilot study in an iterative set of studies, it does not make sense to report all results from the first studies. In general, some applications were more comprehensible and credible than others. Overall, all scenarios were seen as incomplete.	One sample t-tests showed: *Comparability of purpose, t (7) = -0.023, P = ns (non-significant). *Comparability of advantage, t (7) = 0.197, P = ns. *Comparability of disadvantage, t (7) = .009, P = ns. Medicine and supplements had relatively low means and were adjusted and piloted for a second time.
Main conclusions	Scenarios were credible; however, not considered complete.	Scenarios of familiar and unfamiliar technology were in content comparable. Thus a similar purpose, advantage, and disadvantage were described.

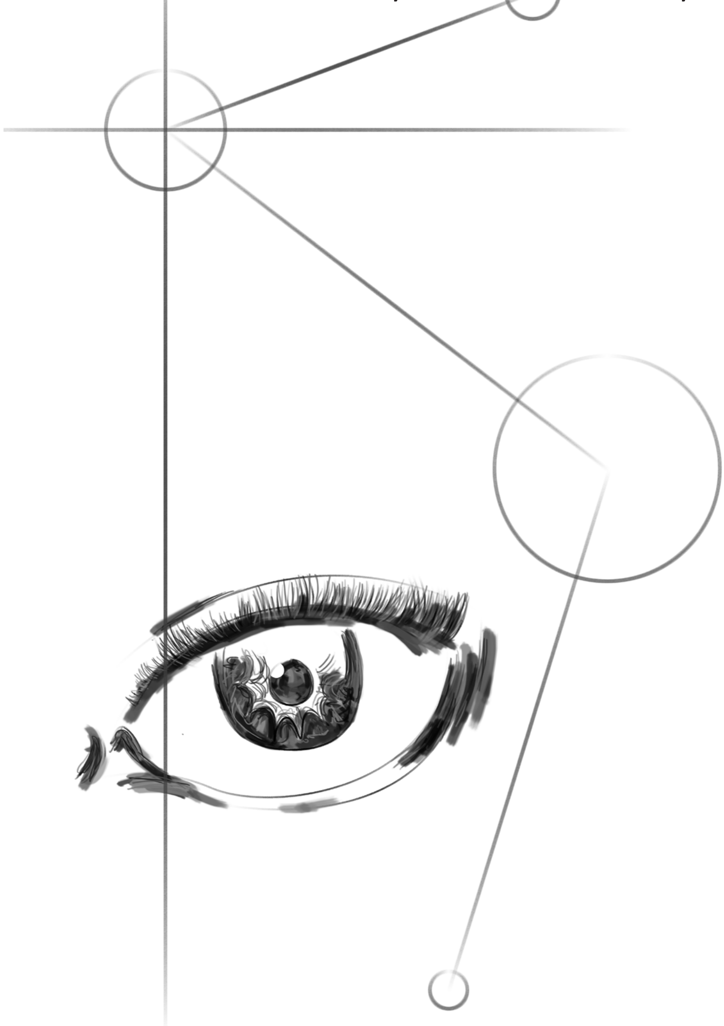
	Pilot study 3	Pilot study 4
Aim	Compare standalone text of either purpose, advantage, or disadvantage of technology on comprehensibility, credibility, complexity, emotional neutrality.	To confirm that the questionnaire is comprehensible for respondents other than university students; to find flaws in scales and survey.
Sample	Wageningen University students (N = 80; $N_{\text{per text}}$ = 10).	Sample with different backgrounds and ages (N = 21; $N_{\text{per application}}$ = 5; M_{age} = 35, SD_{age} = 14.84).
Stimulus material	Six texts of different technologies, with only the isolated purpose, advantage or disadvantage.	Final scenarios (of which an example is presented in Appendix 2.1).
Measures	Seven-point Likert scales (not at all – very much): *Comprehensibility *Credibility *Complexity *Emotional neutrality	(1) Seven-point Likert scales (not at all – very much): *Comprehensibility *Credibility *Complexity *Clarity (2) Questionnaire as used in the study
Results	For the aggregated applications, a MANOVA shows that all applications were considered equally emotionally neutral (F (1, 3) = 0.38 p_{purpose}= 1.0; $p_{\text{advantage}}$ = .60; $p_{\text{disadvantage}}$ = .29).	*Comprehensibility: all means >5 *Credibility: all means > 5.3 *Complexity: all means > 5; except lab on a chip and medical test. These scenarios were improved afterwards *Clarity: all means > 5 *Knowledge familiar (81%) > Knowledge unfamiliar (45%) *Affect scale: α = .77 *Cognition scale: α = .75
Main conclusions	Pairs of familiar and unfamiliar applications are comparable on all criteria.	All scenarios were considered as comprehensible, credible, understandable, and clear. Familiar technologies were seen as more familiar than unfamiliar technologies.

Main conclusion: With confidence it is concluded that stimulus material does not differ in comprehensibility and emotional neutrality. Furthermore, familiar technological applications were judged as more familiar than unfamiliar applications.

2

Chapter 3

Tracing attitude expressions: An eye-tracker study



This chapter is based on: Giesen, R.I. van, Fischer, A.R.H., Dijk, H. van, & Trijp, J.C.M. van. Tracing attitude expressions: An eye-tracker study
Manuscript under review.

Abstract

Attitudes represent object-evaluations, comprising complex underlying cognitive and affective knowledge structures. People have access to immediate object-evaluation linkages and a rich network of cognitive and affective attribute-evaluations. In most daily decisions they are likely to stick to their primary response based on object-evaluation linkages. More elaboration is required if the primary response is less satisfactory or less informative. In attitude research much focus is on attitudes as outcomes, ignoring underlying processes in attitude expression. Eye-tracking is used to provide insights in such processes. A procedure was developed which allows monitoring of underlying processes during attitude expression, thereby avoiding problems to which self-reported outcome measures are prone. This procedure is applied in three studies to identify the extent to which elaboration on underlying attribute-evaluations differs for attitude objects differing in strength of object-evaluations (i.e. univalent, neutral, ambivalent). In study 1 the primary response precedes processing of more specific affective and cognitive linkage-evaluations. In study 2 and 3, the order is reversed and attitudinal bases were assessed prior to overall attitude outcomes. For attitude objects with strong univalent or mixed object-evaluations similar outcomes on underlying processes appear independent whether attitudinal bases are assessed prior or after overall attitudes, whereas for weak object-evaluations these processes differ depending on the order. Both affective and cognitive attitudes may require substantial elaboration, albeit for different types of attitude objects. By giving insight in these processes the current chapter shows the usefulness of eye-tracker methods to further attitude research.

Tracing attitude expressions: An eye-tracking study

Attitudes, as a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour (Eagly & Chaiken, 1993) are a central, yet poorly understood concept in judgement and decision making and social psychology research (Gawronski, 2007). Attitudes are central because they are believed to guide object categorization, interpretation and behavioural tendencies (Glasman & Albarracín, 2006). Understanding attitudes is the first step to understanding human judgements and behaviour (Conrey & Smith, 2007).

Attitude research is grounded in two important traditions: attitudes as temporary judgements based on on the spot constructed evaluations, and attitudes as stable entities stored in memory (Olson & Zanna, 1993; Wood, 1982). Besides models that clearly adopt either a stable-entity or a constructionist view, other models take a more intermediate position (Bohner & Dickel, 2011). In the constructivist tradition it is assumed that people often do not have direct access to the relevant evaluation in memory. Evaluations are therefore created on the spot, based on current contextual cues and existing knowledge (Eagly & Chaiken, 1993; Schwarz, 2007). In the stable-entity tradition, attitude judgements can be seen as a function of one's learned response to the attitude object (Bohner & Dickel, 2011; Fazio, 2007; van Overwalle & Siebler, 2005). In this view relevant information is stored in memory as associations and eventually as knowledge structures. These associations and knowledge structures can be accessed during the judgement process whenever an attitude object is perceived (Fishbein & Ajzen, 1975). Thus, once associations are formed in memory and they are accumulated and stored in a memory structure, they can easily be retrieved (Betsch, Plessner, Schwieren, & Gutig, 2001). The current chapter addresses the retrieval process of existing attitudes towards familiar attitude objects. Following this approach it is assumed that associations have been created in the past and that stored knowledge structures are available in memory for attitude retrieval. The salience of information stored in memory may vary, sometimes strongly linked with the attitude object, and sometimes more affective or more cognitive in nature.

In terms of structure attitudes represent summary evaluations and can be viewed as "associations in memory between a given object and one's evaluation of that object" (Ajzen, 2001; Fazio, 2007). Attitudes consist of a layered structure of object-associations and, at a deeper level, object attribute-evaluations (van Overwalle & Siebler, 2005). During the process of attitude expression people can draw upon cognitive and affective components from memory that shape the object-evaluation. Attitudes are therefore not only represented as mere object-evaluation linkages, but also in more complex, structural form wherein cognitive and affective knowledge structures also appear as "object-association linkages" in memory (Chaiken et al., 1999).

Several theorists emphasize that attitudes find their base in object-attribute affect linkages (including feeling and emotions) and object-attribute cognition linkages (including beliefs and thoughts) (Breckler & Wiggins, 1989; Chang & Pham, 2013; Crites et al., 1994; Verplanken et al., 1998). These linkages can be summarized in affective and cognitive attitude components of the overall attitude (Edwards, 1990; Giner-Sorolla, 2004). Depending on the context, overall attitude expressions will find their base more in cognition (reason), or in feelings and other affective factors (Edwards, 1990). In this chapter a distinction is made between affect-based and cognition-based attitude expressions, which are assumed to differ in precedence depending on the attitude object. The process by which different evaluative responses to an attitude object are integrated in an overall attitude, or the process by which detailed affective and cognitive evaluations are derived from overall attitudes, is often left vague (van Overwalle & Siebler, 2005). Understanding underlying processes of attitude expression provides evidence on which attitude base prevails and explains how the judgement process evolves, to derive at a more salient affective or cognitive attitude expression.

In the process of attitude expression the strength of object-evaluation and object-attribute linkages, be it cognitive or affective, is affected by earlier (repeated) exposure with the attitude object. Object-evaluation and object-attribute linkages become stronger if evidence is consistent with prior knowledge, via a process of conditioning (de Houwer et al., 2001; Hofmann et al., 2010). If an attitude object consistently triggered positive or negative object- and attribute-evaluations (both affective and cognitive), which is the case for univalent attitude objects, activation of assocations progresses faster to evaluation. Hence, it is likely that for univalent attitude objects people will rely on their intuitive primary responses in many instances.

Primary responses represent fast global object-evaluations that are activated upon first encounter of an attitude object and have also been labeled primary affective response (Fazio, Jackson, Dunton, & Williams, 1995), or gut feelings (Gigerenzer & Gaissmaier, 2011 p. 42; Glöckner & Witteman, 2010a, 2010b). Primary responses are more easily accessible than the underlying detailed analytical judgements and associations (Crano & Prislin, 2006; Giner-Sorolla, 2004). Depending on motivation and availability of resources to form a stable judgement, the primary response can be perceived as "satisficing" or as an indicator that further processing is necessary (Verplanken et al., 1998; van Raaij, 1989, cited in Ye & van Raaij, 1997). Primary responses are more likely to be judged as "satisficing" if they are based in a consistent pattern of attribute-evaluation linkages, as in the case of univalent attitude objects. If such evidence base is less consistent primary responses may be judged as less satisficing and informative, triggering more elaborate retrieval in the network of affective and cognitive attribute-associations and evaluations (Petty et al., 1997). If a multitude of strong opposite attribute-evaluation linkages are activated ambivalence can be experienced, which also raises the motivation to arrive at a consistent overall attitude (van Harreveld, van der Pligt, & de Liver, 2009).

Motivation and availability of resources are central concepts in dual information processing theories to understand the depth of processing in attitude research (Cacioppo & Petty, 1984; Kahneman, 2003). If motivation to arrive at a decision is high, elaborate processing is more likely as compared with when motivation is low. In addition, less elaborate processing is likely when the decision is reached based on a satisficing heuristic. As a consequence, attitude expression processes are likely to differ between univalent attitude objects (with a consistent underlying evidence base) and mixed attitude objects where the evidence-based is inconsistent (triggering both positive and negative object/attribute linkages in the network). For mixed attitude objects, an important distinction can be made in terms of the strength of the inconsistent attribute-evaluation linkages. If such attribute-evaluation linkages are inconsistent and strong (ambivalent attitude objects) perceived dissonance is assumed to increase motivation to come to an unequivocal attitude, more so than in the case of neutral objects, which trigger a mixed pattern of inconsistent but less strong attribute-evaluations.

Although people in principle have access to a rich memory network of both cognitive and affective attribute-evaluations, in the process of attitude expression for most daily decisions they are unlikely to access all of that information. In the present studies it will be shown that although both affective and cognitive attitudinal bases can be important in attitude expression, one of the bases takes the upper hand and requires a less elaborate process during retrieval of attitudes to well-know objects.

Much of the attitude research has focused on attitude outcomes (Greifeneder, Bless, & Pham, 2011). There is however, still a gap in the understanding of psychological processes underlying attitude expression, and the extensiveness of underlying affective and cognitive processes for different attitude objects (Schulte-Mecklenbeck, Kühberger, & Ranyard, 2010; Topolinski, 2011). Research into the underlying process of attitude expression is complicated by the fact that associative networks in memory constitute a dynamic phenomenon where both object-evaluations and attribute-evaluation linkages can be constructed on the spot. These linkages can either be instrumental in attitude expression, or post-hoc rationalization and/or justification of attitudes. When studying attitudes as an outcome measure it is impossible to distinguish between construction and post-hoc rationalization processes of attitude expression. This is a major complication in much of previous attitude research that has used self-report measures on attitude outcomes (Hendrick, Fischer, Tobi, & Frewer, 2013). Because of their sensitivity to answer format and response editing strategic processes inherent in self-reports, such as social desirability or self-presentation (Schwarz & Bohner, 2001), self-report measures tend to be imperfect indicators for the underlying processes that have led to the attitude outcome (Glöckner & Herbold, 2008). This is well recognized in an important stream of research that uses unconscious measures for attitudes such as implicit associations (Greenwald & Banaji, 1995), affective priming (Fazio, 2001), and affect misattribution (Payne, Cheng, Govorun, & Stewart, 2005). Such measures only partially solve the problem however as they also focus primarily on attitude outcomes and are thus less suited to unravel the underlying attitude retrieval process.

The current chapter builds on an emerging stream of research that is using eye-tracking to provide deeper insights in underlying processes of judgement and decision making (Glöckner & Witteman, 2010a; Payne, 2010). A novel procedure was developed that allows to trace attitude expressions during the process of arriving at this attitude. This was done by means of analysing eye gaze patterns on a specifically designed response scale (see figure 3.1), thereby circumventing the answer formatting and response editing strategic processes to which self-reported outcome measures are prone. Through first eye fixation, eye gaze analysis provides a relevant measure for the primary response. In addition, eye gazes allow for tracking response speed (total dwell time on the scale units) in conjunction with the identification of deliberation processes both within and between the affective and cognitive attribute-evaluation linkages (switches in eye fixations between areas of interest).

This eye-tracking based procedure is applied to three sets of attitude objects, namely univalent, ambivalent and neutral objects, to identify the extent to which processes underlying attitude expression differ, in terms of (1) the extent to which the primary response is predictive for the overall attitude, (2) the extent to which elaboration on underlying attribute-evaluations differs, and (3) the extent to which opposing attribute-evaluations are traded off against each other. It is expected that the overall attitude judgements will be based on the attitude component that requires least elaborate processing. These aspects will be explored in three studies. In the first study the primary response precedes the processing of more specific affective and cognitive bases. In the second study, the order is reversed and attitudinal bases of affect and cognition are given prior to overall attitude. In the third study it is investigated whether the operationalization of the affect measure influences affective processing.

Research approach

In this chapter, insight into attitude expressions was derived from eye gaze analysis on the response scales, while participants were asked to rate their attitude. Three response scales were specifically designed for the purpose of this study: an affective judgement scale, a cognitive judgement scale and a combined judgement scale comprising both the affective and cognitive answering options (see figure 3.1). The affective judgement scale (see left part of figure 3.1) consisted of eight framed pictures (cartoons), based on Desmet (2003). The pictures represented four positive states (joy, desire, fascination, satisfaction) and four negative states (fear, boredom, sadness, disgust). The cognitive judgement scale (based on Crites et al., 1994; Nordgren, van Harreveld, & van der Pligt, 2006) consisted of eight different cognitive words (see right part of figure 3.1). Four words were positive (useful, functional, beneficial, nice) and four negative (necessary, useless, harmful, disadvantageous). Each cartoon or word was placed in a 112x116 pixels square (with the central position empty) to represent them in a meaningful place relative to two dimensions. For the affective scale these dimensions were defined by positive / negative valence, and high / low arousal, based on the affect grid (Russell, 1980). For the cognitive scale these indicated positive/negative valence and hedonic/ utilitarian beliefs. A combined scale with these two scales combined into one panel was used to assess affective versus cognitive dominance (see figure 3.1).

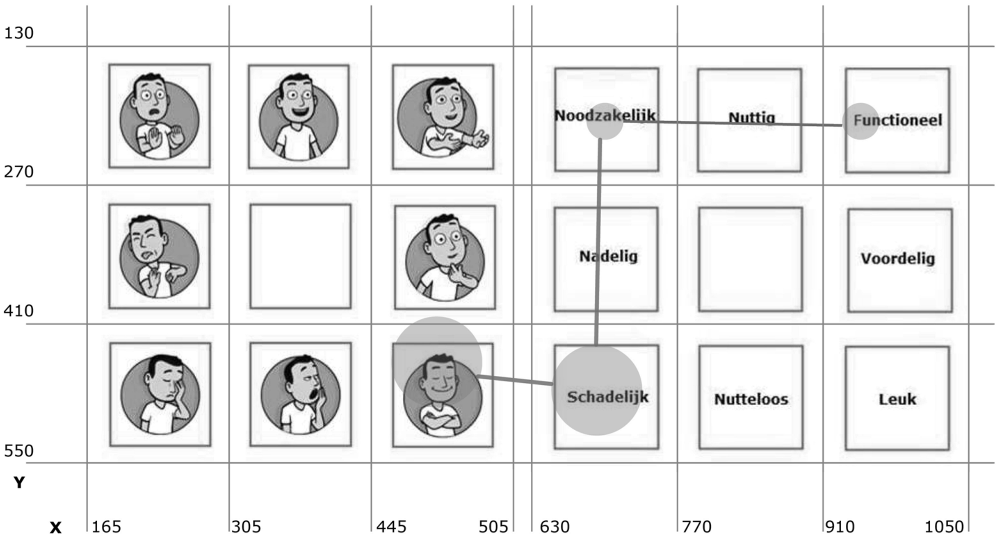


Figure 3.1. Combined scale, with left part of the scale showing the emotions (clockwise starting in the top left corner): fear, joy, desire, fascination, satisfaction, boredom, sadness, disgust. Translations cognitions (clockwise starting in the top left corner): necessary, useful, functional, beneficial, nice, useless, harmful, disadvantageous.
Affective scale and cognitive scale were also assessed separately.
Note. Numbers on x and y- axes are an illustrative example, AOIs were approximately the size of the frames (112x116).

Participants were asked to indicate, through a mouse click, the response option that best describes their opinion towards the attitude object. During the process of arriving at the response option selection, eye gaze was monitored by means of an eye tracker, with the scale items defined as the relevant Areas of Interest (AOI). From the eye gaze patterns for each of the attitude objects on each of the scales, the following measures were derived:

The *primary intuitive response* was operationalized as the location of the first fixation of the eyes on one of the AOIs (adopted from Horstmann et al., 2009).

Elaborateness of processing was operationalized as (a) the total number of fixations on the AOIs of the different scales (b) total dwell time (Velichkovsky, Rothert, Kopf, Dornhöfer, & Joos, 2002) and (c) the length of the eye gaze pattern (in terms of Euclidian distance[1]).

Trade-offs were operationalized as (a) the number of transitions between AOIs, (b) the number of transitions between the positive and negative scale elements, (c) the number of unique AOIs fixated on, and (d) the number of transitions between affective and cognitive scale dimensions (for combined scale only).

Study 1

Method

Participants and design

In the first study the immediate activation of attitudes and how this influences subsequent cognitive and affective associations with these attitude objects is investigated. The study had a 3 (attitude scale: cognitive, affective, combined) x 3 (univalent, neutral, ambivalent) full-factorial within-subject design. Every participant responded three times (affective, cognitive, combined scale) to 18 stimuli, so in total there were 54 trials per participant. Twenty-six undergraduates from Wageningen University participated in the study (six male, M_{age} = 21.50 years,

1 Each frame was given a coordinate on both dimensions (1, 2, or 3) these simple coordinates were used as an approximation for the coordinate of a fixation and used to calculate saccade distance between two relevant fixations.

SD_{age} = 1.92). Three participants were excluded because there were problems with eye movement registration or data transformation. Sometimes several answer options are clicked by respondents, these cases are removed (on average 0.52 out of 54 trials per person). Leaving 1230 cases for analysis (*N* = 23) with an average number of 53.48 trials per person (*SD* = 2.09).

Materials

Stimulus material. As attitude objects 18 stimuli were selected from previous research (Bargh, Chaiken, Govender, & Pratto, 1992; de Liver, van der Pligt, & Wigboldus, 2007; Nohlen, van Harreveld, Rotteveel, Lelieveld, & Crone, 2013; Sawicki et al., 2013). These were either (1) univalent (butterfly, friend, summer, toothache, disease, violence), (2) neutral (storehouse, pliers, tile, lamp, transport, meeting), or (3) ambivalent (abortion, euthanasia, exam, television, operations, dentist). Attitude objects were presented as a picture (left side of the screen) accompanied with a word describing the picture (right side of the screen).

A pen- and paper pilot study (*N* = 17), where affective and cognitive ambivalence were measured on 7-point scales (1 = 'not at all', 7 = 'very much'), confirmed that univalent attitude objects scored lowest on cognitive ($M_{cog.ambi}$ = 1.95, *SE* = 0.14) and affective ambivalence ($M_{aff.ambi}$ = 1.91, *SE* = 0.13). Ambivalent attitude objects scored most ambivalent ($M_{cog.ambi}$ = 2.68, *SE* = 0.14; $M_{aff.ambi}$ = 3.13, *SE* = 0.13), with neutral attitude objects in-between ($M_{cog.ambi}$ = 2.48, *SE* = 0.14; $M_{aff.ambi}$ = 2.35, *SE* = 0.13), with neutral attitude objects not being rated as (significantly) lower than ambivalent attitude objects on cognitive ambivalence.

Tasks. Participants were seated in a separate room in front of a 19 inch LCD monitor with a remote 60 Hz sampling eye-tracker system (RED of SMI, see: www.smivision.com) at approximately 60 cm distance. The eye-tracker was set at a 30 degree angle, allowing for free movement of the participant's head in a 40 x 40 cm virtual box. Fixations were defined with a minimum of 80 ms (cf. Lamme, 2003). Stimulus material was offered to participants via the web-based Qualtrics survey tool, and loaded to the eye-tracker system via Experiment Center 3.0. IViewX 2.7 was used to record eye movements.

Measures

Elaborateness of processing overall attitude judgement, affect and cognition; trade-offs and primary responses were recorded as described under research approach.

Final attitude was measured as the ultimate response option that participants selected by mouse click as best fitting with the attitude object, both on the affective, cognitive and combined scales.

Procedure

Before starting the actual task participants received an introduction to all three answer scales in which scale dimensions and the position of each cartoon (affect scale) or word (cognitive scale) were explained, followed by a training procedure to familiarize them with the scales. Before the training procedure participants received the following instructions: "You are asked what you think of certain attitude objects and how you feel towards these attitude objects. A training procedure follows to familiarize you with the scales which are different from what you are used to". Then, the affect and cognition scale were explained to participants. For the affect scale it was explained that this scale is used to measure how someone feels towards the attitude object. For the cognitive scale it was explained that this scale is used to measure what someone thinks about the attitude object. For both scales the scale dimensions were explained. Subsequently the training procedure started. Participants had to search synonyms for the answer scale options to familiarize them with the location of each cartoon or word (32 synonym trials). After that, two practice trials per scale followed with an attitude object not used in the present research (gift, spider). Then, the combined scale was explained to the participant and five practice trials followed (firework, spider, rainbow, grave, cake).

After the training procedure eye-movements were calibrated by asking participants to follow a calibration point on screen (9-point calibration), before participants started with the actual task. In the actual task, each trial the attitude object was presented on screen for 4 seconds, followed by a screen with one of the three judgement scales located in the middle of the screen. No additional explanation for the judgement scale was given, as participants received a training procedure and were aware what was requested from them as soon as the judgement scale appeared. Participants first judged all 18 attitude objects using the combined scale (randomized order of attitude objects), followed by answering the affective and cognitive scale in which both the order of the attitude objects and the affective and cognitive scales were randomized (another 36 trials). For each scale, participants responded with a mouse click, after which the next attitude object appeared on screen. From the moment the actual task started, eye movements were collected until participants completed all questions. There was no time constraint set on responses.

After completion, participants were debriefed and received a monetary incentive of €3.50 for participating lasting 20-30 minutes. Before and during the debriefing participants were given the opportunity to comment on the study.

Table 3.1
Overall attitude judgement: Number of observations, percentage of total observations, adjusted residuals

Variable	Study	Univalent	Neutral	Ambivalent
First fixation on affect (chance = 50%)	1	83 68.6% (4.4)	44 36.7% (-4.1)	65 50.8% (-0.4)
	2	84 75.7% (4.1)	33 71.7% (1.6)	39 40.2% (-5.5)
	3	85 62% (3.3)	24 41.4% (-1.7)	54 43.9% (-2.1)
First fixation predictive of overall attitude (chance = 6.25%)	1	42 31.6% (.1)	41 30.1% (-0.3)	43 31.9% (0.2)
	2	29 24.4% (0.4)	12 23.5% (-0.3)	25 24.5% (-0.2)
	3	40 26.8% (1.4)	17 26.6% (0.7)	22 17.2% (-2.0)
Overall attitude judgement based on affect (chance = 50%)	1	94 70.7% (7.9)	27 19.9% (-6.7)	53 39.3% (-1.1)
	2	86 72.3% (4.6)	36 66.8% (2.2)	32 18.8% (-6.5)
	3	95 63.8% (7.1)	27 42.2% (0.0)	22 17.2% (-7.3)

Note. Only percentages for affect are given as the percentages for cognition can be derived from here.
Adjusted residuals appear in parentheses bellow observed percentages.

Data analyses

Gaze patterns on the judgement scales were analysed. Analyses were done using SPSS 19. Prior to analysis, all variables were examined for accuracy of data entry (after data transformation), missing values, and distributions. Elaborateness of processing for univalent, neutral, and ambivalent attitude objects (attitude object category) was analysed using general linear mixed model analyses (multilevel). Attitude object category was included at the highest level. For each attitude category (univalent, neutral, ambivalent) multiple stimuli were assessed and included at the lowest level, with a random intercept (within-subject design).

Elaborateness of processing for overall attitude, and the underlying measures of total dwell time, total number of fixations, and length of eye gaze pattern, were the dependent measures and the attitude object category the independent variable. Results are reported in table 3.2, as means per attitude object category. Between attitude object categories means were compared with the posthoc procedure within SPSS' linear mixed model (pairwise comparison of estimated marginal means, LSD).

Trade-offs for the overall attitude, and the underlying measures as number of transitions between AOIs, number of transitions between the positive and negative scale elements, number of unique AOIs fixated on, and number of transitions between affective and cognitive scale dimensions were analysed in the same way. Results are reported in table 3.3, as means per attitude object category.

Analyses for elaborateness of processing for affect and cognition were carried out in a similar way as for the overall attitude. Results are reported in table 3.4, as means per attitude object category.

Results

Overall attitude judgement

Primary response. The extent to which the primary response was predictive for the overall attitude judgement expressed on the combined attitude scale was significantly higher (31.2%) than expected by chance (p_{chance}=1/16=6.25%), χ^2 (1) = 179.12, *p* <.001, *n* = 404. There was no difference in the extent to which primary response was predictive across the attitude object categories χ^2 (2) = 0.11, *p* =.95, *n* = 404. A χ^2-analyses showed that the first fixation being affective or cognitive

Table 3.2

Elaborateness of processing overall attitude judgement

Measure	Study	Univalent	Neutral	Ambivalent	*F(df)*	*P*
Total number of fixations on AOI	1	6.20[a]	5.89[a]	9.22[b]	9.95 (2,379)	<.001***
	2	4.95[a]	5.10[a]	6.95[b]	4.93 (2,253)	.008**
	3	4.32[a]	5.01[a]	6.72[b]	8.42 (2,317)	<.001***
Total dwell time (AOIs) in ms	1	1888.59[a]	1611.78[a]	2710.31[b]	9.35 (2,379)	<.001***
	2	1552.69[a]	1714.27[ab]	2041.10[b]	2.93 (2,253)	.055†
	3	1627.94[a]	1784.98[a]	2345.84[b]	7.02 (2,317)	.001**
Length of eye gaze pattern	1	2.91[a]	1.85[b]	3.51[a]	4.25 (2,272)	.015**
	2	1.89[a]	1.48[a]	2.95[b]	3.68 (2,195)	.027**
	3	1.74[a]	1.74[a]	3.25[b]	7.45 (2,225)	<.001**

Note. † <.10 * <.05; ** <.01; *** <.001. Averages are derived from the posthoc procedure within SPSS general linear mixed model procedure (EM means, LSD). Total decision time is based on the moment the scale appeared on screen until the mouse click.

differed across attitude object types, χ^2 (2) = 24.73, p <.001, n = 369 (table 3.1; study 1). Adjusted residuals show that this is caused by first fixations of univalent attitude objects being more often affective (adjusted residual = 4.4), whereas for neutral attitude objects they are more often cognitive (adjusted residual = -4.1). These results indicate that primary responses are equally predictive of univalent, neutral and ambivalent objects. Furthermore, affect is more relevant when expressing an overall attitude towards univalent attitude objects.

Elaborateness of processing. In terms of elaborateness of processing on the combined scale, overall attitude judgements towards univalent and neutral attitude objects require less elaborate processing compared with ambivalent attitude objects (table 3.2; study 1). This is evidenced by a lower total number of fixations ($M_{univalent}$ = 6.20, $M_{neutral}$ = 5.89 vs. $M_{ambivalent}$ = 9.22; F = 9.95, p <.001), and a lower total dwell time ($M_{univalent}$ = 1888.59ms, $M_{neutral}$ = 1611.78 ms vs. $M_{ambivalent}$ = 2710.31ms; F = 9.35, p <.001) on the combined scale, but not by an increased length of eye gaze patterns, where the length of eye gaze pattern for neutral objects (M = 1.85) is lower than for both univalent (M = 2.91) and ambivalent (M = 3.51) attitude objects, F = 4.25, p = .015[2].

Trade-offs. For overall attitude as expressed on the combined scale (table 3.3; study 1), univalent and neutral attitude objects as compared with ambivalent attitude objects show fewer trade-offs. This is manifested in ambivalent attitude objects triggering more (a) transitions between AOIs ($M_{univalent}$ = 3.58, $M_{neutral}$ = 3.26 vs. $M_{ambivalent}$ = 5.50; F = 7.15, p <.001), (b) transitions between the positive and negative scale elements ($M_{univalent}$ = 1.51, $M_{neutral}$ = 1.81 vs. $M_{ambivalent}$ = 2.72; F = 6.67, p =.001), (c) uniquely inspected AOIs ($M_{univalent}$ = 3.91, $M_{neutral}$ = 3.62 vs. $M_{ambivalent}$ = 4.87; F = 5.86, p =.003), and d) larger number of transitions between affective and cognitive scale dimensions, for the combined scale ($M_{univalent}$ = .58; $M_{neutral}$ = .63, vs. $M_{ambivalent}$ = 1.06; F = 6.52, p =.002)[3]. This confirms that ambivalent attitude objects are less consistent than neutral and univalent attitude objects and require a more elaborate attitude retrieval process.

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2 Correlations between the different measures for the elaborateness of processing construct are between .72 and .92.

3 Correlations between the different measures for the trade-off construct lie between .78 and .86. Except for ‘transitions between affective and cognitive scale dimensions’ with the other trade-off measures, showing correlations of .48 and .50 with other measures.

Table 3.3

Trade-offs overall attitude judgement

Measure	Study	Univalent	Neutral	Ambivalent	*F (df)*	*P*
Number of transitions between AOIs	1	3.58^{a}	3.26^{a}	5.50^{b}	7.15 (2,380)	<.001***
	2	2.38^{a}	2.35^{a}	3.65^{b}	4.21 (2,253)	.016**
	3	3.61^{a}	3.88^{a}	5.75^{b}	8.18 (2,317)	<.001***
Number of transitions between positive and negative scale elements	1	1.51^{a}	1.81^{a}	2.72^{b}	6.67 (2,368)	.001**
	2	0.99^{a}	1.27^{ab}	1.79^{b}	3.89 (2,249)	.022**
	3	0.71^{a}	1.72^{b}	1.70^{b}	11.06 (2,317)	<.001***
Number of unique AOIs fixated on	1	3.91^{a}	3.62^{a}	4.87^{b}	5.86 (2,379)	.003**
	2	3.06^{a}	2.82^{a}	3.85^{b}	4.62 (2,253)	.011**
	3	3.07^{a}	3.15^{a}	4.09^{b}	7.21 (2,317)	.001**
Number of transitions between affective and cognitive scale dimensions	1	0.58^{a}	0.63^{a}	1.06^{b}	6.52 (2,368)	.002**
	2	0.77^{a}	0.82^{ab}	1.22^{b}	2.54 (2,249)	$.08^{\dagger}$
	3	0.82^{a}	0.96^{a}	1.37^{b}	4.99 (2,317)	.007**

Note. † <.10 * <.05; ** <.01; *** <.001. Averages are derived from the posthoc procedure within SPSS general linear mixed model procedure (EM means, LSD).

Drivers of overall attitude. When participants had to express their overall attitude judgement on the combined scale based on both affective and cognitive answer options, the affective attitude is more predictive in the case of univalent attitude objects (70.7%), whereas the cognitive attitude is more predictive for neutral (80.1%) and ambivalent (60.7%) attitude objects, χ^2 (2) = 72.04, p <.001, n = 404 (table 3.1; study 1).

Cognitive and affective attitude judgements

Investigating the affective scale separately (table 3.4; study 1) confirms a similar pattern as discussed for the overall attitude judgement. Expressing an affective attitude towards univalent attitude objects requires a less elaborate attitude retrieval process as evidenced by (a) lower number of fixations ($M_{univalent}$ = 4.76 vs. $M_{neutral}$ = 6.43, $M_{ambivalent}$ = 7.42; F = 15.22, p <.001), (b) lower total dwell time ($M_{univalent}$ = 1537.67 vs. $M_{neutral}$ = 2105.32, $M_{ambivalent}$ = 2378.10; F = 10.57, p <.001), (c) shorter length of eye gaze pattern ($M_{univalent}$ = 3.51 vs. $M_{neutral}$ = 5.19, $M_{ambivalent}$ = 6.15; F = 12.91, p <.001), compared with neutral and ambivalent attitude objects.

For the cognitive scale, however, a different pattern emerges (table 3.4; study 1). In this case, expressing an attitude towards neutral attitude objects requires a less elaborate attitude retrieval process compared with univalent and ambivalent attitude objects as evidenced by (a) lower number of fixations ($M_{neutral}$ = 5.28 vs. $M_{univalent}$ = 6.39; $M_{ambivalent}$ = 7.42; F = 6.79, p =.001), (b) lower total dwell time ($M_{neutral}$ = 1558.52 vs. $M_{univalent}$ = 1882.17; $M_{ambivalent}$ = 2173.22; F = 6.69, p =.001, (c) shorter length of eye gaze pattern ($M_{neutral}$ = 4.18 vs. $M_{univalent}$ = 5.22; $M_{ambivalent}$ = 5.57; F = 3.52, p =.03), compared with neutral and ambivalent attitude objects.

Finally, comparing the elaborateness of affect versus cognition for the different type of attitude objects suggests that for univalent attitude objects expressing affect requires less elaborate processing than cognition, as evidenced by (a) lower number of fixations (F = 13.45, p <.001), (b) lower total dwell time (F = 4.23, p =.041), and (c) shorter length of eye gaze pattern (F = 14.42, p <.001). For neutral attitude objects expressing cognition requires less elaborate processing than affect, (F = 6.45, p =.012), (b) lower total fixation time (F = 10.73, p <.001), and (c) shorter length of eye gaze pattern (F = 4.73, p =.031). For ambivalent attitude objects there are no differences in the amount of elaboration between affect and cognition.

Table 3.4

Elaborateness of processing affective and cognitive judgement

Measure	Study	Affect					Cognition				
		Univalent	Neutral	Ambivalent	*F (df)*	*P*	Univalent	Neutral	Ambivalent	*F(df)*	*P*
Total number of fixations on AOI	1	4.76[a]	6.43[b]	7.42[c]	15.22 (2,387)	<.001	6.39[a]	5.28[b]	7.24[a]	6.79 (2,389)	.001**
	2	5.74[a]	9.56[b]	9.45[b]	14.39 (2,283)	<.001	8.72[a]	11.97[b]	8.11[a]	8.29 (2,283)	<.001***
	3	6.60[a]	8.64[b]	11.17[b]	17.78 (2,328)	<.001	7.52[a]	7.64[a]	6.42[a]	2.24 (2,238)	.11
Total dwell time (AOIs) in ms	1	1573.67[a]	2105.32[b]	2378.10[b]	10.57 (2,387)	<.001	1882.17[a]	1558.52[a]	2173.22[b]	6.69 (2,389)	.001**
	2	1921.44[a]	3549.21[b]	3170.21[b]	14.28 (2,283)	<.001	2612.51[a]	3730.57[b]	2456.97[a]	8.42 (2,283)	<.001***
	3	2153.75[a]	2820.24[b]	3712.11[c]	21.46 (2,238)	<.001	2429.09[a]	2565.24[a]	2263.37[a]	0.92 (2,238)	.40
Length of eye gaze pattern	1	3.51[a]	5.19[b]	6.15[b]	12.91 (2,373)	<.001	5.22[a]	4.18[b]	5.57[a]	3.52 (2,574)	.031**
	2	4.84[a]	7.17[b]	7.66[b]	8.02 (2,274)	<.001	7.85[a]	11.67[b]	6.98[a]	10.94 (2,282)	<.001***
	3	5.46[a]	7.58[b]	10.34[c]	21.45 (2,238)	<.001	6.85[a]	7.12[a]	5.16[b]	4.74 (2,238)	.009**

Note. † <.10 * <.05; ** <.01; *** <.001. Averages are derived from the posthoc procedure within SPSS general linear mixed model procedure (EM means, LSD).

Discussion

For overall attitude expressions less elaborate processing is observed for univalent (simple) and neutral (weak object-linkages) objects compared with ambivalent objects, suggesting higher motivation to solve perceived inconsistencies for the latter category of objects. In addition univalent and neutral objects resulted in fewer trade-offs. This implies that the extent to which people elaborate is dependent on underlying attribute-evaluations in particular whether strong, opposing attribute-evaluations are present. A similar pattern is reflected by gaze patterns when participants are asked to rate their affective and cognitive attitude components in isolation. Participants are fast in creating affect towards univalent attitude objects, with little elaboration, compared with neutral and ambivalent attitude objects. People are fast in creating cognition towards neutral attitude objects, with little elaboration, compared with univalent and ambivalent attitude objects. For expressions of ambivalent attitudes affective and cognitive attitudes require an equally elaborate process.

Affect is the dominant overall attitude judgement component for univalent attitude objects, whereas for neutral and ambivalent attitude objects cognition is dominant. For univalent and neutral objects after activation of the overall attitude, the dominant attitude component is also the most accessible in isolation (requiring least elaborate processing). Although, for ambivalent objects this picture is less clear.

Since the overall attitude is activated first, it is difficult to determine whether participants accessed the attitude component through their object-attribute associations or that the response on the attitude components was reconstructed from the recently activated overall attitude. To investigate this, in study 2, attitude components (cognitive and affective) are activated first which allows unbiased estimates of elaboration in each component, as well as the effect of activating attitude components leading up to overall attitudes.

Study 2

Method

Participants and design

Twenty five undergraduates from Wageningen University participated in the study (8 male, M_{age} = 20.96 years, SD_{age} = 2.11). Five participants were excluded because there were problems with eye movement registration or data transformation.

Materials and procedure

As attitude objects, 16 stimuli were selected from previous research (similar to study 1). These were either (1) univalent (puppy, chocolate, holidays, vomit, disaster, garbage), (2) neutral (nature, stone, water drop), or (3) ambivalent (needle, knife, medicine, fast food, money, alcohol, slot machine). A pen- and paper pilot study (*N* = 15) confirmed that univalent attitude scored lowest on ambivalence (*M* = .33; *SD* = .94). Ambivalent attitude objects scored most ambivalent (*M* = 3.2; *SD* = .86), with neutral attitude objects not significantly different from ambivalent attitude objects (*M* = 3.0; *SD* = 1.31). Just as in study 1 the participants judged the 16 attitude objects on all three scales (thus in total 48 trials). In this study all affective and cognitive scales were presented first, in randomized order (32 trials). And were followed by the combined scales (in randomized order; 16 trials). The remainder of the methods were identical to study 1.

Data preparation and analysis

Analyses were done using SPSS 19, in the same way as study 1. After deleting the missing values and multiple click cases, one participant with more than 25% missing cases on all variables was excluded from analyses. 907 cases were included in the analysis (*N* = 19) with an average number of 46.32 trials per person (*SD* = 5.04).

Results

Cognitive and affective attitude judgements

Expressing an affective attitude towards univalent attitude objects requires a less elaborate process (table 3.4; study 2) as evidenced by (a) lower number of fixations ($M_{univalent}$ = 5.74 vs. $M_{neutral}$ = 9.56, $M_{ambivalent}$ = 9.45; F = 14.39, p <.001), (b) lower total dwell time ($M_{univalent}$ = 1921.44 vs. $M_{neutral}$ = 3549.21, $M_{ambivalent}$ = 3170.21; F = 14.28, p <.001), (c) shorter length of eye gaze pattern ($M_{univalent}$ = 4.84 vs. $M_{neutral}$ = 7.17, $M_{ambivalent}$ = 7.66; F = 8.02, p <.001), compared with neutral and ambivalent attitude objects. For the cognitive scale, however, a different pattern emerges. In this case, expressing an attitude towards neutral attitude objects on the cognitive scale requires a *more* elaborate process compared with univalent and ambivalent attitude objects as evidenced by (a) higher number of fixations ($M_{neutral}$ = 11.97 vs. $M_{univalent}$ = 8.72; $M_{ambivalent}$ = 8.11; F = 8.29, p <.001), (b) higher total fixation duration ($M_{neutral}$ = 3730.57 vs. $M_{univalent}$ = 2612.51; $M_{ambivalent}$ = 2456.97; F = 8.42, p <.001, (c) higher length of eye gaze pattern ($M_{neutral}$ = 11.67 vs. $M_{univalent}$ = 7.85; $M_{ambivalent}$ = 6.98; F = 10.94, p <.001, compared with neutral and ambivalent attitude objects.

Comparing the elaborateness of affect versus cognition for the different attitude objects shows that for univalent attitude objects expressing affect requires less elaborate processing than cognition, as evidenced by (a) lower number of fixations (F = 20.20, p <.001), (b) lower total dwell time (F = 10.27, p =.002), and (c) shorter length of eye gaze pattern (F = 17.82, p <.001). For neutral attitude objects expressing affect requires less elaborate processing than cognition, as evidenced by marginally lower number of fixations (F = 3.23, p =.08), and shorter length of eye gaze pattern (F = 10.92, p <.001). For ambivalent attitude objects no differences in the amount of elaboration between affect and cognition were observed.

Overall attitude judgement

Primary response. The extent to which the primary response was predictive of the overall attitude judgement expressed on the combined attitude scale was significantly higher (23.2%) than expected by chance (p_{chance}=1/16=6.25), χ^2 (1) = 132.77, p <.001, n = 272. There was no difference in the extent to which primary response was predictive across the attitude object categories, on the χ^2 (2) = 0.19, p =.91, n = 272. A χ^2-analysis showed that the first fixation being affective or cognitive differed across attitude object types (χ^2 (2) = 30.01, p <.001, n = 254). Adjusted residuals show that this is caused by first fixations of univalent attitude objects being more often affective (adjusted residual = 4.1), whereas for ambivalent attitude objects more first fixations were on cognition (adjusted residual = -5.5). These results indicate that primary responses are equally predictive for univalent, neutral and ambivalent objects. Furthermore, affect is more salient when expressing an overall attitude towards univalent attitude objects.

Elaborateness of processing. Results (reported in table 3.2; study 2) show that in terms of elaborateness of processing, overall attitude judgements towards univalent and neutral attitude objects require less elaborate processing compared with ambivalent attitude objects. This is evidenced by (a) a lower total number of fixations ($M_{univalent} = 4.95$, $M_{neutral} = 5.10$ vs. $M_{ambivalent} = 6.95$; $F = 4.93$, $p = .008$), (b) a marginally lower total dwell time ($M_{univalent} = 1552.69$, $M_{neutral} = 1714.27$ vs. $M_{ambivalent} = 2041.10$; $F = 2.93$, $p = .055$), and (c) a shorter length of eye gaze patterns, ($M_{univalent} = 1.89$, $M_{neutral} = 1.48$ vs. $M_{ambivalent} = 2.95$; $F = 3.68$, $p = .027$)[4].

Trade-offs. In terms of underlying affective and cognitive processing when the overall attitude was expressed (table 3.3; study 2), trade-offs for univalent and neutral attitude objects as compared with ambivalent attitude objects show fewer trade-offs. This is manifested in ambivalent attitude objects triggering more (a) transitions between AOIs ($M_{univalent} = 2.38$, $M_{neutral} = 2.35$ vs. $M_{ambivalent} = 3.65$; $F = 4.21$, $p < .016$), (b) transitions between the positive and negative scale elements ($M_{univalent} = .99$, $M_{neutral} = 1.27$ vs. $M_{ambivalent} = 1.79$; $F = 3.89$, $p = .022$), (c) uniquely inspected AOIs ($M_{univalent} = 3.06$, $M_{neutral} = 2.82$ vs. $M_{ambivalent} = 3.85$; $F = 4.62$, $p = .011$, and d) a larger number of transitions between affective and cognitive scale dimensions ($M_{univalent} = .77$; $M_{neutral} = .82$, vs. $M_{ambivalent} = 1.22$; $F = 2.54$, $p = .08$)[5]. This confirms that ambivalent attitude objects are less consistent than neutral and univalent attitude objects and require a more elaborate process of attitude expression.

Drivers of overall attitude. When participants had to form their overall attitude judgement based on both affective and cognitive answer options, the affective attitude is more important for univalent (72.3%) and neutral (66.8%)

4 Correlations between constructs lie between .85 and .95.

5 Correlations between constructs lie between .85 and .87.
Except for 'transitions between affective and cognitive scale dimensions' with the other trade-off measures, showing correlations of .28, .29 and .33 with other constructs.

attitude objects, whereas the cognitive attitude is more important for ambivalent (81.2%) attitude objects, χ^2 (2) = 67.64, *p* <.001, *n* = 272.

Discussion

Using a different order of expression of attitude components, study 2 confirms most of the results from study 1. Attitude expression involving neutral attitude objects was however notably different from study 1. Cognitive attitudes for neutral attitude objects require more elaborate processing and the cognitive attitude component is less frequently dominant in overall attitudes. This suggests that for neutral attitude objects expressing cognitive – affective components before overall attitude may result in a different activated associative structure than expressing overall attitude first. For both univalent and ambivalent objects, on the other hand, a similar associative structure is activated regardless of order of expression. For neutral attitude objects with no strong object-evaluation linkages, it seems that the salience of activated information varies depending on the context, sometimes strongly linked with affect and sometimes more cognitive from nature. Neutral attitude objects combine features from memory-based processing and on the spot processing.

The discrepancy between the two studies could be due to the different stimulus sets used for neutral attitude objects. On face value, it might be argued that the neutral attitude objects are more cognitively based in study 1, and more affectively based in study 2. Additional analyses on the neutral attitude object in study 2, which was rated more cognitive in the pilot study than any of study 1, shows this is not the case. The attitude object stone, which was considered as most cognitive in the pilot study, and more cognitive than any of the neutral stimuli in study 1, was further explored. Results show that there is even extremer elaborate cognitive processing for total number of fixations (*M* = 12.32), total dwell time (*M* = 3910.70), length of the eye gaze pattern (*M* = 12.07). Thus, results also hold when looking at individual attitude objects, even if these are the most cognitively rated attitude objects and therefore the discrepancy in results between the two studies seems not to be due to the stimulus set.

Study 3

A confound in affective processing could be the presentation mode of the scales. The cognitive scale is presented in written format whereas the affective scale is presented pictorially. A pictorial presentation could be more arousing than written words, or alternatively, different mental coding schemes could be used caused by the representation as words or images (see e.g. Hogarth, 2002; Johnson, Paivio, & Clark, 1996; Kim & Lennon, 2008). As a result, pictorial presentation could trigger a more fluent affective processing. To exclude that the effect found for affective processing is due to the pictorial operationalization of affect, in study 3 the affective cartoons were replaced by corresponding words. Otherwise, the study was identical to study 2.

Twenty nine undergraduates from Wageningen University participated in the study (10 male, M_{age} = 22.13 years, SD_{age} = 5.72). Six participants were excluded because there were problems with eye movement registration or problems with data transformation. After deleting missing values and multiple click cases, one participant with more than 25% missing cases on all variables was excluded from analyses, leaving 1045 cases for analysis (*N* = 22) with an average number of 47.50 trials per person (*SD* = 2.35).

Results and discussion

First fixation on affect, final choice on affect and predictiveness of first fixation for final choice showed a similar pattern as in study 2, although less pronounced (table 3.1; study 3). For elaborateness of processing a similar pattern across the attitude object categories was found as in study 2, for total number of fixations on the affective scale F (2,328) = 17.78, p <.001, for total dwell time, F (2,328) = 21.46, p < .001, and length of eye gaze pattern, (2,328) = 21.45, p <.001. It should be noted that the pattern for cognition measured with the same scale as in study 2, showed a similar pattern but with less pronounced differences between types of attitude object compared with study 2 (table 3.4; study 3). For overall attitude measured on the combined scale (tables 3.2 and 3.3; study 3) similar results were found as in study 2, with univalent and neutral attitude objects requiring less elaborate processing than ambivalent attitude objects. Although the effects in study 3 are less pronounced than in study 2, the patterns are similar. Hence, it is concluded that preference for affective processing cannot be attributed to the presentation mode of the affective scale (word vs. picture).

General discussion

Despite an abundance of research on attitudes as an outcome measure, the underlying processes leading to attitude expression require more attention. The present research meets the call for research into better understanding of underlying processes (for instance Schulte-Mecklenbeck et al., 2011), and adds to a growing research stream on primary responses and intuitive processes in judgement and decision making (Topolinski, 2011; Topolinski & Strack, 2009). In three studies the extent to which the primary response is predictive for the overall attitude, the extent to which elaboration on underlying attribute-evaluations differs and the extent to which opposing attribute-evaluations are used was explored for three types of attitude objects: univalent, neutral and ambivalent. Using a specifically developed eye-tracking based research approach, eye gaze patterns on the response scales during attitude expression provided additional information on the underlying affective and cognitive processes. This concords with an emerging stream of research claiming that eye-tracking research is a useful addition to the toolbox for investigating the commonalties between intuitive and deliberative processes in decision making, using process data (Glöckner & Herbold, 2008; Horstmann et al., 2009).

Eye-tracking was used to study how attitude expression differs between different types of attitude objects. In all three studies it is shown that in making overall attitude judgements less elaborate processing is required for univalent and neutral objects compared with ambivalent objects. Furthermore, it is shown that if attitudinal bases are assessed prior to the overall attitude, the attitude component that required least elaboration is more dominant in the overall attitude for all attitude object categories. In terms of affective processing it is observed that neutral objects behave like ambivalent attitude objects, both requiring a more elaborate process independent of whether attitudinal bases were assessed prior to the overall attitude, or the other way around. However, cognitive processing for neutral attitude objects was found to differ when attitude components were expressed first vs. the overall attitude first. Expressing the cognitive attitude for neutral attitude objects required least elaborate processing when the overall attitude was expressed first.

In study 2, where overall attitudes were expressed after the cognitive and affective attitude expressions, neutral attitude objects required most elaborate processing. Study 3 replicated these patterns albeit less pronounced, which may be because of variation between the samples. Future research should shed further light on such differences in order to establish robustness of these findings. Nevertheless these findings suggest that for neutral attitude objects cognitive attitudes are constructed rather than retrieved even for well-known objects. For both univalent and ambivalent objects a similar associative structure is activated regardless of whether attitudinal bases or overall attitudes were assessed first.

The results suggest that for strong attitude objects, such as univalent attitude objects, attitude expression always goes smoothly, with limited need to elaborate. For strong but mixed object-evaluations attitude expression requires more elaboration and typically in the domain of cognitive attribute-evaluation processing. This is in line with studies on ambivalence showing that the reduction of ambivalence over time is often the result of an effortful cognitive process (Jonas, Broemer, & Diehl, 2000; van Harreveld et al., 2009). For neutral attitude objects with inconsistent, but weak object-associations and evaluations, the results are mixed. As in the absence of a strong automatic attitude an attitude needs to be created, cognition is most indicative for an evaluation and initially dominant in determining the overall attitude. Reconstruction of the cognitive component subsequently requires less effort (study 1). However, when both cognition and affective attitude components are expressed prior to the overall attitude (study 2 & 3), affect is expressed faster. In that case, affect, the component requiring least elaborate processing is the dominant component in the subsequent overall attitude.

In order to investigate elaborations and trade-offs as well as primary affect, a new eye-tracking procedure was developed with affective and cognitive scales, suitable for an eye-tracking approach. For the cognitive scale cognitive words were used which were arranged on a positive/negative and hedonic/utilitarian dimensions. Besides a two-dimensional scale for cognition a two-dimensional affect scale was used. The affect scale consisted of positive/negative and high/low arousal dimensions. The affective pictures (study 1 & 2) that were used show emotional gestures. Pictures may relate to a different evaluation mode and therefore might be more specific and arousing than the cognitive words that were used for the cognitive scale.

In study 3 it is shown that affective processing is not different when the affective scale is operationalized with words, thus that the difference between cartoons and words is no alternative explanation for these findings. When operationalizing affect with emotion gestures and equivalent words the differences between affect and emotion need to be considered. The affective component of attitude is often used as an umbrella term covering primary affect, feelings, and emotions (Edwards, 1990). At the same time, emotion and affect are seen as different constructs (Eagly & Chaiken, 1993), where affect is a relatively straightforward positive or negative feeling while emotions are considered more developed than affect and contain cognitive appraisals (Clore & Schnall, 2005). In the presents research a measure was needed that could record both primary affect and more developed affective judgement. Primary affect as used in the study, also called “gut feeling”, fits with what Russell (2003) labels “core affect”. Core affect can be consciously experienced, but is not cognitive or reflective. Affective judgement fits with what Russell (2003) labels “attributed affect”. Attributed affect covers many topics such as affective reactions, liking, displeasure motives, and empathy. Attributed affect like emotions include some cognitive appraisals, albeit less specific than fully-fledged discrete emotions. Emotional pictures can easily be interpreted (Desmet, 2003) and allow registration of both core and attributed affect. Nevertheless by imposing emotional gestures this may have introduced additional complexity to the research approach. It should be noted that cognitive evaluations like ‘useful’ also introduce higher order contexts, and that this is not unique to affective components. The exact level at which affective and cognitive scales need to be constructed, to be both accurate measures and able to pick up primary and more elaborate responses should be investigated further.

Many scholars emphasize the importance of primary responses in decision making (see Edwards, 1990; Glöckner & Witteman, 2010a, 2010b; Mikels, Maglio, Reed, & Kaplowitz, 2011). In the present research it was shown that the primary response predicts overall attitudes at a level above chance. However, it was also shown that in most cases the primary response is revised during a process of more elaborate processing preceding the expression of final overall attitude judgement. The predictiveness of the primary response for overall attitude judgement does not differ across univalent, neutral or ambivalent attitude objects. This may indicate that no clear differences in predictiveness of the primary response exist between attitude objects. More answer options are considered while expressing judgements for all types of attitude objects regardless of whether these are simple univalent or complex neutral or ambivalent objects. Alternatively, the current measure for primary response may need improvement as it is possible that participants needed more fixations to localize the exact position of their preferred answer option. Future research using eye tracker data on scoring scales should take these considerations into account in further refining the method.

A possible limitation is that presentation of the combined judgement scales was not counterbalanced. The affective part of the overall attitude scale was always presented on the left side of the screen. Hence, response options were not controlled for people's tendencies to look left or right which may favour first fixations to be on the left part of the scale (affect), based on reading order. Another limitation is that there were no masks provided before the scales appeared on screen. It should be noted that first fixations were operationalized as first fixations on the scales. This was done to avoid methodological artefacts that come along with first fixations on the screen (instead of the scale), which are determined by a variety of low level factors (Horstmann et al., 2009; Tatler, 2007). By taking into account the first fixation on the scale and not the first fixation on the screen, at least some of the bias of not presenting a mask could be overcome. There was no predisposition to first focus on the left-positioned affective scale, as about half of all first fixations were on the affective part of the overall attitude scale, and the other half on the cognitive part. In addition, there were no predispositions to only take into account the middle of the screen as about half of all first fixations were in the middle of the screen, and the other half of fixations on the outer parts of the overall attitude scale. It thus seems that although the scale was not counterbalanced and no mask was provided, the first fixations on the scale are not biased. Additional evidence to this is that it is shown that for ambivalent attitude objects cognition is more important, and there is a difference in cognitive processing for neutral attitude objects across the studies. Nevertheless for future development of this new approach systematic investigation of such effects would be welcomed.

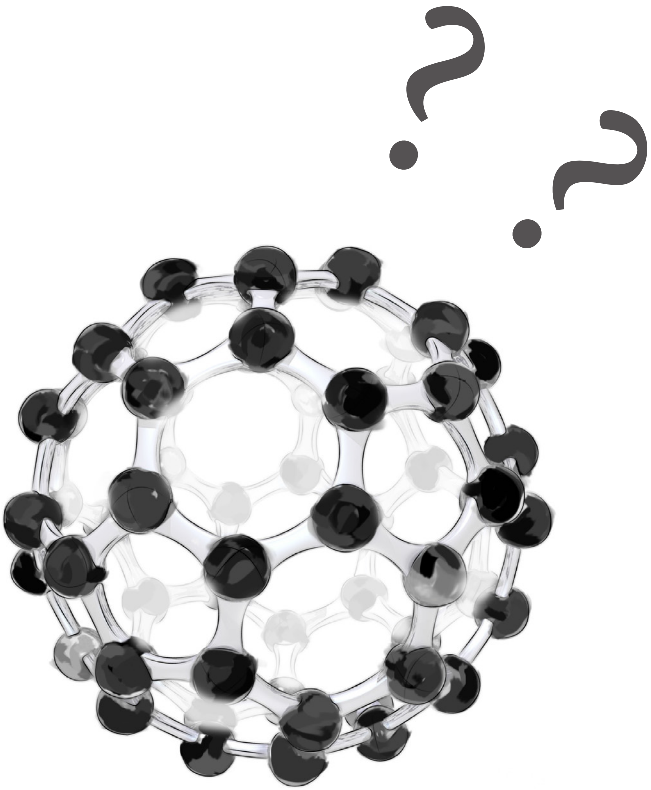
The present research approach raises an interesting direction for future research. While attitude expression towards familiar attitude objects, with existing associations and knowledge structures, was measured, attitudes towards unfamiliar objects are non-existent (Fazio, 2007; Fazio et al., 2004; Zajonc, 1980). Measuring attitude expression of non-attitudes in similar fashion as the current study may help shed light in how attitude formation towards unfamiliar attitude objects occurs.

The use of eye tracking to follow eye gaze patterns during scale completion provides valuable insights into elaborations people make when judging attitude objects. A first important finding is that for attitude objects with strong univalent or mixed object-evaluations order of attitude expression (overall attitude first vs. separate attitude components first) does not lead to different outcomes and underlying processes. For weak object-evaluations attitude expression processes differ however, depending on whether the attitude is constructed prior to the overall attitude or after the overall attitude is constructed. A second important finding is that both affective and cognitive attitude may require substantial elaboration, albeit differently for different attitude objects. This shows that people unobstructed in their attitude expression process will sometimes think through all alternatives in order to form attitude judgements, but for some objects may actually need to “feel through” their affect as well.

Chapter

4

Attitude formation towards unfamiliar attitude objects



This chapter is submitted for publication as: Giesen, R.I. van, Fischer, A.R.H. & Trijp, J.C.M. van. Attitude formation towards unfamiliar attitude objects.

Abstract

Attitude formation when people lack knowledge about the attitude object is an under researched area in attitude research. In this chapter, the role of affect and cognition in attitude formation towards such objects where individuals lack knowledge was studied in three ways applying this to familiar and unfamiliar technologies. In study 1 technology descriptions were provided without context, in study 2 these technology descriptions were placed in a product context addressing the benefit of the technology. In study 3 underlying affective and cognitive processes on the products from study 2 were studied by means of eye-tracking. It is shown that for a familiar technology attribute, which fits existing knowledge structures, both affect and cognition support attitude formation. For unfamiliar attributes attitude formation is context dependent. If the context provides cues the unfamiliar attribute is ignored and people rely on affect; if not people need to cognitively solve the incongruency. The component that is decisive in expressing overall attitudes (affect or cognition), later on requires less processing. People thus choose the attitude path of least resistance, and rely on affect or cognition depending on how easily it leads to attitude construction.

Attitude formation towards unfamiliar attitude objects

In daily life we perceive all sorts of attitude objects, which we can often evaluate on the basis of previous experiences. Sometimes we encounter a new and unfamiliar attitude object where we do not have previous experience with, for instance, a nanotechnology application. Still, people are able to form an attitude towards such an attitude object. Attitudes are evaluations people have about attitude objects, which can be positive or negative and help people to make sense of their environment (Eagly & Chaiken 1993, Fazio, 2007). Attitudes are often based on earlier experiences, however if earlier experiences are not available people still can construct an attitude (Schwarz, 2007), for example, by relying on retrieved associations related to the unfamiliar attitude object. In this chapter it is investigated how people construct attitudes, based on underlying affect and cognition when existing knowledge structures fall short. More specifically, the extent to which affective and cognitive processes differ in terms of predictivity for the overall attitude and the amount of elaboration necessary to form the affect and cognition will be investigated. This is done by comparing unfamiliar and familiar attributes (technologies) without and within a product context.

In terms of structure, attitudes represent summary evaluations and can be viewed as "associations in memory between a given object and one's evaluation of that object" (Ajzen, 2001; Fazio, 2007). An attitude-object can in itself be viewed as a collection of object-associated attributes from which people derive utility (Lancaster, 1966). Attitudes have a layered structure, consisting of multiple object-associated attributes, attribute-evaluations, and object-evaluation linkages (van Overwalle & Siebler, 2005). At the higher-order level, attitude objects represent a collection of integrated attribute-evaluations that are summarized in an overall attitude towards the object. At the lower-order level, attitude objects represent separate evaluations of all attributes related to the attitude-object (Ajzen, 2001).

Expressing evaluations requires knowledge about the attitude object as a point of reference for evaluation. Individuals' knowledge structures are organized in categories, represented by schemata in the brain (Pavelchak, 1989). Schemata are like databases of stored, related information, that are used to interpret new experiences. Schemata are built up in the course of interaction with a product, as small units of information combine to make more meaningful complexes of information (Mandler, 1982). Schemata cover both lower-order level attributes as well as more general categories related to the attitude object, from where evaluations are derived.

Evaluations can be based in affective responses, cognitive beliefs, one's past behaviour and experience with the object, or a combination of all of these (Fazio, 2007). To understand attitudes in full it is important to distinguish between those evaluation linkages which draw on cognitive and those which draw on affective knowledge structures (Chaiken et al., 1999). Several theorists emphasize that attitudes find their base in object-attribute affect linkages (including feeling and emotions) and object-attribute cognition linkages (including beliefs and thoughts) (Breckler & Wiggins, 1989; Chang & Pham, 2013; Crites et al., 1994; Verplanken et al., 1998). These linkages can be summarized in affective and cognitive attitude components of the overall attitude (Edwards, 1990; Giner-Sorolla, 2004). Depending on the familiarity of the attribute or attitude object an attitude will be based more in affect than cognition, or the other way around. In this study the affective and cognitive processes that follow mental categorization of attitude objects are studied.

Attitude formation is relatively straightforward when it concerns familiar attitude objects with familiar attributes. Individuals can then easily infer self-relevant benefits from the familiar attribute constellation of the attitude object (for instance, in the present research the benefit of having a specific technology within a product). These constellations are available due to repeated exposure and experience with the attitude object (Fazio, 2001; van Overwalle & Siebler, 2005). When perceiving the attitude object, these constellations are easily activated from memory, together with the associated knowledge structure, producing an overall positive or negative attitude (Ajzen, 2001). Any attitude object which fits with the existing schema is considered as a variation on a familiar object, and the stage is set for a fast and easy evaluation, which will often be based on affect (Fiske et al., 1987; Mandler, 1982).

When the attitude object is unfamiliar or when it contains attributes that the consumers find unfamiliar, attitude formation becomes more challenging. In this case there can be no close fit between the existing schema or category and the attribute that needs to be incorporated. Hence, the attitude object will consist of an unfamiliar attribute constellation which does not link to existing knowledge structures. As a consequence, no relevant representations are available in memory as evaluation-linkages are not established yet. In this case individuals lack a priori evaluative associations (Fazio, 2007), and evaluations towards the attitude object need to be constructed right away (Schwarz, 2007). People can do this by fitting the unfamiliar attributes of the unfamilar attitude object within the knowledge structure of a largely familiar attitude object (Peracchio & Tybout, 1996). While trying to incorporate the unfamiliar attribute, the existing knowledge structure needs to be adjusted (Mandler, 1982). The evaluation that follows is then based on resemblance to a schema for which one already has attitudes represented in memory (e.g. Duckworth et al., 2002; Fazio et al., 1995). After a while, when people become more familiar with the unfamiliar attitude object, the newly established object-attribute-evaluation linkages can evolve to strong object-evaluation linkages that can immediately be retrieved from memory (van Overwalle & Siebler, 2005).

For instance, when presenting an unfamiliar attribute (e.g. nano-enhanced) to a well-known object (phone), the attribute-evaluation linkage does not exist or is weak, and is not part of the schema. Understanding of the unfamiliar attribute-evaluation then becomes important as a precursor to the attribute-object connection (nano-enhanced phone). The specific unfamiliar attribute-evaluation linkage will determine whether incorporation is successful. If unsuccessful, then frustration will be experienced, and cognition needs to take over to fit the unfamiliar attribute constellation in existing schemas. More mental effort is likely to be required as the individual may deliberate extensively about the specific attributes and the favourability of the attribute constellations in a piecemeal approach (e.g. Mandler, 1982; Sanbonmatsu & Fazio, 1990).

Existing schemata can be adjusted in both affective and cognitive ways. If adjustment is based on affect, than feelings are used as information inputs in the judgement (Clore & Huntsinger, 2007). In addition, the unfamiliar attribute can be integrated in the knowledge structure on the basis of repeated stimulus exposure which leads to increased liking of the unfamiliar instance on the basis of affect (mere exposure) (Zajonc, 1980). Affective responses do not necessarily require conscious elaboration and can therefore be created more quickly (Bornstein, 1989; Hansen & Wänke, 2009; Zajonc, 1980). For people it is therefore usually easier to access the broader range of affective feelings than to access their cognitive beliefs (Clore & Huntsinger, 2007; Clore & Schnall, 2005). On the other hand, schemata can also be updated on the basis of cognitive inferences. Cognitive connections can, for instance, be derived from imagined experience with the attitude object or attribute, or from analogical reasoning (Cohen & Reed II, 2006). It can be expected that there are differences in reliance on affect and cognition between somewhat unfamiliar and completely unknown attributes, as for somewhat unfamiliar attributes at least some exposure has occurred and some, possibly weak, associations have been built up.

The present research investigates how consumers form overall attitudes towards attitude objects based on underlying affective and cognitive structures, when they are confronted with a novel version of a well known attitude object. More specifically, the attribute combination is unfamiliar, which makes the novel combination incongruent with their existing schema. A distinction is made between attitude objects with familiar attributes added, largely unfamiliar attributes added, and completely unfamiliar attributes added. Attitude objects with familiar attributes added are largely congruent with existing knowledge structures and schema (i.e. conventional technology). Attitude objects with largely unfamiliar attributes added are incongruent to individuals' existing knowledge structure and schema (i.e. nanotechnology). Attitude objects with completely unfamiliar attributes added are incongruent to any schema or knowledge structure (i.e. unrealistic unfamiliar technology).

In study 1 affective and cognitive information processing are explored, at the level of attribute evaluations in isolation (i.e. the technology), without any reference to the benefits they will deliver. Thus, no context or relation to a specific product is given. In study 2 a context is provided, (by including a benefit of the technology relating this to a relevant product schema), in order to explore whether the link to existing object knowledge and the support of attribute-evaluation linkages affects information processing in attitude formation. In the second study, two additional important reference points are therefore made available to participants in order to foster attitude formation. In the third study, the underlying mechanisms were explored, taking a process approach using eye-tracking. This is in line with research using eye-tracking to provide deeper insights into underlying processes of judgement and decision making (Glöckner & Witteman, 2010b; Payne, 2010).

The attitude formation process was monitored during attitude response formation from eye gaze patterns on a response scale. Eye gazes allow for tracking response speed (total fixation time on the scale units) in conjunction with the identification of deliberation processes both within and between the affective and cognitive attribute-evaluation linkages (switches in eye fixations between areas of interest).

Study 1: Attribute in isolation

In the first study, the attributes in isolation (i.e. the technology) are investigated without any reference to the benefits they will deliver. Nanotechnology, an existing yet little known technology, was used comparing this to a familiar conventional variant. Nanotechnology provides a good research context to operationalize unfamiliar realistic attitude objects, as at the time of the study, people had limited knowledge about nanotechnology and its applications (Stijnen et al., 2011). Nanotechnology is about the manipulation of materials at the smallest possible physical levels (molecular or atomic levels), and enables the creation of a large range of new products and the improvement of existing products (Borisenko & Ossicini, 2012). An unrealistic unfamiliar (non-existing) technology was added as a true novel condition. Attribute descriptions were presented without context and without relation to any product. For instance, for the attribute description active ingredient, “yeast extract” was used as conventional technology description; “nano-grinding” as nanotechnology description, and “ethylene ripening” as unrealistic unfamiliar technology description.

Method

Participants and design

The study had a 3 (technology: conventional technology, nanotechnology, unrealistic unfamiliar technology) x 4 (attribute description: active ingredient, packaging technology, coating, fibres) incomplete design. Participants always rated three attributes, one from each technology selected in such a way they always rated three different technology attribute-description combinations (see table 4.1 for the assignment of attributes to the conditions). A total of 137 students from Wageningen University participated in the study (40 male, M_{age} = 20.84 years, SD_{age} = 2.95). One (non-Dutch) participant was removed before data analyses because of insufficient understanding of Dutch language.

Materials

Stimulus material. Participants judged attribute descriptions of conventional, nano, or unrealistic unfamiliar technology. A pilot study with students from Wageningen University (N = 39; 16 males, M_{age} = 21.10, SD = 1.89) was conducted in which different attribute descriptions were assessed on familiarity, realism, fear, positivity, credibility and comprehensibility. Each respondent judged several attribute descriptions, without knowing the product context or additional attribute benefit. For all of the attribute descriptions the conventional technology was perceived as most familiar, and the nanotechnology and the unrealistic unfamiliar technology were significantly less familiar.

Measures[1]

Affective attitude. The affective attitude component was measured with an affective semantic differential scale using four item pairs on a seven-point scale (‘satisfaction/fear’, ‘sadness/desire’, ‘boredom/joy’, ‘disgust/fascination’) (based on Crites et al., 1994). Items were averaged to form a qualified reliable affective attitude scale (α = .80).

Cognitive attitude. The cognitive attitude component was measured with a cognitive semantic differential scale using five item pairs on a seven-point scale (‘necessary/nice’, ‘useful/useless’, ‘disadvantageous/functional’, ‘harmful/beneficial’) (based on Crites et al., 1994). Items were averaged to form a qualified reliable cognitive attitude scale (α = .67).

Overall attitude. Overall attitude was measured with two items on a seven-point scale: ‘My overall attitude towards the technology-attribute is…’, (1 = ‘very negative’ and 7 = ‘very positive’), and ‘Do you like the technology-attribute?’ (1 = ‘not at all’ and 7 = ‘very much’) (based on Crites et al., 1994). Items were then averaged to form a qualified reliable attitude scale (α = .83).

Familiarity. Familiarity with the attribute was measured as: ‘To what extent have you heard of this attribute?’, on a 7-point scale (1 = ‘not at all’ and 7 = ‘a lot’).

1 In the present chapter, affective, cognitive and overall attitudes were measured in a different way than chapter 2. Overall reliabilities are comparable to the measures used in Chapter 2.

Table 4.1
Attribute descriptions without product context used in study 1

Type	Technology	Attribute description (study 1)	Product characteristic (attribute incorporated in product context, study 2)
Active ingredient	Realistic Familiar	yeast extract	Improved flavour by flavour enhancers based on *yeast extract*
	Realistic unfamiliar	nano-grinding	Improved flavour by flavour enhancers based on *nano-grinding*
	Unrealistic unfamiliar	ethylene ripening	Improved flavour by flavour enhancers based on *ethylene ripening*
Packaging technology	Realistic Familiar	bio-film	Fresh longer through improved packaging based on *bio-film*
	Realistic unfamiliar	nano-film	Fresh longer through improved packaging based on *nano-film*
	Unrealistic unfamiliar	creogeen-film	Fresh longer through improved packaging based on *creogeen-film*
Coating	Realistic Familiar	mineral coating	Better visibility through improved dirt rejection based on *mineral coating*
	Realistic unfamiliar	silica nano coating	Better visibility through improved dirt rejection based on *silica nano coating*
	Unrealistic unfamiliar	oxygen barrier coating	Better visibility through improved dirt rejection based on *oxygen barrier coating*
Fibres	Realistic Familiar	glass-based fibres	Stronger screen by improved glass based on *glass-based fibres*
	Realistic unfamiliar	carbon nanotubes	Stronger screen by improved glass based on *carbon nanotubes*
	Unrealistic unfamiliar	cellulote hybrids	Stronger screen by improved glass based on *cellulote hybrids*

Note. Attribute descriptions and product characteristics are translated from Dutch.

Procedure

The experiment was programmed in Qualtrics. An online survey link to the study was distributed to students of Wageningen University via email. In addition, participants were asked in person to participate in the study in a computer room on campus. Participants were told that they would judge different attribute descriptions of technological innovations. In total, participants judged three different attribute descriptions (one for each technology type), and were randomly assigned to one of four conditions. Attribute descriptions were shown for 5 seconds, after which participants reported their affective, cognitive and overall attitude and familiarity with the attribute. The order of affective, cognitive, and overall attitude scales was randomized. This process was also repeated for all three attribute descriptions in random order. At the end of the questionnaire some demographic information was assessed. Participants were given the opportunity to comment on the study and could participate in a lottery to win one of five gift vouchers of €25. One week later, participants were debriefed by e-mail. In debriefing, it was told that most of the technologies were unrealistic or still under development and therefore non-existent at this time.

Data analysis

To assess the impact of *affect*, *cognition*, and *technology* on *overall attitude*, attitude scores were subjected to a repeated-measures mixed linear model using SPSS 19. Mixed linear models can deal with incomplete repeated measure designs (respondents rated three out of twelve attribute descriptions). *Attribute description* was entered as a repeated variable in the model. Scores on the continuous independent variables (affective and cognitive attitude) were mean centred. The variance-covariance matrix was set at a simple structure. A model was estimated with all main effects (affect, cognition, technology, attribute description), and the two-way interactions of interest (affect and technology, cognition and technology, attribute description and affect, attribute description and cognition). Unstandardized regression coefficients are reported in the results.

Results

Participants were more familiar with conventional technology attributes (M = 3.08) than nanotechnology (M = 2.10) and unrealistic unfamiliar technology attributes (M = 1.87), F (1, 405) = 20.95, p < .001. Both affect and cognition had a positive main effect on overall attitude, F_{affect} (1, 389) = 148.21, p < .001, b=0.48; $F_{cognition}$ (1, 389)

Table 4.2
Regression coefficients for familiar and unfamiliar technology descriptions

Variable	Study 1		Study 2	
	Affect	Cognition	Affect	Cognition
Conventional	.63	.42	.58	.55
Nanotechnology	.63	.43	.25	.76
Non-existing	.49	.76	.69	.45

Note. Non-existing refers to unrealistic unfamiliar technology.

= 106.94, $p < .001$, b=0.77. Technology had no main effect on overall attitude, F (1, 389) = .09, p = .92. Attribute description showed a main effect on overall attitude F (1, 389) = 2.92, p = .03.

The interaction between technology and affect did not have an effect on overall attitude, F (1, 389) = .75, p = .48. The interaction between technology and cognition had an effect on overall attitude, F (1, 389) = 3.74, p = .03, showing that cognition has a higher association with overall attitude towards unrealistic unfamiliar technology compared with familiar technology. In addition there was an interaction effect between attribute description and affect on overall attitude, F (1, 389) = 5.07, p = .002, and between attribute description and cognition on overall attitude, F (1, 389) = 4.71, p = .003. The unstandardized regression coefficients for affect and cognition for the different technologies are reported in table 4.2, corrected for attribute description. For unrealistic unfamiliar technology, there is a relatively strong association between cognition and overall attitude compared with conventional technology and nanotechnology. In conclusion, there is a relatively stronger association between cognition and overall attitude, instead of affect, for unrealistic unfamiliar attitude objects. However, for conventional and nanotechnolgoy there are similarly strong associations between cognition and overall attitude, and affect and overall attitude.

Discussion

When a technology attribute is completely unfamiliar (unrealistic unfamiliar) and no product context is provided, cognition is more predictive than affect for the overall attitude. Nanotechnology parallels conventional technology in overall attitudes, being relatively more based on affect. It seems that when people need to make sense of non-existing technological attributes they do this in a cognitive manner. Also, it seems that people are familiar enough with nanotechnology attributes to construct their attitudes more on affect similar to conventional technologies.

In practice, technology is always part of a product. Therefore in study 2 the same attributes as in study 1 are studied in a product context. Adding a new attribute to an existing attitude object (e.g. product), should change the evaluation towards the product as this addition brings new attribute beliefs and evaluations into play (e.g. following Fishbein & Ajzen, 1975).

Study 2: Attributes in a realistic product context

In this study the attribute is investigated within a product context. When the attribute is placed in a familiar product context, consumers perceive a combination of various product characteristics and various technology characteristics. Some of these characteristics might be evaluated in a more affective or a more cognitive way. When keeping the product context constant, any differences in affective and cognitive processing between products can only be assigned to the differential influence of the technology attribute. To ensure internal validity the benefit of each technology was the same across conditions. For instance, an attribute added to yogurt was presented as a flavour enhancer and a benefit. This was the same both for a familiar technology based flavour enhancer and a flavour enhancer based on nanotechnology.

Method

Participants and design

The study had an incomplete 3 (technology: conventional technology, nanotechnology, unrealistic unfamiliar technology) x 4 (product type: yogurt, bread, window, phone) design; where, similar to study 1, all participants rated different product types for each technology. A total of 140 students from Wageningen University participated in the study (57 male, M_{age} = 21.28 years, SD_{age} = 2.66).

Materials and procedure

Attitude objects were advertisements for: yogurt with a (new) flavour enhancer, bread with (new) packaging technology, a window with (new) coating technology, and a smartphone screen based on (new) fibre technology. Three versions of each advertisement were created reflecting the different attributes for conventional technology, nanotechnology, and unrealistic unfamiliar technology (as used in study 1). For instance, participants received the yogurt advertisement with one out of three different claims: a) contains flavour enhancers based on yeast extract for additional flavour, b) contains flavour enhancers based on nano-grinding for additional flavour, c) contains flavour enhancers based on ethylene ripening for additional flavour. All advertisements were specifically designed for the experiment and do not exist in the market (see table 4.1 and Appendix 4.1).

A pilot study with students and employees from Wageningen University (N = 40; 19 males, M_{age} = 22.73, SD = 6.85) in which each participant judged three attributes in a product context on familiarity, realism, fear, positivity, credibility and comprehensibility, confirmed that the attributes displayed in a product advertisement context were equally realistic, credible, comprehensible, positive and non-fearful. The familiar technology attribute-description was considered as more familiar than the other technology attribute-descriptions. However, familiarity with the technologies was low overall. Therefore, the advertisements were slightly adjusted to make the familiar claim even more familiar (instead of a “new technology” claim, an “improved technology” claim was used).

The rest of the methods were identical to study 1. Scales had acceptable to good reliabilities (α_{affect} = .80; $\alpha_{cognition}$ = .75; $\alpha_{overall}$ = .87).

Results

In a product context participants were similarly familiar with conventional technology (*M* = 2.54), nanotechnology (*M* = 2.50) and unrealistic unfamiliar technology attributes (*M* = 2.23), F (1, 393) = 1.45, p =.24. Both affect and cognition had a positive main effect on overall attitude, F_{affect} (1, 371) = 69.43, $p < .001$, b=0.75; $F_{cognition}$ (1, 371) = 105.26, $p < .001$, b=0.28. Technology had no main effect on overall attitude, F (1, 371) = .31, p = .74. Product type showed a main effect on overall attitude F (1, 371) = 4.11, p = .007.

The interaction between technology and affect on overall attitude was significant, F (1, 371) = 6.59, p = .011, showing that affect has a higher association with overall attitude towards unrealistic unfamiliar technology as compared with conventional technology. The interaction between technology and cognition had a marginally significant effect on overall attitude, F (1, 371) = 2.67, p = .07, suggesting that cognition has a higher association with overall attitude towards nanotechnology compared with unrealistic unfamiliar technology. There were no interaction effects between product type and affect or cognition on overall attitude, F_{affect} (1, 371) = .25, p = .86; $F_{cognition}$ (1, 371) = 1.60, p = .19. Unstandardized regression coefficients for affect and cognition across technologies corrected for product type are reported in table 4.2. For unrealistic unfamiliar technology there is a relatively high association between affect and overall attitude, compared with conventional and nano-technology. In table 4.2 it is also shown that for nanotechnology there is a relatively high association between cognition and overall attitude, compared with unrealistic unfamiliar and conventional technology, although this is only marginally significant. In conclusion, there is a relatively stronger association between affect and overall attitude for unrealistic unfamiliar attitude objects, whereas for nanotechnology a strong association between cognition and overall attitude was observed.

Discussion

For conventional technology affect and cognition are comparably important in overall attitude expression in a product context, which resembles the evaluation of the technology attribute in study 1. When a technology is completely unfamiliar (unrealistic unfamiliar) and placed within a product context, affect is more predictive for the overall attitude. Between study 1 and study 2 the process apparently shifts from cognitive (without product context) to affective (within product context), possibly because affect associated with the product takes over in the lack of any knowledge. For nanotechnology, adding a product context, makes cognition more predictive for the overall attitude. The process apparently shifted from a more affective process when only attributes are provided (study 1), to a more cognitive process when attributes are provided in a product context (study 2). Expressing attitudes when an unfamiliar nanotechnology attribute is integrated into a well-known product may thus be more difficult than expected, especially if it needs to be done without any additional information.

Although finding which attitude component is more predictive for the overall attitude hints at shifts in underlying processes, further investigation of that process approach is needed for better understanding of the ease with which attitudes are constructed. In study 3 the focus is on the elaborateness of underlying affective and cognitive processes that determine whether people rely on affect or cognition. As in study 2, attributes within a product context are studied, but this time while using an eye-tracking approach.

Study 3: Underlying processes

In the third study affective and cognitive processes were compared in terms of elaborateness on underlying attribute-evaluations for the products used in study 2. Insight into the attitude formation process is derived from eye gaze analysis during attitude expression. In addition to study 1 and 2, it is investigated whether first reporting an overall attitude influences subsequent affective and cognitive processing, and, vice versa, whether first reporting affect and cognition influences how people answer when reporting an overall attitude.

Method

Participants and design

The present study followed the procedure as described in Chapter 3. The study had a 3 within (technology: conventional technology, nanotechnology, unrealistic unfamiliar technology) x 3 between (attitude object: yogurt, bread, phone) incomplete block design; chosen in such a way that each participant received all three technologies applied to three different products similar to study 2. To present the attitude objects the same advertisements as in study 2 were used. Half of the participants were instructed to report their overall attitude, after which affect and cognition were assessed (condition A in table 4.3, 4.4, 4.5). The other participants assessed affect and cognition prior to overall attitude (B in table 4.3, 4.4, 4.5). In total, ninety six undergraduates from Wageningen University participated in the study (33 male, M_{age} = 21.46 years, SD_{age} = 2.71); who recorded affect, cognition and overall attitude for three product technology combinations. Twelve participants were excluded because there were problems with eye movement registration or data transformation, leaving 84 participants with a total of 756 trials for data analysis.

Materials

Tasks. Participants were seated in a separate room in front of a 19 inch LCD monitor with a remote 60 Hz sampling eye-tracker system (RED of SMI, see:www.smivision.com) at approximately 60 cm distance. The eye-tracker was set at a 30 degree angle, allowing for free movement of the participant's head in a 40 x 40 cm virtual box. Fixations were defined as a stationary eye-gaze position of at least 80 ms (cf. Lamme, 2003). Stimulus material was offered to participants via the web-based Qualtrics survey tool, and loaded to the eye-tracker system via Experiment Center 3.0. IViewX 2.7 was used to record eye movements.

Measures

Three response scales were specifically designed for this purpose (as described in Chapter 3): an affective judgement scale, a cognitive judgement scale and a combined scale comprising both the affective and cognitive answering options (see figure 4.1). Participants were asked to indicate, through a mouse click, the response option that best described their opinion towards the attitude object. During the process of response option selection, eye gaze was monitored by means of an eye-tracker, with the scale items defined as the relevant Areas of Interest (AOI). From the eye gaze patterns for each of the attitude objects on each of the scales, the following measures were derived:

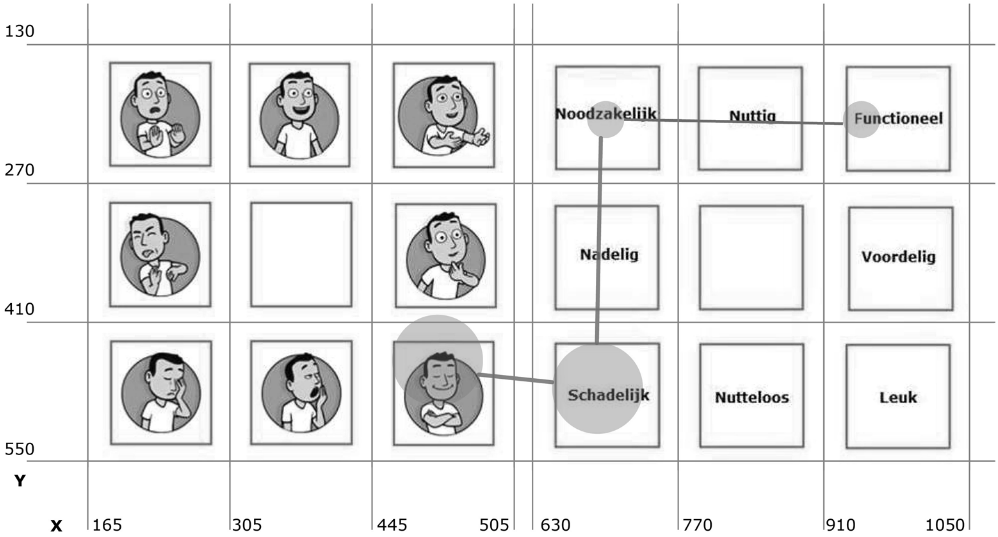


Figure 4.1. Combined scale, with left part of the scale showing the emotions (clockwise starting in the top left corner): fear, joy, desire, fascination, satisfaction, boredom, sadness, disgust. Translations cognitions (clockwise starting in the top left corner): necessary, useful, functional, beneficial, nice, useless, harmful, disadvantageous.
Affective scale and cognitive scale were also assessed separately.
Note. Numbers on x and y- axes are an illustrative example, AOIs were approximately the size of the frames (112x116).

Elaborateness of processing was operationalized as (a) the total number of fixations on the AOIs of the different scales (b) total dwell time (Velichkovsky et al., 2002) and (c) the length of the eye gaze pattern (in terms of Euclidian distance[2]).

Trade-offs were operationalized as (a) the number of transitions between AOIs, and (b) the number of unique AOIs fixated on.

Final attitude was measured as the response option that participants selected by mouse click as best fitting with the attitude object, both on the affective, cognitive and combined scales.

2 Each frame was given a coordinate on both dimensions (1, 2, or 3). These simple coordinates were used as an approximation for the coordinate of a fixation and used to calculate saccade distance between two relevant fixations.

Procedure

Before starting the actual task participants received an introduction to all three answer scales in which scale dimensions and the position of each cartoon or word were explained, followed by a training procedure to familiarize them with the scales. Practice trials were provided with attitude objects not used in this study.

After the training procedure and before participants started with the actual task, eye-movements were calibrated by asking participants to follow a calibration point on screen (9-point calibration). In the actual task for each trial the attitude object was presented on screen for 7 seconds, followed by a screen with one of three judgement scales located in the middle of the screen. Participants judged for each type of attitude object (yogurt, bread, phone) one type of technology (conventional, nanotechnology, unrealistic unfamiliar). Participants either judged all advertisements using the combined scale first (randomized order of attitude objects), followed by answering the affective and cognitive scale, or the other way around (starting with affective and cognitive scale). Participants thus judged three attitude objects on each of the three scales. For each scale, participants responded with a mouse click, after which the next attitude object appeared on screen. From the moment the actual task started, eye movements were collected until participants completed all the questions. Only eye–gaze fixations on the scales were analysed. There was no time constraint set on responses.

After completion, participants were debriefed and received a lunch voucher of €2 for 10 minutes of participation. Before and during the debriefing participants were given the opportunity to comment on the study.

Data analyses

Analyses were conducted with SPSS 19. Prior to analysis, all variables were examined for accuracy of data entry, missing values, and distributions. Number of fixations, dwell time, length of the eye gaze pattern, number of transitions, and number of unique AOIs were analysed for conventional, nanotechnology, and unrealistic unfamiliar technology, using general linear mixed model analyses (multilevel). Product type was included at the highest level. For each product, multiple technologies were assessed and included at the lowest level, with a random intercept (within-subject design).

Elaborateness of processing for affective attitude compared with cognitive attitude, and the underlying measures of total fixation duration, total number of fixations, and length of eye gaze pattern, were the dependent measures and technology the independent variable. Results are reported in table 4.3, as means for affect and cognition per technology, for the two different orders (A = overall attitude first; or B = affect and cognition first). Between technologies means were compared with the posthoc procedure in SPSS's linear mixed model (pairwise comparison of Estimated Marginal means, LSD). Trade-offs for cognitive and affective attitude, and the underlying measures as number of transitions between AOIs, number of unique AOIs fixated on were analysed in the same way (table 4.3).

Results

Elaborateness of processing for affect and cognition

For each technology, the elaborateness of processing and the trade-offs for the affective and cognitive scale are compared. Without taking into account the order of judgement, there are no differences in affective and cognitive processing for each technology (see table 4.3, total). Also, when investigating the different order of judgement, for conventional and unrealistic unfamiliar technology, affective and cognitive processes do not differ (see table 4.3, condition A and B). For nanotechnology however, there were differences on several measures when overall attitude was expressed prior to affect and cognition (see table 4.3, condition A). For nanotechnology, cognition requires less elaborate processing than affect as shown by (a) a lower number of fixations on AOIs (M_{affect} = 7.49 vs. $M_{cognition}$ = 5.61; F = 4.3, p = .04), and (b) a lower total dwell time (M_{affect} = 2326.38 vs. $M_{cognition}$ = 1581.68; F = 6.43, p = .02), but not by a shorter length of the eye gaze pattern (M_{affect} = 6.35 vs. $M_{cognition}$ = 4.77; F = 1.85, p = .18). These results suggest that, for nanotechnology attributes in a product context, less elaborate processing is necessary to express cognition compared with affect when the overall attitude has been expressed first.

Table 4.3

Elaborateness of processing affective and cognitive judgement per technology

Elaborateness of processing		Conventional technology				Nanotechnology				Unrealistic unfamiliar technology			
Measure	Condition	Affect	Cognition	*F (df)*	*P*	Affect	Cognition	*F(df)*	*P*	Affect	Cognition	*F(df)*	*P*
Total number of fixations on AOI	Total	7.26	6.83	0.33 (1,83)	.57	7.20	6.82	0.27 (1,83)	.83	7.19	7.75	0.39 (1,83)	.53
	A	7.47	7.67	0.04 (1,42)	.85	7.49	5.61	4.30 (1,42)	**.04****	6.98	7.91	0.43 (1,42)	.51
	B	7.05	5.95	1.17 (1,80)	.28	6.90	8.10	1.19 (1,40)	.28	7.42	7.59	0.025 (1,40)	.88
Total dwell time (AOIs) in ms	Total	2234.24	1988. 24	0.83 (1,83)	.37	2207.50	1880.20	2.43 (1,83)	.12	2247.93	2182.56	0.05 (1,83)	.82
	A	2188.62	2263.60	0.04 (1,42)	.85	2326.38	1581.68	6.43 (1,42)	**.02****	2287.21	2295.26	0.00 (1,42)	.99
	B	2282.09	1699.43	2.58 (1,80)	.11	2082.82	2193.29	0.15 (1,40)	.70	2206.73	2064.36	0.14 (1,40)	.71
Length of eye gaze pattern	Total	5.89	5.75	0.03 (1,81)	.86	5.82	5.86	0.002 (1,81)	.96	5.88	6.84	1.03 (1,82)	.31
	A	5.75	6.56	0.42 (1,41)	.52	6.35	4.77	1.85 (1,41)	.18	5.82	7.12	0.83 (1,42)	.37
	B	6.05	4.91	1.16 (1,40)	.29	5.21	6.99	2.43 (1,40)	.13	5.93	6.57	0.26 (1,40)	.62

Trade-offs		Conventional technology				Nanotechnology				Unrealistic unfamiliar technology			
Measure	Condition	Affect	Cognition	*F (df)*	*P*	Affect	Cognition	*F(df)*	*P*	Affect	Cognition	*F(df)*	*P*
Number of transitions between AOIs	Total	3.69	3.79	0.03 (1,83)	.86	3.86	3.57	0.34 (1,83)	.56	3.70	4.13	0.52 (1,83)	.47
	A	3.61	3.32	0.17 (1,40)	.68	3.49	4.05	0.63 (1,40)	.43	3.61	3.71	0.02 (1,40)	.88
	B	3.77	4.23	0.36 (1,42)	.55	4.21	3.12	2.67 (1,42)	.11	3.79	4.54	0.58 (1,42)	.45
Number of unique AOIs	Total	3.86	3.64	.52 (1,83)	.48	3.92	3.49	1.99 (1,83)	.16	3.74	3.86	.18 (1,83)	.68
	A	3.71	3.66	.01 (1,40)	.91	3.88	3.76	.07 (1,40)	.79	3.61	3.83	.41 (1,40)	.53
	B	4.00	3.63	.77 (1,42)	.39	3.95	3.23	3.12 (1,42)	.08†	3.86	3.88	.003 (1,42)	.96

Overall attitude

In general, for all technologies, the overall attitude is about equally frequently based on affect and cognition. When comparing whether affect or cognition was more decisive for the overall attitude, conventional technology and nanotechnology are insensitive to order of attitude scales (see table 4.4). For unrealistic unfamiliar technology affect is least frequently chosen when overall attitude was assessed first (34.9%), whereas when the order of scales is reversed affect is most frequently chosen (61.0%).

Although affect and cognition were about equally decisive for the overall attitude for the different technologies, it can be expected that people who rely on cognition while forming overall attitudes, later on have a less elaborate cognitive process. Similarly people who chose affect on the overall attitude scale are expected to have a less elaborate affective process later on. Therefore, the elaborateness of processing for the affective and cognitive judgements, after the overall attitude was reported, are investigated in more detail. MANOVAs were conducted with the

Table 4.4
Overall attitude judgement based on affect (chance = 50%)

Condition	Measure	Conventional technology	Nanotechnology	Unrealistic unfamiliar technology
Total	Count	34	36	40
	Percentage	40.5%	42.9%	47.6%
	Adjusted residual	-.7	-.2	.9
A	Count	17	18	15
	Percentage	39.5%	41.9%	34.9%
	Adjusted residual	.1	.5	-.6
B	Count	17	18	25
	Percentage	41.5%	43.9%	61%
	Adjusted residual	-1.1	-.8	1.9

Note. A indicates that overall attitude is assed prior to affective and cognitive attitude, and B indicates that affective and cognitive attitude are assessed prior to overall attitude. Only percentages for affect are given as the percentages for cognition can be derived from here.
Statistical tests: Total: χ^2 = .90, *df* = 2, *p* = .64; Condition A: χ^2 = 3.71, *df* = 2, *p* = .16; Condition B: χ^2 = .46, *df* = 2, *p* = .80

process measures for affect and cognition as dependent variables (within) and the response on the overall attitude scale (affect or cognition) as independent variable. A significant interaction effect indicates that there are differences in underlying affective and cognitive processes, depending on whether the overall attitude response was based on affect or cognition (see table 4.5, interaction).

It is shown that for products with conventional technology, when overall judgement is based on cognition, there is less extensive cognitive processing later on, compared with when the overall attitude is based on affect. There are no differences in affective processing independent whether the overall atitude judgement was based on affect or cognition. Similarly, for products with unrealistic unfamiliar technology it is shown that when overall judgement is based on cognition there is less extensive cognitive processing later on, compared with when overall attitude is based on affect. For products with nanotechnology, however, it is shown that when overall attitude judgement is based on affect, later on there is less extensive affective processing, as compared with when the overall attitude is based on cognition. There are no differences in cognitive processing, independent whether the overall attitude judgement was based on affect or cognition.

Although affect and cognition were about equally decisive for conventional and nanotechnology, the affective and cognitive processing that follows differ. In the case of conventional technology, when cognition was decisive for the overall attitude, later cognitive processing was less elaborate, independent of affect. For nanotechnology, on the other hand, whether affect or cognition was decisive for the overall attitude scale seems to be related to less elaborate processing of affect, independent of cognition. For unrealistic unfamiliar technology similar patterns as for familiar attributes were found although interpretation is less obvious because there is a much smaller group of people choosing cognition than affect on overall attitude. All together these results could indicate that, as respondents have formed their attitude already on the overall attitude scale, they later on quickly scan the answer options without too much effort until the most suitable answer option has been found.

Table 4.5

Affective and cognitive processing after affect or cognition is decisive on overall attitude (condition A)

		Cognitive processing				**Affective processing**				**Interaction**	
Technology	**Measure**	*Aff. decisive*	*Cog. decisive*	*F (df)*	*P*	*Aff. decisive*	*Cog. decisive*	*F (df)*	*P*	*F (df)*	*P*
Conventional	Total number of fixations on AOI	9.18	6.70	1.70 (1,41)	.20	6.64	8.00	1.70 (1,41)	.20	1.54 (2,40)	.23
	Total dwell time (AOIs) ms	2648.81	2011.74	.92 (1,41)	.92	2022.59	2297.18	.22 (1,41)	.64	.65 (2,40)	.53
	Total distance	9.04	**4.85**	4.52 (1,40)	.040*	4.71	6.46	1.37 (1,40)	.25	3.15 (2,39)	.054†
	Transitions between AOIs	5.65	**3.31**	3.32 (1,41)	.076†	3.35	4.04	.41 (1,41)	.53	2.06 (2,39)	.14
	Number of unique AOIs	4.76	**2.88**	9.33 (1,41)	.004**	3.71	4.19	.45 (1,41)	.51	5.92 (2,40)	.006**
Nano-technology	Total number of fixations on AOI	6.44	5.00	1.17 (1,42)	.29	**5.67**	8.80	3.97 (1,42)	.053†	3.49 (2,41)	.040*
	Total dwell time (AOIs) ms	1759.14	1453.90	.59 (1,41)	.45	1845.67	2672.49	2.45 (1,41)	.13	1.90 (2,40)	.160
	Total distance	6.01	3.93	1.99 (1,39)	.17	**4.42**	8.16	3.65 (1, 39)	.063†	3.31 (2,38)	.047*
	Transitions between AOIs	3.61	2.76	.73 (1,41)	.40	**2.78**	*5.24*	4.31 (1,41)	.044*	3.40 (2,40)	.040*
	Number of unique AOIs	3.56	3.00	.86 (1,41)	.36	**3.17**	4.52	4.50 (1,41)	.040*	3.19 (2,40)	.052†
Unrealistic unfamiliar	Total number of fixations on AOI	12.73	**5.32**	8.58 (1,41)	.006**	7.53	6.68	.22 (1,41)	.64	4.19 (2,41)	.022*
	Total dwell time (AOIs) ms	3775.80	**1502.12**	9.48 (1,41)	.004**	2525.63	2159.49	.32 (1,41)	.57	4.63 (2,40)	.016*
	Total distance	12.40	**4.67**	8.86 (1,37)	.005**	6.39	5.88	.081 (1,37)	.77	4.33 (2,36)	.021*
	Transitions between AOIs	7.73	**2.82**	7.55 (1,41)	.009**	4.07	3.64	.12 (1,41)	.73	3.70 (2,40)	.033*
	Number of unique AOIs	5.53	**3.00**	13.13 (1,41)	.001**	4.27	3.64	.67 (1,41)	.42	6.41 (2,40)	.004**

Note. †<.10 *<.05; **<.01; ***<.001. Results are reported per technology for each of the dependent variables. Affective and cognitive processing refer to the process of answering the affective / cognitive scale after the overall attitude is reported. When affect was chosen on the overall attitude scale this is referred to as 'affect decisive' or when cognition was chosen 'cognition decisive'. Bold indicates that which is decisive for the overall attitude later on required less elaborate processing compared to the other attitude component.

Discussion

By means of eye-tracking this study showed that for nanotechnology cognition required less elaborate processing than affect, but only after the overall attitude had been expressed. This finding aligns with the results from study 2 where people relied relatively more on cognition for nanotechnology. Study 3 provides evidence that people rely relatively more on cognition for nanotechnology, because cognition is probably the easier process. This may be because it is relatively difficult to integrate a nanotechnology attribute in an affective way into existing knowledge structures. This is supported by additional analyses where it was shown that it is probably the ease of affective processing that determines the choice for affective option for nanotechnology on the overall scale. In contrast, it appears that it is the ease of cognitive processing that determines which option is chosen most often for conventional and unrealistic unfamiliar technologies.

General discussion

The current chapter provides new insights into how attitudes are formed when people lack sufficient knowledge about an attitude object with a novel attribute. More specifically the role of affect and cognition in attitude formation towards (un) familiar technologies was investigated in three complementary ways. In study 1 only technology descriptions were provided, in study 2 these technology descriptions were placed in a product context addressing the benefit of the technology. In study 3 underlying affective and cognitive processes on the products from study 2 were studied by means of eye-tracking.

When expressing attitudes people in principle have access to a rich network of affective responses and cognitive beliefs. In some cases, the attitude is more grounded in affect and in other cases more in cognition. Attitudes towards well known objects are embedded in extensive knowledge structures, composed of beliefs, feelings, behaviors, and prior experiences (Eagly & Chaiken, 1995). The present research shows that for such well known objects, in this case conventional technology, affect and cognition are equally predictive for the overall attitude. This is the case for attribute-evaluations as well as attribute-product-evaluations, which suggests that conventional technology attributes and their embedding in products are part of established knowledge structures (Marks & Olson, 1981).

When product knowledge is incomplete, in this case because of the addition of an unknown technology attribute, incomplete associations towards the attitude object exist. Hence, attributes of the attitude object will be encountered that can not easily be associated with existing knowledge structures and schemata (Fiske & Taylor, 1991). Whether overall attitudes are subsequently based on affect or cognition depends on people's ability to interconnect the unfamiliar attribute into existing schemata and knowledge structures (Peracchio & Tybout, 1996). The present research shows that when asked to judge an unrealistic unfamiliar technology attribute on its own, guidance is found in cognition. These results are in line with research by Sujan (1985), who describes that when the match between incoming information and category knowledge is low, more analytical processes would be needed to arrive at the attitude. This in turn suggests that when there is no association with existing knowledge, cognitive analytical processes can be used to construct the evaluation. However, when the unrealistic unfamiliar technology attribute was embedded in a product, the results show that evaluation is based more on affect. A possible explanation could be that the multitude of known product associations are salient and inform the final attitude. This could indicate that people search for an easy solution by relying on affect associated with the product. This is consistent with previous research that suggested that if the task of fitting an unknown attribute is too difficult, people give up and seek a simple solution (Bettman & Park, 1980).

A different outcome is found when people have some, but limited, knowledge about an attribute, as is the case for nanotechnology. Nanotechnology is perceived as unfamiliar, but because people might already have encountered nanotechnology, or at least heard of it before (Ho, Scheufele, & Corley, 2013), it is more familiar than a non-existing (unrealistic unfamiliar) technology. This explains the observation that when a nanotechnology attribute is evaluated on its own, affect is relatively more important compared with evaluation of a completely unknown attribute. An explanation consistent with previous research could be that recognition of the technology (in this case the word 'nano') allows affect stored with the technology category to be triggered, leading to an affective reaction towards the technology attribute (Sujan, 1985). However, when the somewhat familiar nanotechnology is included into a product context, it seems that the new attitude object becomes incongruent with existing schemata. This seems to be solved by integrating the technology attribute rather than disregarding the attribute. Although it could not be confirmed whether the unfamiliar attribute indeed was integrated within the existing knowledge structures, it seems that people search for guidance that can be provided by cognitive construction of a product attitude. It is also relatively easier to solve this incongruency cognitively (study 3). Future research should take this a step further and address how unfamiliar technologies and technology attributes relate to respondents existing schemata, for example, by means of think-out-loud protocols involving discussion with respondents.

The extent to which the results for nanotechnology can be generalized for the larger population can also be doubted, as the samples consisted of university students who are probably more familiar with technological applications than the average member of the population and are better able to draw on cognitive inferences. Therefore, in future research, attitude formation towards (un)familiar technologies should be investigated with a more diversified sample (see Chapter 5). Nevertheless at a theoretical level, it is expected to find a similar shift from fully unfamiliar through somewhat familiar to fully familiar and the effect on the relative influence of affect and cognition on attitude in the population at large.

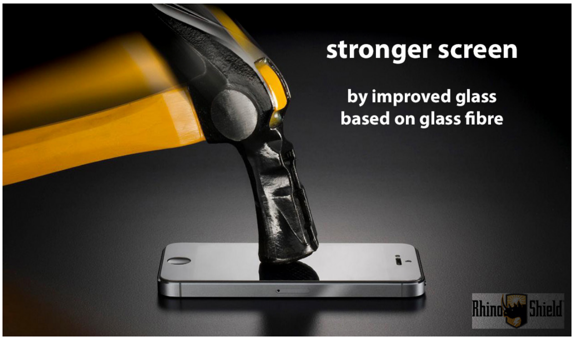
Together, the results imply that both with extensive (conventional technology) and no knowledge levels (i.e. nanotechnology attributes; unrealistic unfamiliar technology in a product context) affect is relatively more important in attitude formation. With intermediate levels of knowledge cognition is relatively more important. This follows a pattern similar to the use of intuitive strategies influenced by an individual's expertise level (Baylor, 2001). When individuals are true novices they do not possess the ability to address the attitude object analytically and therefore rely on an immature form of intuition (Baylor, 2001). Experts, on the other hand, often lack the motivation and need to evaluate the attitude object extensively and therefore rely on information from memory and prior experience, often in an affective, intuitive manner (Bettman & Park, 1980).

The current research follows an emerging stream of research claiming that eye-tracking research is a useful addition to the toolbox for investigating the commonalties between intuitive and deliberative processes in decision making, using process data (Glöckner & Herbold, 2008; Horstmann et al., 2009). More particularly in the current studies, the use of eye-tracking to follow eye gaze patterns during scale completion provides further insights into the process of elaboration whilst judging attitude objects. The eye-tracker study showed that the attitude component that is decisive in expressing overall attitudes (affect or cognition), later also requires less processing when the attitude components are separately assessed. People who rely relatively more on cognition over affect more easily arrive at a cognitive attitude. Whereas those who tend to prefer affect over cognition more easily arrive at an affective attitude. People thus choose the path of least resistance, which is consistent with the ideas behind most dual process models (Evans, 2008). Interestingly, the results show that affect is not always the easiest path but that in specific situations cognition may be easier. This aligns with the results of Chapter 3 that found that expressing the cognitive attitude for neutral attitude objects required less elaborate processing compared with affect, when the overall attitude was expressed first . Neutral attitude objects can also be considered objects with weak object-evaluations. Hence, this provides evidence that for weak attitude objects the order of processing matters, as it seems that attitudes for attitude objects with less developed knowledge structures need to be constructed, instead of being immediately retrieved from memory. By means of eye-tracking it was possible to go beyond investigating attitude outcomes, and also examine underlying processes in attitude formation. The eye-tracker data support the interpretation of the study with technologies placed in context, which gives more confidence in the current interpretation of the underlying processes.

Respondents were presented with realistic advertisements of products. Advertisements and claims (benefits) were kept constant for each product, except the technology was varied. Whilst keeping everything the same except the technology, differences in affect or cognition being more decisive for the overall attitude can solely be explained by difference in the technology attribute. Products were chosen in such a way that three different technologies could be applied within the same product. At the same time, it could be that by doing so an artificial product context was created, for instance by providing a yogurt with 'yeast extract' as flavour enhancers. By choosing the current product set (yogurt, bread, phone) other evaluative processes could have played a role as well, such as evaluating the products (unconsciously) in a more hedonic or utilitarian way (Voss, Spangenberg, & Grohmann, 2003). In the current research there was controlled for this by introducing the technologies and objects as random repetitions, to control as much as possible for such effects. However, if there are systematic effects these might have influenced the results. Hence future research should substantiate the current findings using different product and technology attribute sets.

By systematically studying attitude formation towards (un)familiar technologies without reference to any context, within a context, and exploring underlying process mechanisms, valuable insights in attitude formation processes were derived. A first important finding is that if the technology attribute can be integrated within existing knowledge structures, both affective and cognitive processes can be addressed. For unfamiliar attributes attitude formation is context dependent. If the context provides cues the unfamiliar attribute is ignored and people rely on affect, and if not, people need to solve the incongruency using cognition. It is therefore important to integrate unfamiliar attribute constellations within existing affective and cognitive knowledge structures. A second important finding is that in attitude formation the component that is decisive in expressing overall attitudes (affect or cognition), later on also requires less processing. People thus choose the attitude path of least effort, and rely on the component that is easier to construct, be it affective or cognitive.

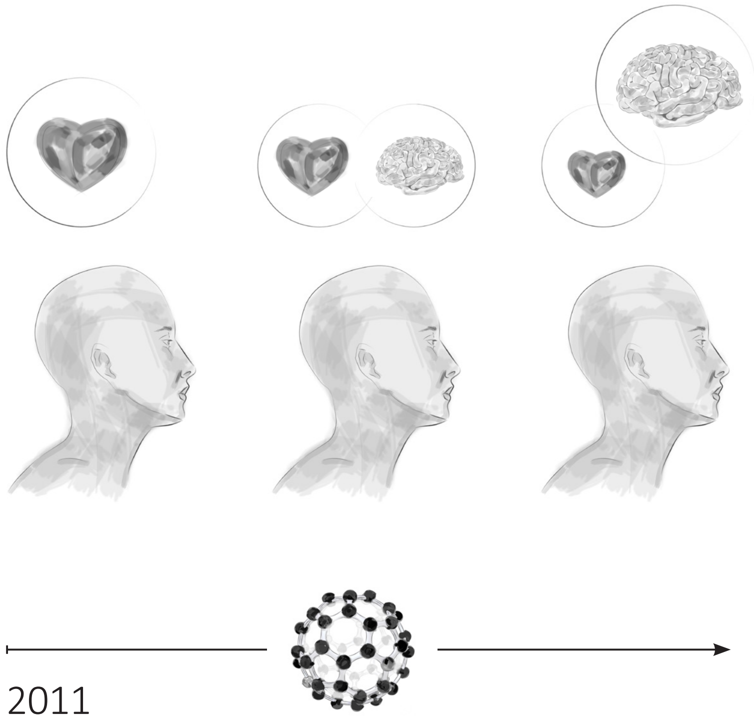
Appendix 4.1. Examples of stimulus material



Examples of advertisements for different product characteristics: a smartphone ad with realistic familiar technology, a bread ad with nanotechnology and a yoghurt ad with unrealistic unfamiliar technology. Text is translated from Dutch language.

Chapter 5

Changes over time in the influence of affect and cognition on consumer attitude formation towards nanotechnology: A longitudinal survey study



This chapter is submitted for publication as: Giesen, R.I. van, Fischer, A.R.H. & Trijp, J.C.M. van. Changes over time in the influence of affect and cognition on consumer attitude formation towards nanotechnology: A longitudinal survey study.

Abstract

Insights into how consumer attitudes towards nanotechnology are formed and develop are crucial for understanding and anticipating possible barriers in consumer acceptance of nanotechnology applications. In this study the influence of affect and cognition on overall opinion is investigated longitudinally for emerging nanotechnologies, and compared with conventional technologies. Overall, in attitude formation towards nanotechnology applications, people rely relatively more on affect than cognition. Over time, reliance on affect decreases whereas reliance on cognition increases for nanotechnology. This suggests that over time nanotechnology applications have become somewhat more integrated within people's already existing knowledge structure. However, for conventional technologies the influence of affect and cognition on overall attitude remains stable over time. The current study shows that it is essential to address both affective and cognitive aspects of public opinion of nanotechnology.

Changes in the influence of affect and cognition over time on consumer attitude formation towards nanotechnology: A longitudinal survey study

Nanotechnology is a promising yet little known novel technology. Nanotechnology enables the creation of completely new products, as well as substantial improvement of properties of existing products. Consumers lack knowledge about and experience with nanotechnology, which makes it difficult for them to understand the full range of possible risks and benefits associated with nanotechnology and nano-based products (Siegrist, 2010). Previous technologies, such as genetic modification, biotechnology and nuclear energy have met with much resistance from the public, leading to rejection of these technologies by the public at large (Currall et al., 2006; Einsiedel & Goldenberg, 2004). Certain applications of nanotechnology hold the risk of running into similar issues (Frewer, et al., 2011; Gupta, et al., 2012; Siegrist, Stampfli, Kastenholz, & Keller, 2008). Consumer response may thus significantly influence the development of nanotechnology. Therefore, it is important to understand public attitudes, and particularly how these develop over time (Schenk et al., 2011).

Currently, knowledge about nanotechnology among the general public is very limited (Gupta, Fischer, & Frewer, 2015; Stijnen et al., 2011), which could be attributed to low media attention and exposure (Fischer, van Dijk, de Jonge, Rowe, & Frewer, 2013). Even though knowledge on nanotechnology is low, people seem to be able to form opinions about nanotechnology anyhow (Cobb, 2005; Scheufele & Lewenstein, 2005; Siegrist, 2010). Nanotechnology, in general, is perceived more positive in the United States than in Europe (Cobb, 2005; Gaskell, Eyck, Jackson, & Veltri, 2005). The question is how consumer opinions towards nanotechnology arise. Previous research has identified that value predispositions, religious beliefs, and heuristic cues are important in shaping consumer perception of nanotechnology applications (Cacciatore, Scheufele, & Corley, 2011; Scheufele, Corley, Shih, Dalrymple, & Ho, 2009). Also, it has been shown that consumer opinion as well as acceptance are dependent on the specific domain of nanotechnology applications under evaluation (Pidgeon, Harthorn, & Satterfield, 2011). For instance, food-related nanotechnology applications are perceived as less positive than applications in other domains, such as energy (Siegrist, Cousin, Kastenholz, & Wiek, 2007;

Siegrist, et al., 2008). By and large, most of these studies have focussed more on comparison between different applications of nanotechnology but not comparison of nanotechnology with its conventional counterparts. In addition, it is not clear how the attitude structure of nanotechnology develops and changes over time (Pidgeon et al., 2011). Understanding attitude development over time requires longitudinal studies facilitating the tracking of opinions and their determinants over time, and to shed light on what causes potential changes in attitudes over time (George, 2000; Vandermoere, Blanchemanche, Bieberstein, Marette, & Roosen, 2011). Monitoring attitude formation for nanotechnology longitudinally can provide insights into how the attitude structure, in terms of underlying affect and cognition, evolves over time.

The present study aims to investigate whether the influence of affect and cognition on the overall opinion of nanotechnology will change over time, and if so, whether changes can be explained by knowledge growth. This is done by means of a longitudinal survey study in which attitudes for nanotechnology applications and conventional applications are compared.

Attitudes

Consumer opinions are studied by attitudes, which represent summary evaluations. Attitudes can be viewed as “associations in memory between a given object and one’s evaluation of that object” (Ajzen, 2001; Fazio, 2007). In attitude research a distinction is made between affect-based (feelings and other affective factors) and cognition-based (cognitive beliefs) attitude expressions (Edwards, 1990). In many situations prior knowledge towards the attitude object is available, so that attitudes are based on earlier affective and cognitive experience with the attitude object (Fazio, 2007). Depending on the context with the attitude object, overall attitude expressions will find their base more in cognition or more in affect.

Having an established knowledge base, which is likely to be the case for applications of conventional technologies, means that relevant affective and cognitive information and experiences are available (Edwards, 1990; Plessner & Czenna, 2008). As people can draw on both affective and cognitive associations with the conventional attitude object, the attitude formation process is relatively straightforward.

Attitude formation becomes more challenging when the attitude object contains attributes that the consumer is unfamiliar with, which is the case when evaluating nanotechnology applications. When individuals lack a priori evaluative associations (Fazio, 2007), evaluations towards the attitude object need to be constructed on the spot (Schwarz, 2007). New connections between unfamiliar attitude objects and existing knowledge structures will have to be created to reach a better understanding (Peracchio & Tybout, 1996).

In cases with a lack of concrete factual information, attitudes are often based on affect (Kahan et al., 2007; Satterfield, Kandlikar, Beaudrie, Conti, & Harthorn, 2009; Slovic et al., 2004), which compared with cognitive weighing of pros and cons requires less formal information in decision making (Slovic et al., 2002). Affective responses do not necessarily require conscious elaboration and can therefore be created more quickly (Bornstein, 1989; Hansen & Wänke, 2009; Zajonc, 1980). In addition, people can more easily access the broader range of affective feelings, further contributing to the heavier weighting of affective information compared with factual information (Clore & Huntsinger, 2007; Clore & Schnall, 2005). Affect experienced at the moment of evaluation thus plays an important role in people's early judgments of unfamiliar applications (Loewenstein, Weber, Hsee, & Welch, 2001). It is likely that for nanotechnology, in contrast to conventional technologies, people cannot access all relevant representations as evaluation-linkages are not established yet, and no fully-fledged evaluation is stored in memory. It is therefore expected that:

- H1: For nanotechnology compared with conventional technology there are differences in the influence of affect and cognition on overall attitude, with affect being relatively more influential for nanotechnology.

Prior knowledge influences information search and information processing and is also expected to influence the attitude formation process. Having a knowledge base of relevant information about a technology, allows the formation of informed attitudes (Edwards, 1990; Plessner & Czenna, 2008). People with higher domain knowledge and expertise, are better able to use recalled evidence and are influenced by content (Ofir, 2000).

When prior knowledge is however limited, as is the case with nanotechnology, it tends to be structured in a rudimentary fashion involving few linkages among its elements. The new (nanotechnology) information is not yet integrated with previous knowledge (Peracchio & Tybout, 1996). Compared with initial attitudes towards nanotechnology applications when knowledge is low and attitudes are based more in affect, as people learn more about the technology attitudes should become influenced more by values and cognitive beliefs (Reisch, Scholl, & Bietz, 2011). When knowledge starts to expand, previously unfamiliar nanotechnology applications will be increasingly interconnected within knowledge structures, and incongruities may be resolved with a minimum of effort (Peracchio & Tybout, 1996).

As knowledge towards conventional technology is more developed than towards nanotechnology, the attitude structure of conventional technological applications is expected to be more stable over time compared with nanotechnology. With increasing knowledge growth about nanotechnology it will be easier to integrate information and connect it in an already existing knowledge structure. People are then able to access and use this knowledge to supplement their attitudes in a cognitive way. In the case of nanotechnology it can therefore be expected that knowledge growth over time leads to a decrease of the influence of affect on the overall attitude over time. This leads to the following hypotheses:

- H2a: The influence of affect and cognition on overall attitude towards conventional technology is stable over time.
- H2b: For nanotechnology, affect becomes relatively less predictive for the overall attitude over time.

In the present study both objective and subjective knowledge about nanotechnology will be taken into account, and changes in both are monitored over a time span of 2.5 years. Objective knowledge refers to accurate stored information, whereas subjective knowledge refers to self-beliefs about one's own knowledge (Carlson, Vincent, Hardesty, & Bearden, 2009). Although subjective knowledge might give a biased view, there are also some drawbacks in using objective knowledge. It is difficult for people to develop objective knowledge around nanotechnology because nanotechnology applications are not widely available on the market yet, and because there is little consensus on what constitutes fundamental nanotechnology knowledge (Dyehouse, Diefes-Dux, Bennett, & Imbrie, 2008), or what knowledge is relevant for consumers to learn. Together, objective and subjective knowledge might provide a more accurate view on consumer knowledge towards nanotechnology.

The present study

The main aim of this study is to examine to what extent the relative influence of affect and cognition on overall attitude change over time for nanotechnology and conventional technologies. A shift in importance between different modes of attitude formation has not been studied over time, but may provide useful guidelines for developing communications about new technology applications. For instance, on balancing affective and cognitive information in communication to better connect to consumers instead of only providing factual information (Slovic et al., 2002). In addition, the influence of subjective and objective knowledge is taken into account as possible explanation for observed changes in affective and cognitive influence over time.

Monitoring on the basis of longitudinal data brings advantages over cross-sectional data, as consumer attitudes can be compared with the "base level" measurement of the first time point (de Jonge, van Trijp, Renes, & Frewer, 2010). At first, respondents are expected to not have much previous experience with nanotechnology, compared with conventional technology. It must therefore reflect the information and conditions present at the time of attitude formation (Glasman & Albarracín, 2006). Later on, changes in knowledge about nanotechnology applications are monitored and are expected to converge more towards conventional technology knowledge, as with maturation of nanotechnology and its applications more information and knowledge becomes available to the consumer (Maynard, 2006).

In this study, changes in the influence of affect and cognition on the overall opinion of nanotechnology over time are investigated using structured approaches such as confirmatory factor analyses and path analyses. Structured approaches allow for formal comparisons of the construct measures over time to check if the constructs have the same content and meaning across different measurement occasions.

Method

Sample

Consumer attitudes towards nanotechnology and its applications were assessed in three surveys, about 10-11 months apart. The first round of data collection took place during a three-week period in October-November 2012. The second and third data collection round took place during a three-week period in September 2013 and July 2014 respectively. Data were collected through a market research agency (GfK; see www.gfk.com), with a standing panel of individuals. The research complies with the Netherlands Code of Conduct for Scientific Practice and the Social Sciences Ethics Committee of Wageningen University waived the need for ethical consent. GfK anonymized and de-identified all data prior to author access, so there was no access to any identifying information about participants. In-depth analyses of the first data collection round are reported in Chapter 2.

As socio-demographic information of panel members is known, the panel allowed for stratified random sampling of a nationally representative sample on gender, age, and education level of the Netherlands. The GfK panel consisted of approximately 12,000 participants, who were repeatedly invited to participate in studies. Through a range of sampling techniques, the panel is maintained such that it remained representative for the population. In the first data collection round the research agency approached a gross sample of 2500 respondents from their panel, out of which 1907 participated (response rate of 76%). In the first round, there were 37 respondents who indicated that they did not want to be part of the follow up study, or were not serious in their replies. Therefore in the second data collection round the research agency approached 1870 people of whom 1335 responded (response rate of 74%), and in the third round 856 from 1297 invited responded (response rate of 66%). The socio-demographic make-up of the samples, regarding gender, age, and education level can be found in table 5.1.

Table 5.1
Sample Characteristics

Data collection period	2012 (*N* = 1907) October 16-November 6	2013 (*N* = 1335) September 5 – September 16	2014 (*N* = 856) June 5 – June 17	Population statistics (CBS, 2014) (January 1, 2014)
Response rate	76% (of 2500)	74% (of 1870)	66% (of 1297)	-
Gender				
Male	50.7%	51.7%	55.6%	49.5%
Female	49.3%	48.3%	44.4%	50.5%
Age				
18-35	34.9%	29.0%	26.4%	34.7%
36-49	30.6%	30.0%	29.7%	31.2%
50-65	34.5%	41.0%	43.9%	34.1%
Education level				
Low	27.8%	27.1%	27.9%	28.1%
Average	44.4%	44.4%	42.7%	43.1%
High	27.8%	28.5%	29.4%	28.8%

Note. There were 37 people in the first data collection round who indicated that they did not want to be part of the follow up study, or were not serious in their replies. Therefore in the second data collection round the research agency approached 1870 people instead of 1907. Over time there is a higher drop out among females, χ^2 (2) = 9.34, p =.009, Cramer's V =.048, and among the young age group, χ^2 (4) = 33.70, p <.001, Cramer's V =.064. There are no differences in dropout across education levels, χ^2 (4) = 1.17, p =.88.

Materials

Measures to assess the key constructs of the influence of affect, cognition, and knowledge on overall attitude are reported in appendix 5.1 (all measures were 7-point scales unless indicated). In the second and third wave, questions related to media exposure were added. Respondents were asked whether they have read, watched television programs, and accessed the internet, for more information about nanotechnology and its applications (see appendix 5.1).

Respondents judged a familiar (conventional) and an unfamiliar (nanotechnology) application, from the same application domain. This was repeated for two application domains (either water and energy, or medicine and food) to limit response fatigue. In addition, the design was replicated with two different target products for each application domain to make sure effects were not due to the choice of product. Each respondent therefore judged in total four of the sixteen available applications, representing an incomplete repeated measures factor across four domains. During the three annual surveys respondents saw the same applications. The structure of the longitudinal design can be found in appendix 5.2.

Attitude objects

Stimuli were 16 descriptions of technological applications. For each domain two specific applications were selected: food additives and food supplements; water purification and water quality monitoring; medical home tests and drugs; solar energy and batteries. In addition, for each application type a conventional and a nano-based technology was used to manipulate familiarity between the applications. For example, water purification using a nano-membrane versus water purification using a sand-filter were used, where it was expected that people would be more familiar with the sand-filter compared with the nano-membrane.

Respondents received a short description of an application, consisting of: a) information about the technology behind the application, b) examples in which the application can be used, and c) advantages and disadvantages of the application. Descriptions were checked by an expert on nanotechnology and pilot tested.

Data analysis

First, the measurement model was tested using confirmatory factor analysis with maximum likelihood estimation in the R package Lavaan (Rosseel, 2012). Goodness of fit index (GFI) and comparative fit index (CFI) values above .95 and root mean square error of estimation (RMSEA) below .07 were adopted as indication of good fit. χ^2 is reported as customary, but not indicative of model fit with large samples (Kline, 2005). The three waves of data were analysed using multigroup modelling, where each wave of data collection was considered as a separate group. By simultaneously estimating the model for the different time points it could be established whether the properties of the measurement model were stable over time. In the establishment of the measurement model, the relationships between the determinants (affect, cognition) and the dependent variable (overall attitude) for conventional and nanotechnologies were not estimated because testing group differences between the structural parameters was part of the second step of analyses.

After fitting the measurement model, path analyses on the latent constructs were conducted. The first step involved the analysis of a model with affect and cognition on overall attitude for nanotechnology and conventional technology, taking into account the three different time points. The model was trimmed by constraining parameters until the model with the least number of parameters was reached that showed no worse fit compared with the full model by comparing $\Delta\chi^2$, with a significance level smaller than .10. In the second step knowledge level and its' interaction with affect and cognition was added to the model, to check whether changes in affective and cognitive b's were due to changes in knowledge.

Results

Measurement model

The latent variables for affect and cognition were both defined by seven indicators, including positive and negative items. Overall attitude was measured with one item in the first data collection round (T1) and three items in the second and third data collection round (T2 and T3). Confirmatory factor analyses (CFA) were conducted on all key concepts (affect, cognition, overall attitude) taking into account the different time points, and negative versus positive wording of items (see figure 5.1) (Lattin, Carroll, & Green, 2003). The CFA showed an acceptable to good fit across time points, χ^2 (1122) = 1246.27, p < .001; RMSEA = .054; SRMR = .077; CFI = .920; and TLI = .916, supporting the assumption that the measurement model is robust across time periods. Items were then averaged to form affective, cognitive and overall attitude scales.

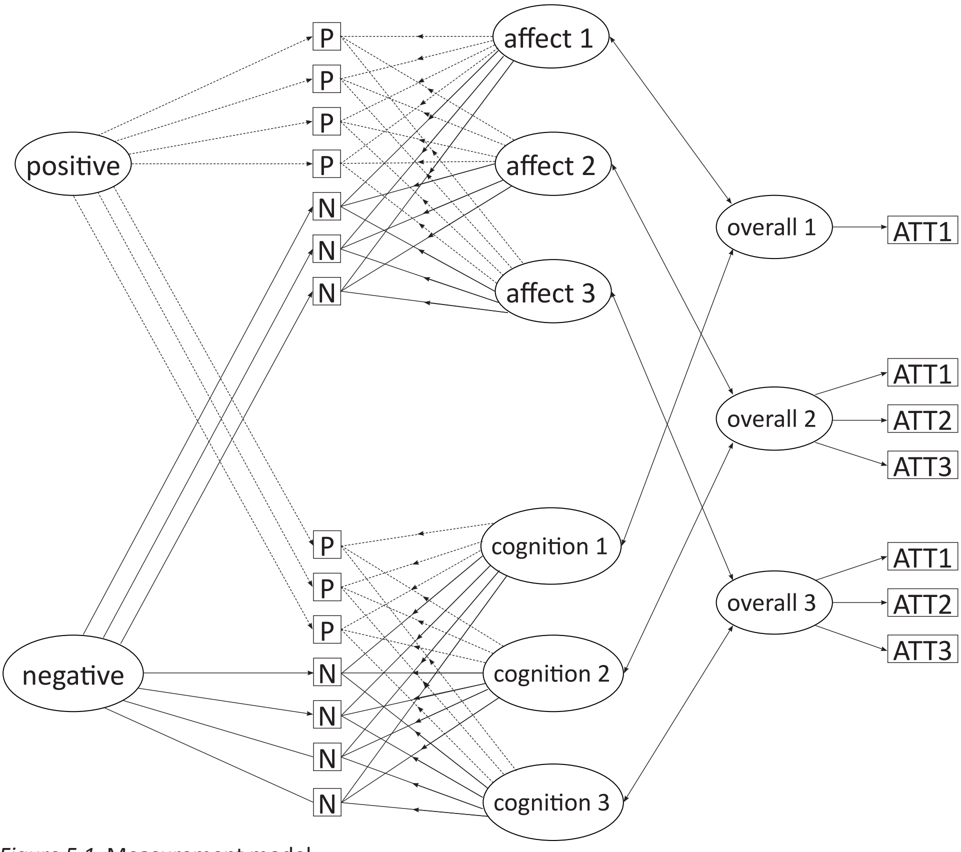


Figure 5.1. Measurement model

Path models

Subsequently, the relative influence of affect and cognition on overall attitude, over time was investigated in a multi-group model (conventional technology and nanotechnology), starting with the full model and subsequent trimming the model. The overall model fit was good for the full model where only the covariances between the overall attitudes were constrained to be equal at the different time points, Model A in table 2, χ^2 (28) = 145.91, $p < .001$; RMSEA = .042; SRMR = .029; CFI = .990; and TLI = .986 (see figure 5.2).

A first step tested whether the same relations hold for conventional technology and nanotechnology, by constraining all path coefficients to be equal for nanotechnology and conventional technology, as well as the covariances between the overall attitudes (Model B). The chi-square difference between model A and Model B, shows a decrease in model fit when constraining technology, $\Delta\chi^2$ = 13.08, $\Delta df = 7$, $p = .070$ (see table 5.2). This shows that it is meaningful to address differences between nanotechnology and conventional technology when predicting the influence of affect and cognition on overall attitude, which is in line with H1.

Next, the time effects for affect and cognition were estimated for nanotechnology and conventional technology. This allowed to test the hypothesis that for nanotechnology affect becomes less predictive for the overall attitude over time. First, a more restricted model was estimated where for conventional technology the relations for affect and cognition on overall attitude were constrained to be equal over time (all b's equal), while there were no restrictions on nanotechnology over time (Model C). This model shows no worse fit than the unconstrained model, $\Delta\chi^2$ = 3.20, $\Delta df = 4$, $p = .52$ (Model C versus A, see table 5.2). This indicates that for conventional technology the effects of affect and cognition on overall attitude are stable over time. Next, for nanotechnology the relations for affect and cognition on overall attitude were constrained to be equal over time (all b's equal), while there were no restrictions on conventional technology over time (Model D).

Table 5.2

Path models with affect and cognition on overall attitude

	χ^2	Df	CFI	TLI	RMSEA	RMSEA 90% LB	RMSEA, 90% UB	SRMR	AIC	BIC	$\Delta \chi^2$	Δdf	*p*
Full model													
Model A: Full model, no restrictions	145.91	28	.990	.986	.050	.042	.058	.029	71631.67	71791.27			
Technology effect													
Model B: $B_{A1\_N} = B_{A1\_C}$ $B_{A2\_N} = B_{A2\_C}$ $B_{A3\_N} = B_{A3\_C}$ $B_{C1\_N} = B_{C1\_C}$ $B_{C2\_N} = B_{C2\_C}$ $B_{C3\_N} = B_{C3\_C}$	158.98	35	.990	.988	.045	.038	.053	.029	71630.37	71747.38	13.08	7	.070*
Conventional													
Model C: $B_{A1\_C} = B_{A2\_C} = B_{A3\_C}$ $B_{C1\_C} = B_{C2\_C} = B_{C3\_C}$	149.11	32	.991	.988	.046	.039	.054	.030	71626.87	71761.92	3.20	4	.523
Nanotechnology													
Model D: $B_{A1\_N} = B_{A2\_N} = B_{A3\_N}$ $B_{C1\_N} = B_{C2\_N} = B_{C3\_N}$	155.06	32	.990	.987	.047	.040	.055	.030	71632.82	71767.87	9.16	4	.057*

	χ^2	Df	CFI	TLI	RMSEA	RMSEA 90% LB	RMSEA, 90% UB	SRMR	AIC	BIC	$\Delta \chi^2$	Δdf	*p*
Time effect (compared to model C)													
T1 & T2 equal for nano													
Model E1:	150.97	34	.991	.988	.045	.038	.052	.030	71624.73	71747.50	1.86	2	.395
$B_{A1\_N} = B_{A2\_N}$													
$B_{C1\_N} = B_{C2\_N}$													
$B_{A1\_C} = B_{A2\_C} = B_{A3\_C}$													
$B_{C1\_C} = B_{C2\_C} = B_{C3\_C}$													
T2 & T3 equal for nano													
Model E2:	155.17	34	.990	.988	.046	.038	.053	.030	71628.93	71751.71	6.06	2	.048**
$B_{A2\_N} = B_{A3\_N}$													
$B_{C2\_N} = B_{C3\_N}$													
$B_{A1\_C} = B_{A2\_C} = B_{A3\_C}$													
$B_{C1\_C} = B_{C2\_C} = B_{C3\_C}$													
T1 & T3 equal for nano													
Model E3:	154.97	34	.990	.988	.046	.038	.053	.030	71628.73	71751.50	5.86	2	.053*
$B_{A1\_N} = B_{A3\_N}$													
$B_{C1\_N} = B_{A3\_N}$													
$B_{A1\_C} = B_{A2\_C} = B_{A3\_C}$													
$B_{C1\_C} = B_{C2\_C} = B_{C3\_C}$													

Note: the fully unconstrained model includes 42 parameters, $\chi^2 = 12375.39$, $p < .001$
A1_N = affect T1 nano; A2_N = affect T2 nano; A3_N = affect T3 nano
C1_N = cognition T1 nano; C2_N = cognition T2 nano; C3_N = cognition T3 nano
A1_C = affect T1 conventional; A2_C = affect T2 conventional; A3_C = affect T3 conventional
C1_C = cognition T1 conventional; C2_C = cognition T2 conventional; C3_C = cognition T3 conventional

5

This model showed a decrease in model fit, $\Delta\chi^2 = 9.16$, $\Delta df = 4$, $p = .057$ (Model D versus A, see table 5.2), indicating that for nanotechnology there are differences in the effect of affect and cognition on overall attitude over time. Therefore, it is meaningful to take into account the time effect of affect and cognition for nanotechnology, but not for conventional technology, in line with H2a and H2b. For further model comparisons the model with unconstrained affect and cognition over time for nanotechnology, and constrained affect and cognition for conventional technology, is taken as baseline model (Model C).

In the next step it was further investigated whether the differences in affect and cognition change across specific time points for nanotechnology, keeping conventional technology constrained. Constraining the relations for affect and cognition on overall attitude to be equal at T1 and T2 (Model E1) resulted in no worse model fit, $\Delta\chi^2 = 1.86$, $\Delta df = 2$, $p = .395$ (Model E1 versus C, see table 5.2). A model where the relations for affect and cognition on overall attitude were constrained to be equal at T2 and T3 for nanotechnology resulted in a decrease in model fit compared with Model C, $\Delta\chi^2 = 6.06$, $\Delta df = 2$, $p = .048$ (Model E2, table 5.2). A model where the relations for affect and cognition on overall attitude were constrained to be equal at T1 and T3 showed a decrease in model fit compared with Model C, $\Delta\chi^2 = 5.86$, $\Delta df = 2$, $p = .053$ (model E3, table 5.2). This shows that differences in affect and cognition over time exist for nanotechnology, and mainly between T3 and earlier waves.

Interpreting the results based on empirical relations shows that for nanotechnology the influence of affect decreases after T2 and stabilizes at T3 ($b_{T1} = .63$, $b_{T2} = .58$, $b_{T3} = .59$), which provides support for H2b (see figure 5.2). Furthermore, the influence of cognition increases at T2 and drops again at T3 ($b_{T1} = .50$, $b_{T2} = .54$, $b_{T3} = .48$). The b's for conventional technology are relatively stable across time points for affect ($b_{T1} = .54$, $b_{T2} = .54$, $b_{T3} = .54$) and also for cognition ($b_{T1} = .55$, $b_{T2} = .55$, $b_{T3} = .55$) (see figure 5.2), which provides support for H2a. The correlations between the constructs over time are low for affect, cognition and overall attitude (figure 5.2). Low correlations indicate that attitudes towards nanotechnology as well as conventional technology are not stable yet.

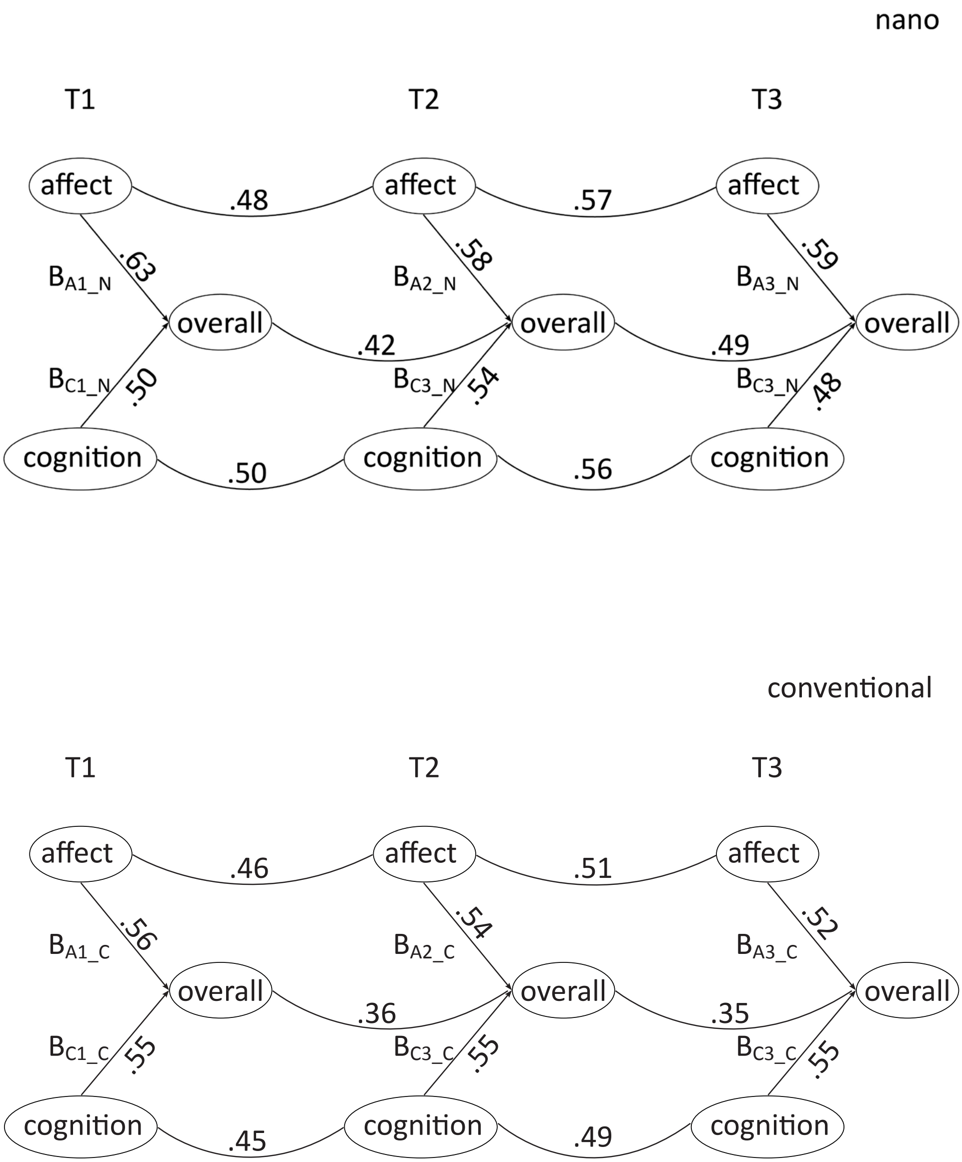


Figure 5.2. Path models for nanotechnology and conventional technology. Straight lines represent b's. Curved lines represent correlations of the construct across time points.

Knowledge

In the final step the moderating effect of subjective knowledge and objective knowledge on the influence of affect and cognition on overall attitude for nanotechnology is investigated. In general, subjective knowledge is low, but there is a small growth over time, F (1, 5135) = 22.96, p < .001, M_{T1} = 2.12, M_{T2} = 2.26, M_{T3} =2.47. Similarly, objective knowledge is low, but increases over time, F (1, 4413) = 138.39, p < .001, M_{T1} =1.39, M_{T2} =2.33, M_{T3} = 2.58 (objective knowledge was measured on a scale from -2 t/m 9, see appendix 5.1).

A model was estimated where the main effects of affect, cognition, subjective knowledge as well as the interactions of subjective knowledge with affect and cognition were allowed to differ over time for nanotechnology. The model fit was good, χ^2 (72) = 207.69, p < .001; RMSEA = .033; SRMR = .018; CFI = .989; and TLI = .985. A model where the interactions were not taken into account and the main effect of subjective knowledge was constrained to be equal over time did not fit the data worse, $\Delta\chi^2$ = 11.95, Δdf = 8, p = .150. This shows that there is no moderating effect of subjective knowledge.

For objective knowledge a similar approach was used, which led to the same conclusions: there was a good model fit χ^2 (72) = 124.18, p < .001; RMSEA = .027; SRMR = .015; CFI = .992; and TLI = .989, and the model with no objective knowledge interactions at all fits the data equally well, $\Delta\chi^2$ = 11.23, Δdf = 8, p = .186. Together, this shows that taking subjective and objective knowledge into account does not affect changes in the influence of affect and cognition on overall attitude over time.

One reason that subjective and objective knowledge do not have a moderating effect on the influence of affect and cognition on overall attitude might be that knowledge did not grow enough. Related to this is that respondents' exposure to different media sources is low. Respondents did not read much about nanotechnology, and even less at T3 compared with T2, F (1, 5135) = 10.18, p < .001, M_{T2} = 1.87, M_{T3} = 1.81, measured on a seven-point scale. The same is true for watching documentaries about nanotechnology, F (1, 5135) = 18.30, p < .001, M_{T2} = 1.78, M_{T3} = 1.70. Also, in general people almost did not search on the internet for more information about nanotechnology (M = 1.50). Thus, over time people did not acquire more information on nanotechnology via the media.

Discussion

This study showed that the attitude formation process evolves differently for nanotechnology compared with conventional technology. For conventional technologies, the influence of affect and cognition on overall attitude stays stable over time. In attitude formation towards unfamiliar nanotechnology attitude objects, people rely relatively more on affect than cognition. Over time, for nanotechnology, reliance on affect decreases whereas reliance on cognition increases. At time point 2 the effect of cognition is higher for nanotechnology. Knowledge growth, neither objective nor subjective, does explain these changes.

Knowledge did not moderate the lower reliance on affect and the increase in reliance on cognition in attitude formation towards nanotechnology. People with higher knowledge levels did not rely differently on affect and cognition in attitude formation towards nanotechnology compared to people with lower knowledge levels. Over time knowledge increased somewhat, but this has not been reflected in changes in attitude. This could be because, knowledge towards nanotechnology and its applications is still low and within the 2.5 years of this study there has been no large increase in knowledge levels, which is in line with results from previous studies (Reisch et al., 2011). A possible explanation why knowledge changed relatively little may be that respondents did not take up the information reported through different media sources.

Even though knowledge growth was limited the results suggest that, over time, people start to think in a more cognitive way about nanotechnology. This suggests that nanotechnology applications have become somewhat more integrated within people's already existing knowledge structures. This in turn indicates some learning effects, consistent with previous research that suggested than when people start to learn more about nanotechnologies, their reactions are more heavily influenced by their values and beliefs (e.g. cognition) (Kahan et al., 2007; Reisch et al., 2011). Compared with conventional technology, for which no learning should be assumed, this also makes sense, as it is shown that the influence of affect and cognition on overall attitude stays stable over time.

An unexpected finding is that, for nanotechnology, the relative influence of cognition increases between time 1 and time 2, and decreases again between time 2 and time 3. This can be understood by assuming that at time 1, nanotechnology applications are newest to consumers, who then mostly need to rely on affect even though there are only few crystallised affective associations available (Slovic et al., 2007). The second time (T2) that people are exposed to the same applications, some cognitions of the now less unfamiliar nanotechnology applications emerged. One suggestion why people rely on cognition, even without learning much about nanotechnology, may be because they make some analogies with more familiar technologies that people can relate to nanotechnology (Kahan et al., 2007). Drawing analogies allows people to classify and integrate unfamiliar nanotechnology into existing (technology) schemata (Davies, 2011; Kearnes, Macnaghten, & Davies, 2014). Once people have classified products, subsequent attitudes may be based more on heuristics and affect associated with that class (Pavelchak, 1989; Sujan, 1985), which may explain that between time 2 and time 3, reliance on cognition slightly decreases. The current study did however not assess whether, and if so into which categories, nanotechnology was classified. In future research, a better understanding should be derived of the reasons behind changes in affect and cognition over time. For instance, in experimental studies it could be investigated how nanotechnology and products with added nanotechnology are categorized and integrated within people's schemata and knowledge structures.

In the current study objective knowledge was measured and shown to be low. This might be because some of the items covered required highly advanced levels of nanotechnology knowledge. Even though objective knowledge is low, it might be that people think they understand much about nanotechnology. It was however shown that subjective knowledge was also low, which indicates that people do not overestimate their knowledge levels of nanotechnology.

Attitudes towards both conventional and nanotechnology applications vary considerably over time (i.e. low correlations across time points). For conventional technology attitudes are anyway more crystallized than for nanotechnology, as for conventional technology the internal weighing structure of affect and cognition remains stable over time. The lack of a stable long-term attitude for nanotechnology is an indication that attitudes are not strongly established yet and sensitive to change, which in turn makes it difficult for policy makers and stakeholders to predict consumer behaviour (Petty et al., 1997). This also indicates that in case of negative incidents associated with nanotechnology it can lead to negative consumer opinion about the technology, and one single incident can trigger public backlash for other domains in which nanotechnology is utilized (Siegrist, 2010).

The fact that consumer attitudes towards nanotechnology are not strongly established also means that attitudes still can develop in different ways and directions. One option is that knowledge will continue to grow while affect does not become dominant, in which case people rely most on cognitive cues. This does require motivation of consumers to inform themselves (Petty et al., 1997), which seems unlikely given that respondents in the current study indicated to not have searched for additional information on nanotechnology. So, it can be expected that besides cognition, affect will continue to play a major role. If a positive affective response develops, the technology perception will also be positive. Alternatively, a negative affective response may develop, which might lead to a general fear-response or aversion towards the technology. The fear of a fear-responses is a scenario that is often reported when nanotechnology is paralleled to GMO (Einsiedel & Goldenberg, 2004; Macoubrie, 2006; Sandler & Kay, 2006).

For policy makers and stakeholders, to better connect with the general public, the design of information about nanotechnology and its applications is important. The results of this study show that currently public response is largely driven by affect. To align with this current dominance on affect, and at the same time contribute to a factual knowledge base, communication to the general public should be both cognitive and affective by nature. This combination seems important since it has been shown that factual information on its own is often of limited value in influencing consumer attitudes (Kahan et al., 2008). One way of designing this information is to provide people with information that connects to their existing knowledge structures, so that it becomes easier for people to integrate that unfamiliar instance in their current knowledge structure (Gregan-Paxton & John, 1997). For instance, the usefulness of nanotechnology applications in consumers' daily life can be emphasized to increase their understanding. In the end, effective communication requires stepping back, assessing the extent of prior knowledge, and deciding how to communicate the basics of nanotechnology in such a way that it can be relevantly learned (Castellini et al., 2007). The media might operate as a primary source of science information for the public (Su, Cacciatore, Scheufele, Brossard, & Xenos, 2014). Effective communication strategies may lead to more consistent consumer opinions, which helps policymakers to anticipate trends that will dictate how the general public might react to new technology developments (Currall et al., 2006).

Conclusion

This longitudinal study investigated the attitude formation process for nanotechnology as an emerging technology, comparing this to conventional technologies. The affective-cognitive attitude structure for conventional technology was stable over time, whereas for nanotechnology this was not the case. This shows that consumer attitudes towards nanotechnology are not well established yet, which in turn means that consumer attitudes are vulnerable to external impact. Therefore, the current study underlines the importance of addressing both affective and cognitive aspects of public opinion towards nanotechnology.

Appendix 5.1
Questionnaire items

Subjective knowledge questions (based on Klerck & Sweeney, 2007)

Have you heard of nanotechnology before? (yes / no)

Do you know what nanotechnology means? (yes / no)

How much do you know about nanotechnology in general (not at all – very much)

The third item was recoded such that 1 reflects no knowledge (not heard of the technology, not knowing the meaning of the technology) and 7 reflects expertise.

Objective knowledge questions (based on Klerck & Sweeney, 2007)

Indicate whether these concepts have anything to do with nanotechnology (yes/no):

A nanometer is one billionth of a meter	Developing new materials
Nanomaterials are not visible for the naked eye	Different features of particles
Moving of individual atoms	Product improvement
Natural nanoparticles	Microscale
Robots	Buckyball
Deliberate production nanoparticles	Nanotubes

Items were added so that a summary knowledge index was created. Penalties were assigned for items not related to nanotechnology, so that an index between -2 and 9 emerged.

Per application

Affect: to what extent do you experience the emotion when reading about the application (not at all – very much); (based on Desmet, 2003; Russell, 1980)

Joy	Fascination
Desire	Satisfaction
Fear	Sadness
Boredom	Disgust

Cognition: to what extent do you think the cognitions apply when reading about the application (not at all – very much); (based on Crites, Fabrigar, & Petty, 1994)

Useful	Useless
Functional	Harmful
Beneficial	Disadvantageous
Nice	Unusable

Overall attitude: (based on Crites et al., 1994; Lee & Scheufele, 2006)

What is your overall opinion towards the application? (negative – positive)

To what extent do you think this application is good? (bad – good)

To what extent do you support the technology behind the application? (not at all – very much)

Media exposure (never, once again, quarterly, every month, every week) (based on Cacciatore, Scheufele, & Corley, 2011)

How often have you read during the past year about nanotechnological applications (e.g. in newspapers)?

How often have you watched during the past year tv programs / documentaries about nanotechnological developments?

How often did you surf the internet during the past year to search for information about nanotechnological applications?

Note: all items were rated on 7-point scales, unless something else was indicated.

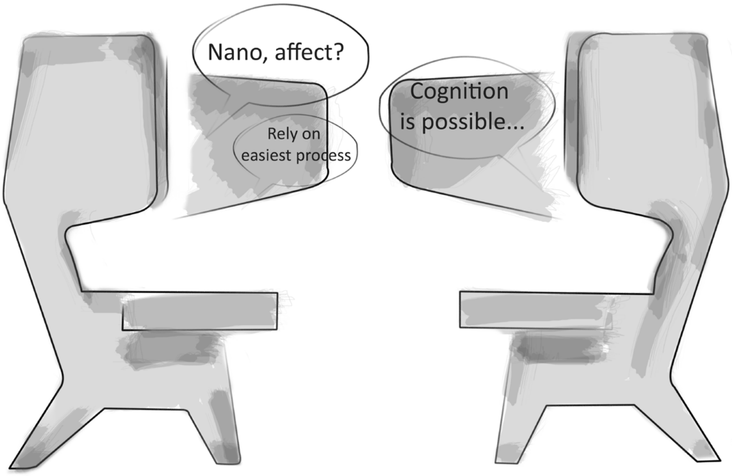
Appendix 5.2
Longitudinal design survey

Group	Application Nano Time 1	Application Conventional Time 1	Application Nano Time 2	Application Conventional Time 2	Application Nano Time 3	Application Conventional Time 3
1	Water purification nano-membrane Nano-solarcel	Water purification sand filtration Solarcel	Water purification nano-membrane Nano-solarcel	Water purification sand filtration Solarcel	Water purification nano-membrane Nano-solarcel	Water purification sand filtration Solarcel
2	Water monitoring nano sensor Nano battery	Water monitoring Battery	Water monitoring nano sensor Nano battery	Water monitoring Battery	Water monitoring nano sensor Nano battery	Water monitoring Battery
3	Lab-on-a-chip Nano food additives	Medical home test Food additives	Lab-on-a-chip Nano food additives	Medical home test Food additives	Lab-on-a-chip Nano food additives	Medical home test Food additives
4	Nano medicine Nano supplements	Medicine Supplements	Nano medicine Nano supplements	Medicine Supplements	Nano medicine Nano supplements	Medicine Supplements

Note. Every group of respondents judged three times the same four applications, of which two were conventional applications and two were nanotechnology applications.

Chapter 6

Conclusions and general discussion



The aim of this thesis was to understand how people form attitudes toward unfamiliar attitude objects. To do so, both affective and cognitive attitude components as well as underlying mental processing strategies were studied and compared between familiar and unfamiliar attitude objects. Three key themes were addressed: (1) the relative influence of affect and cognition in attitude formation, (2) the elaborateness of processing of the affective and cognitive attitudes components, and (3) the changing influence of affect and cognition over time. Moreover, across different studies, several factors that impact the relative influence of affect and cognition were explored: individual differences (Need for Cognition and Faith in Intuition), the amount of available context information, and growing awareness. Differences in elaborateness of processing of affect and cognition were investigated for attitude objects differing in strength of underlying object-associations.

Overview of main findings

The relative influence of affect and cognition

Chapter 2 contributes to a better understanding of the attitude formation process of unfamiliar compared to familiar attitude objects. It is shown that, compared with familiar attitude objects, for unfamiliar attitude objects people rely more on affect than on cognition. In addition, for familiar attitude objects the influence of individually preferred thinking styles (Need for Cognition and Faith in Intuition) is reflected, whereas for unfamiliar attitude objects preferred thinking style is less influential. Individuals with high Need for Cognition did rely relatively more on cognition also for unfamiliar attitude objects. Thus, in addition to previous research which showed that when it regards unfamiliar attitude objects people often rely on affect instead of more cognitive evaluations (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic et al., 2007), it is shown here that people are able to draw on cognitive inferences, even for unfamiliar attitude objects. By taking into account faith in intuition in relation to unfamiliar attitude objects, this chapter contributes to the literature on individual thinking styles (see for instance Epstein et al., 1996), in showing that even people with low faith in intuition use affect as default for unfamiliar attitude objects.

Reliance on affect or cognition also depends on the amount of available context information. In chapter 4 it is shown that for a familiar technology attribute which fits to existing knowledge structures, both affect and cognition support attitude formation about equally. For unfamiliar attributes, attitude formation is context dependent. If the context provides enough cues, the unfamiliar attribute is ignored and people rely on affect. If this is not the case people solve the incongruency of perceiving an unfamiliar attribute in a familiar product in a more cognitive way. Along with chapter 2, this chapter shows that people do not exclusively rely on affect in attitude formation toward unfamiliar attitude objects, but can draw on cognitive inferences. In addition, by varying the level of familiarity within and without a product context, new insights are derived about the conditions when affect is relatively more important in attitude formation. The use of affect in attitude formation appears to follow a pattern similar to the use of intuitive strategies influenced by an individual's expertise level (Baylor, 2001). People rely on affect when extensive or no knowledge is available, while at intermediate levels people are able to draw cognitive inferences.

To answer the research question how attitude formation toward familiar and unfamiliar attitude objects differs in terms of the relative influence of affect and cognition, it can be concluded that for familiar attitude objects both affective and cognitive object-evaluation linkages are available and can be used. For unfamiliar attitude objects, the default is to rely on affect. This does however not mean that people always rely on affect toward unfamiliar attitude objects, as it is shown that people can also use cognitive linkages if there are enough cues available that trigger cognitive attitude formation (e.g. high need for cognition, or solving an incongruency in a cognitive way). Hence, it appears that affect can only partially explain the findings for unfamiliar attitude objects, and a closer look at underlying processes is warranted. In the next section it will be explained how underlying processes while expressing an attitude play a role in determining whether affect or cognition is the preferred attitude component to rely on.

Underlying processes

Chapters 3 and 4 followed an emerging stream of research which focusses on mapping underlying processes in judgment and decision making research and attitude formation research (Schulte-Mecklenbeck et al., 2011). In these chapters a novel eye-tracking procedure was developed and used that allowed to trace the attitude process itself. In this way, further understanding is derived of the role of the amount of processing in determining which attitude component (affect or cognition) is decisive in attitude formation, taking into account both intuitive-deliberative and affective-cognitive processing.

In chapter 3 it is shown that expressing affective as well as cognitive attitudes may require substantial elaboration. This is dependent on the strength of underlying object-associations with the attitude object (with univalent and ambivalent attitude objects having strong object-associations). Especially for neutral attitude objects, typified by weak object-associations the order in which affective, cognitive and overall attitudes are expressed is decisive for the amount of elaboration in attitude expression. These results are in line with research showing that for familiar attitude objects with strong object-evaluations a fast evaluation process reflects greater attitude certainty, as people have previously evaluated the object and stored associations can be retrieved (Tormala, Clarkson, & Henderson, 2011).

In chapter 4, a different category of weak object-evaluation linkages was studied, namely unfamiliar attributes and attitude objects. It is shown that the incongruency evoked by adding an unfamiliar nanotechnology attribute to a product, is solved in a cognitive way as this is the relatively easier process. In addition, it is shown that the component that is decisive in expressing overall attitudes (affect or cognition), later on requires less processing. People thus rely on the attitude path that requires relatively less effort, which is also reflected in dual process models and domains such as persuasive communication (Chaiken, 1980; Evans, 2008).

To answer the research question to what extent underlying processes of affective and cognitive attitudes differ between attitude objects with varying strength of object-evaluations, it can be concluded that the stronger the object-evaluation linkages the lower the need to elaborate on the attitude object to arrive at an evaluation. The weaker the object-evaluation linkages (e.g. for neutral attitude objects or for unfamiliar nanotechnology attitude objects) the more influential the context is. The type of attitude object and the strength of its' underlying object associations determine whether affect or cognition is the easier process. In addition, the attitude component that is decisive in expressing overall attitudes (affect or cognition), later on requires less processing. This shows that affect does not necessarily have to be the more intuitive and easier process, as is often assumed (Hansen & Wänke, 2009; Topolinski & Strack, 2009). People choose the attitude path of least resistance, and rely on affect or cognition depending on how easily it leads to the overall attitude.

Changes over time

In chapter 5 the question is answered how affect and cognition in attitude formation toward unfamiliar attitude objects evolve over time (across 2.5 years), taking into account knowledge growth of consumers. It can be concluded from chapter 5 that for conventional technologies, the influence of affect and cognition on overall attitude remains stable over time. For unfamiliar nanotechnology attitude objects, reliance on affect decreases over time whereas reliance on cognition increases. Knowledge growth does not have an effect on changes in the influence of affect and cognition on overall attitude over time. It should be noted that, in line with previous research, knowledge growth was minimal (Reisch et al., 2011). At this point in time, affect is still relatively more important in attitude formation toward nanotechnology, which might be because affect-based attitudes produce greater certainty (Barden & Tormala, 2014). This could well be because affective associations and knowledge structures are more accessible.

Chapter 5 thus brings insights on how the affective-cognitive attitude structure changes, each time people become somewhat more familiar with an unfamiliar technology. It shows that although knowledge does not increase over time, people are able to integrate the unfamiliar applications in their existing knowledge structures. As people think more about an attitude object, stronger affective and cognitive object-association linkages are acquired, which strengthens people's attitudes (Barden & Tormala, 2014). However, as the attitude structure is still subject to change it shows that attitudes toward unfamiliar attitude objects are at this point still less accessible, as people only have weak object-evaluation linkages when it regards nanotechnology and its applications.

Implications: Contributions to theory

By studying both affective and cognitive attitudes and elaborateness of the underlying processes leading to these attitudes, and using several methodologies, this thesis contributed to the attitude literature in a number of ways. First of all, a special case of attitude objects was studied by investigating unfamiliar attitude objects, in this case nanotechnology applications. Attitude formation toward unfamiliar attitude objects is different from familiar attitude objects since the starting point is a knowledge deficit situation. By comparing attitude formation between familiar and unfamiliar attitude objects a better understanding is derived of how the attitude structure between these types of attitude objects differs. For known attitude objects both affective and cognitive object-evaluation linkages are available and accessible, whereas for unfamiliar attitude objects object-evaluation linkages are less strong and affect is easily used as the default option. In addition, the current thesis extends previous research by using realistic unfamiliar attitude objects. In previous attitude research on unfamiliar attitude objects, often a meaningful reference point is lacking by using fictitious attitude objects, such as Chinese characters (e.g. Edwards, 1990; Hansen & Wänke, 2009; Peters, Slovic, & Gregory, 2003; Zajonc & Markus, 1982). In such situations it is often the feelings of familiarity and fluency that activate affect (Topolinski, 2011). This thesis confirms that also in the situation of realistic unfamiliar attitude objects the default is to rely on affect. It also extends previous research by showing that for unfamiliar realistic attitude objects attitude formation is not exclusively reserved to affect, as at least some context information can be derived. Hence, people are able to draw on cognitive inferences, and will sometimes do so.

A second contribution of this thesis is the development of a unique and innovative eye-tracking methodology, which considers eye-gazes on scales during the judgment process. This allowed studying the processes required to arrive at the attitude expression, instead of only reporting the outcomes of the attitude process. In addition, this eye-tracking approach allowed to simultaneously study the affective-cognitive and the deliberative-intuitive dimension as no boundary conditions were imposed on the processes. The approach developed here, complements the more common approach to trace eye-gazes during stimuli presentation (see for instance Glaholt & Reingold, 2011; Orquin & Mueller Loose, 2013). In this way the current eye-tracking approach contributes to further process understanding, taking the perspective from the attitude formation process itself.

The third contribution of this thesis comes from the integration of both the affective-cognitive and intuitive-deliberative dimensions. Where dual process theories focus on the processes underlying judgment and decisions, and much attitude research focused on outcomes (Sinclair, 2010), this thesis combined both perspectives. By constraining the intuitive or the deliberative process only partial insight in underlying processes can be derived as the attitude process will not evolve naturally. As a consequence, a large proportion of the underlying processes, between the extremes of the dimensions, remains unstudied (Hogarth, 2010). In practice, intuitive and deliberative processes work in conjunction and rely on similar principles (Kruglanski & Gigerenzer, 2011; Smith & DeCoster, 2000). Therefore, instead of making a strict distinction between intuitive and deliberative processes, hybrid processes deserve more attention. This more closely resembles how attitude formation occurs in real life situations. This thesis has made a first step to investigate non-constrained processes in attitude formation, by means of a novel eye-tracking procedure.

The results of the eye-tracker studies show that people use different strategies to arrive at their attitudes. Which strategy people use is dependent on the strength of underlying object-evaluation linkages. First of all, it is shown that affect is not necessarily more informative for the overall attitude towards attitude objects with weak object-evaluation linkages. This implies that people do not necessarily use an affect heuristic or rely only on feelings as information to arrive at their attitude (Chaiken, 1980; Schwarz, 2012; Slovic et al., 2007), even though there are no strong object-evaluation linkages available. Second, it is shown that affect does not always equate intuitive processing because in some cases a considerable amount of elaboration is required to arrive at the affective attitude (compared with the cognitive attitude). This shows that affect can also be deliberated. Similarly, cognition does not have to be a deliberate process, but has shown to be an intuitive process as well. The current thesis suggests that both intuitive and deliberative processes underpin judgments and that people rely on the process that brings them to a satisfying outcome. Often this is an intuitive process, based in either affect or cognition.

A fourth contribution of this thesis regards understanding of the stability of underlying attitude structures, providing insights on the strength and development of attitudes in a realistic context. The affective-cognitive attitude structure for conventional technology was stable over time, whereas for nanotechnology this was not the case. A strong and stable attitude structure is often based on direct experience with the attitude object, is persistent over time, resistant to change, and has a strong impact on behaviour (Krosnick, Boninger, Chuang, Berent, & Carnot, 1993; Prislin, 1996). The lack of a stable long-term attitude structure for nanotechnology is an indication that attitudes are not strongly established yet and sensitive to change.

Limitations and future research

In this thesis, the implicit assumption was made that people form attitudes when the attitude object is unfamiliar. There is however no evidence that this is necessarily only an attitude formation process, as next to construction, retrieval processes may take place. In determining whether construction or retrieval processes are at work, the strength of underlying object-evaluation linkages plays a role. With strong object-evaluation linkages people do not have to recompute their overall attitude, as they can retrieve this from memory (van Harreveld & van der Pligt, 2004). In this way familiar objects more likely call for attitude expression based on retrieval processes because they have been encountered before. Attitudes toward unfamiliar attitude objects, on the other hand, are more likely based on attitude formation because these objects have never been encountered or evaluated, and require a process of integrating and constructing the attitude (Bargh et al., 1992). It is however also likely that, when it regards unfamiliar attitude objects, there will be some common grounds with more familiar counterparts so that part of the attitude can be based on retrieval. This thesis hints on both construction and retrieval processes regarding unfamiliar attitude objects. Eye-tracking seems to be a promising tool to further examine and disentangle construction and retrieval process in attitude formation. At the same time however, the current methodology requires further development as in the current set-up there was a time gap between stimulus exposure and eye-gaze registration on the scale. Although it was assumed that the eye gazes reflect an attitude formation process, it cannot be ruled out that the attitude was already formed at the very moment that the attitude object was displayed. In future research the time gap could be reduced by presenting the attitude object and the scale simultaneously.

In this thesis conventional and nanotechnology applications were compared. The conventional – nanotechnology distinction was assumed to be an operationalization of the familiar – unfamiliar distinction. Conventional – nanotechnology however does not necessarily have to reflect familiar – unfamiliar. For nanotechnology applications it was clear that they reflected unfamiliar attitude objects. However, the conventional counterparts were not completely familiar either. Nevertheless the affective-cognitive attitude structure was stable for conventional technology and differed over time for nanotechnology, even though the differences in familiarity were limited. Future research can investigate differences in attitude formation between familiar and unfamiliar attitude objects further, by using other pairs of realistic familiar and unfamiliar attitude objects. For example by comparing attitudes toward (unfamiliar) products from other cultures against familiar products from own culture, or by manipulating the familiarity of advertisements.

Some of the ideas tested in this thesis were inspired by categorization literature, where it is assumed that in the case of low knowledge, people draw on analogies with more familiar attitude objects in order to integrate the unfamiliar instance into existing knowledge structures. The results from this thesis are consistent with categorization research, however rely on indirect evidence. Future attitude research could gain from integrating categorization and attitude formation insights (Ranganath, Spellman, & Joy-Gaba, 2010), by specifying how the integration of an unfamiliar attribute in existing knowledge structures proceeds. This requires studying existing knowledge schemata and how new attitude objects are linked to those (Tourangeau et al., 1991). A mix of judgmental, associative, and attentional approaches may help to unlock this. For instance, the current research can be extended with judgmental and associative approaches in which it studied how well the unfamiliar attitude object represents a category and how well it is linked to existing schema structures, using typicality ratings. Methodologies such as means-end chain laddering or think-out-loud protocols could provide useful insights in categorization of unfamiliar instances. In addition, attentional approaches may help to understand whether unfamiliar attributes are integrated within the existing knowledge structure or are entirely ignored in the attitude process. Future research could look into how much attention is given to unfamiliar attributes while perceiving the attitude object, for instance by means of eye-tracking methodologies.

Practical relevance

As the public has little knowledge about nanotechnology, attitudes are still malleable. The affective-cognitive attitude structure changes over time for nanotechnology and its applications, in contrast to the attitude structure of conventional technology applications. The findings in this thesis have implications for communication around nanotechnology and its applications, and for communication toward different groups of consumers.

In this thesis it is shown that attitudes toward nanotechnology without context are formed in a different way than attitudes toward specific nanotechnology attributes in context, for instance a yogurt product with nanotechnology. Attitudes toward nanotechnology without context are formed in a more affective way, whereas attitudes toward specific nanotechnology attributes in context were formed in a more cognitive way. This also implies that communication about nanotechnology as a generic technology needs to be positioned differently than communication about specific nanotechnology applications. As people often rely on affect toward nanotechnology it would be helpful for people's understanding to address them in affective ways, for instance by providing them with visual information. It is also important to simplify information and not introduce too many new concepts, and to avoid jargon (Castellini et al., 2007). For unfamiliar applications within a product context it is important to design information in such a way that it connects to peoples' existing knowledge structure, so that the unfamiliar technology application can be embedded herein (Cobb, 2005). For instance, the unfamiliar application can be explained in terms of a more familiar one, so that the familiar one can be used as reference point for comparison. In general, it is important to keep in mind the other's point of view and design information that speaks to peoples' imagination, affectively as well as cognitively.

In addition, the results of this thesis show that a large group of consumers rely on affect in attitude formation toward unfamiliar nanotechnology applications. There is however also a group of consumers who do rely more on cognition (people with high Need for Cognition). So even when there is little information available, there are people who still draw on cognitive inferences in attitude formation. The vast majority of consumers however relies, and probably remains to rely, on affect. The findings in this thesis also show that, at this point in time, attitudes toward nanotechnology applications are still relatively more based on affect. Thus, in communication towards consumers it is important to address both affective and cognitive aspects. This implies that only factual information will not suffice, as people need to integrate the unfamiliar application within their existing knowledge structures in both affective and cognitive ways. Affective integration can be increased by providing visual and vivid cues to consumers, for instance explaining the usefulness of a nanotechnology application to consumers in a short movie. In written media affective communication can be increased by working with appealing visuals. Cognitive integration could take place by drawing on analogies and experiences relating to everyday life, thus enabling a discussion on nanotechnology and its applications (Burri, 2009).

Final conclusion

The research presented in this thesis contributed to understanding how people form attitudes toward unfamiliar attitude objects. Situations in which affect or cognition is the better predictor of overall attitudes were investigated, as well as the underlying processes in attitude formation, and how the attitude structure evolves over time.

In general the following conclusions can be drawn:

- People often rely on affect when forming attitudes toward unfamiliar attitude objects. People are however able to draw on cognitive inferences provided that there are enough cues available (e.g. product context or being more often exposed) or there is a disposition to rely on cognition (high Need for Cognition).
- Whether people rely on affect or cognition depends on which process is the easiest.
- The relative influence of affect and cognition in attitude formation for nanotechnology, as an example of unfamiliar attitude objects, is not crystallized yet which makes such attitudes malleable.

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Summaries
(English and Dutch)

Acknowledgements

About the author

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Summary

Attitudes play a major role in everyday life, determining how people make judgments and decisions. The evaluation of unfamiliar attitude objects, such as nanotechnologies, can be quite challenging as people have limited knowledge available. Therefore, a better understanding of the factors and processes leading to attitude evaluation is required. The aim of this thesis was to understand how people form attitudes toward unfamiliar attitude objects.

Attitudes are defined as summary evaluations, and are multi-faceted with a complex layered structure. Attitude evaluation stems from affect and cognition associated with the attitude object. In addition, the attitude process can be the result of a more intuitive (automatic and unconscious) or deliberative (conscious and controlled) process. Along these lines, this thesis takes a multidimensional view on attitudes, with one dimension covering affect-cognition and the other dimension intuitive-deliberative processing. A combination of these dimensions results in different strategies for people to arrive at attitudes. Which strategy people take is also dependent on the familiarity with the attitude object. For familiar attitude objects, attitude expression is relatively straightforward as people can draw upon established affective and cognitive knowledge structures that have been built up over time. For unfamiliar attitude objects, such as nanotechnology applications, knowledge structures fall short and attitude formation is more challenging. This thesis addressed three key themes while comparing the attitude formation process between familiar and unfamiliar attitude objects: (1) the relative influence of affect and cognition in attitude formation, (2) the elaborateness of processing of affective and cognitive attitudes, and (3) the changing influence of affect and cognition over time.

A survey study with a cross-section of Dutch consumers provided insight into the relative influence of affect and cognition on attitudes (chapter 2). For unfamiliar compared to familiar attitude objects, people rely more on affect than on cognition. In addition, for familiar attitude objects the influence of individually preferred thinking styles (Need for Cognition and Faith in Intuition) is reflected, whereas for unfamiliar attitude objects preferred thinking style is less influential. Individuals with high Need for Cognition did rely relatively more on cognition also for unfamiliar attitude

objects. Also, the amount of available context information influences the relative influence of affect and cognition (chapter 4). For a familiar technology attribute which fits existing knowledge structures, both affect and cognition support attitude formation. For unfamiliar attributes attitude formation is context dependent. If the context provides enough cues, the unfamiliar attribute is ignored and people rely on affect. If this is not the case people solve the incongruency in a cognitive way. This shows that affect is often the default option in attitude formation toward unfamiliar attitude objects. However people do not exclusively rely on affect as they are also able to draw on cognitive inferences when it regards unfamiliar attitude objects.

A process method to explore underlying process mechanisms, such as eye-tracking, helps in understanding why affect or cognition is the preferred attitude component to rely on (chapter 3 and 4). In chapter 3, familiar attitude objects differing in strength of underlying object-evaluations (i.e. univalent, neutral, ambivalent) were investigated. In chapter 4 familiar attitude objects (with strong object-evaluations) were compared to unfamiliar attitude objects (with weak object-evaluations). These chapters show that the stronger the object-evaluation linkages the lower the need to elaborate on the attitude object to arrive at an evaluation. The weaker the object-evaluation linkages (e.g. for neutral attitude objects or for unfamiliar nanotechnology attitude objects) the more influential the context is. This shows that affect does not necessarily have to be the more intuitive and easier process. Rather this is dependent on the type of attitude object and the strength of its' underlying object associations. The component that is decisive in expressing overall attitudes (affect or cognition), later on requires less processing. People thus choose the attitude path of least resistance, and rely on affect or cognition depending on how easily it leads to the overall attitude.

Monitoring attitudes longitudinally helps in understanding how the influence of affect and cognition on overall attitude might change over time. For conventional technologies, the influence of affect and cognition on overall attitude remains stable over time (chapter 5). For unfamiliar nanotechnology attitude objects reliance on affect decreases over time whereas reliance on cognition increases. Knowledge growth, had no effect on changes in the influence of affect and cognition on overall attitude over time. This shows that although knowledge does not increase over time, people are able to integrate the unfamiliar attribute constellation into their existing knowledge structures. However, the attitude structure of affect and cognition for unfamiliar nanotechnology attitude objects is not crystallized yet and subject to change.

Together, the chapters in this thesis show that although the default is to rely on affect, in attitude formation toward unfamiliar attitude objects, people are able to draw on cognitive inferences provided that there are enough cues available (e.g. product context, high Need for Cognition, or being more often exposed). In addition, whether people rely on affect or cognition depends on which process is the easiest. The attitude component which is decisive in the attitude formation process requires the least elaborate process. This thesis contributes to a better process understanding as both affective-cognitive and deliberative-intuitive dimensions were simultaneously studied. Finally, it is concluded that attitudes toward unfamiliar attitude objects, in this case nanotechnology applications, are still subject to change. This has implications for communication about new technologies, as it is important to address both affective and cognitive aspects.

Samenvatting (Dutch Summary)

Affect en cognitie in attitudevorming van bekende en onbekende attitude objecten: De casus nanotechnologie

Attitudes zijn belangrijk in ons dagelijks leven omdat ze bepalen hoe mensen oordelen vormen en beslissingen maken. Het evalueren van onbekende attitude objecten, zoals nanotechnologie toepassingen, is een uitdaging omdat mensen maar beperkte kennis over die objecten beschikbaar hebben. Een beter begrip van de factoren en processen die leiden tot evaluaties is nodig. Het doel van dit proefschrift was om te begrijpen hoe mensen attitudes vormen ten aanzien van onbekende attitude objecten.

Attitudes worden gezien als een soort gewogen gemiddelde van kleinere evaluaties. Attitudes zijn complex en hebben een gelaagde structuur. Attitude evaluaties vinden hun basis in affect en cognitie geassocieerd met het attitude object. Qua proces is een attitude het resultaat van een intuitief (automatisch en onbewust) of deliberatief (bewust en gecontroleerd) proces. Dit proefschrift bekijkt attituden vanuit een multidimensionaal perspectief, met als dimensies (1) affect-cognitie en (2) intuitief-deliberatieve verwerking. Combinaties van deze dimensies resulteert in verschillende strategieën om tot een attitude te komen. Voor bekende attitude objecten is het uiten van een attitude relatief eenvoudig. Dat komt omdat mensen dan kunnen putten uit zowel affectieve als cognitieve kennisstructuren, welke ze al door de tijd heen hebben opgebouwd. Voor onbekende attitude objecten, zoals nanotechnologie toepassingen, zijn dergelijke kennisstructuren niet voorhanden en is het vormen van een attitude moeilijker. In dit proefschrift zijn drie kernthema's ten aanzien van de vorming van attitudes nader bestudeerd en vergeleken tussen bekende en onbekende attitude objecten: (1) de relatieve invloed van affect en cognitie in attitudevorming, (2) de uitgebreidheid van mentale verwerking van cognitieve en affectieve attitudes, en (3) de veranderende invloed van affect en cognitie over de tijd.

Een survey-onderzoek, onder een doorsnede van de Nederlandse bevolking, verschafte inzicht in de relatieve invloed van affect en cognitie in attitudes (hoofdstuk 2). Voor onbekende, ten opzichte van bekende, attitude objecten bleek dat mensen meer op affect dan cognitie afgaan. Daarnaast bleek dat voor bekende attitude objecten de invloed van verschillende denkstijlen (need for cognition en faith in intuition) terug te zien was, terwijl dit voor onbekende attitude objecten veel minder het geval was. Mensen met een hoge Need for Cognition baseerden hun attitudes relatief meer op cognitie, ook bij onbekende attitude objecten. Daarnaast is de hoeveelheid context-informatie van invloed op de relatieve invloed van affect en cognitie (hoofdstuk 4). Voor een bekend technologie attribuut, met raakvlakken met bestaande kennisstructuren, ondersteunen zowel affect als cognitie de attitudevorming. Voor onbekende attributen is dat context-afhankelijk. Als de omgeving voldoende bruikbare cues verschaft dan wordt het onbekende attribuut genegeerd en gaan mensen op affect af. Als dat niet het geval is, dan wordt de incongruentie op een cognitieve manier opgelost. Dit laat zien dat affectieve verwerking vaak de standaardoptie is wanneer het gaat om attitudevorming ten aanzien van onbekende attitude objecten. Het is echter niet zo dat mensen alleen maar op affect afgaan, want zoals blijkt zijn mensen in staat om ook cognitieve gevolgtrekkingen te maken zelfs wanneer het gaat om onbekende attitude-objecten.

Door de onderliggende mentale processen te bestuderen, in dit geval door gebruik te maken van eye-tracking, wordt een dieper begrip verkregen waarom affect of cognitie de voorkeurscomponent is in attitudevorming (hoofdstuk 3 en 4). In hoofdstuk 3 werden bekende attitude objecten geëvalueerd die varieerden in sterkte van onderliggende object-evaluaties (namelijk univalente, neutrale, ambivalente attitude objecten). In hoofdstuk 4 werden bekende attitude objecten (sterke object-evaluaties) vergeleken met onbekende attitude objecten (zwakke object-evaluaties). Uit deze studies blijkt dat hoe sterker de object-evaluatie connecties zijn hoe minder de noodzaak er is voor uitgebreide mentale verwerking om tot een evaluatie van het attitude object te komen. Hoe zwakker de object-evaluatie connecties zijn (bv. voor neutrale attitude objecten of voor onbekende nanotechnologie attitude objecten) hoe invloedrijker de context is. Dit toont aan dat affect niet noodzakelijkerwijs het meer intuitieve en gemakkelijkere proces is. In plaats daarvan is dit afhankelijk van het type attitude object en de sterkte van onderliggende object associaties. De component die doorslaggevend is in het uiten van een attitude (affect of cognitie) vraagt later ook minder mentale verwerking. Mensen kiezen dus voor het pad van de minste weerstand en vertrouwen op affect of cognitie afhankelijk van hoe gemakkelijk dit tot hun attitude leidt.

Het volgen van attitudes in de tijd helpt in het beter begrijpen hoe de invloed van affect en cognitie op de algemene attitude verandert over tijd. Voor bekende technologieën blijkt dat de invloed van affect en cognitie op de algemene attitude stabiel blijft over de tijd (hoofdstuk 5). Echter, voor onbekende attitude objecten blijkt de invloed van affect af te nemen over tijd, terwijl de invloed van cognitie toeneemt. Kennisgroei had geen effect op de veranderingen in de invloed van affect en cognitie over tijd. Dit laat zien dat zelfs zonder noemenswaardige toename in mensen hun kennisniveau, ze na verloop van tijd toch in staat blijken om de onbekende attribuut samenstelling in hun bestaande kennisstructuur te integreren. Voor onbekende nanotechnologie attitude-objecten is de affectieve-cognitieve attitude structuur nog niet uitgekristalliseerd en nog steeds aan verandering onderhevig.

Samen laten de hoofdstukken in het proefschrift zien dat, hoewel affectieve verwerking de standaardoptie is, mensen in attitudevorming ten aanzien van onbekende attitude objecten toch in staat zijn om cognitieve gevolgtrekkingen te maken op voorwaarde dat er in de omgeving voldoende cues beschikbaar zijn (bv. de productcontext, hoge Need for Cognition, of er vaker mee in aanraking zijn geweest). Bovendien blijkt dat of mensen op affect of cognitie afgaan afhangt van welke van de twee attitudecomponenten de minst uitgebreide mentale verwerking vraagt. De attitudecomponent die bepalend is in het attitudevormingsproces is vaak ook de component die de minst uitgebreide verwerking vraagt. Hiermee draagt dit proefschrift bij aan een beter procesbegrip omdat de affectief-cognitieve en intuitief-deliberatieve dimensies tegelijkertijd zijn bestudeerd. Daarnaast kan geconcludeerd worden dat onbekende attitude objecten, in dit geval nanotechnologie toepassingen, nog steeds aan veranderingen onderhevig zijn. Dit heeft implicaties voor de communicatie over nieuwe technologieën. Het is namelijk belangrijk om in communicatie zowel affectieve als cognitieve aspecten in ogenschouw te nemen.

Acknowledgements

While writing the acknowledgments I am thinking back over all the great things I did during this PhD, the many inspiring people I met, and everyone who supported me. I would like to take this opportunity to express a big ‘thank you’ to several people.

First of all, I would like to thank my promoter Hans van Trijp, and my co-promoter Arnout Fischer. Hans, your guidance and coaching have been enormously valuable to me. During the many conversations we had about my research you really helped me to become an independent scientist by changing my way of thinking, illustrating this with many schemes, and always pushing me to go one level deeper. Arnout, you are a great daily supervisor. You were always out there to challenge me and to help with structuring my thoughts, improving my research designs and helping me to find solutions to theoretical issues and practical problems. Especially the ‘writing together’ sessions were very insightful. Hans and Arnout, I learned many things from both of you – thank you so much.

Heleen van Dijk: for the last years of my PhD you were unfortunately not my supervisor anymore, instead you became a coach and friend. No one in the team understood the ups and downs of a PhD better than you did, so thank you for all your advice.

I would like to thank the members of the reading committee: Prof. Gerrit Antonides, Prof. Andreas Glöckner, Prof. Michael Siegrist, and Dr Frank van Harreveld for their time and effort in reviewing this thesis and for coming to Wageningen for the public defence. Thank you also for the many inspiring discussions during several other occasions and conferences.

I would also like to thank NanoNextNL for giving me the opportunity to work on this project and present my work at various NanoNextNL or RATA meetings and even Lowlands. I would like to thank Hans Marvin for his expert view and useful comments in creating the scenarios for the different applications used in Chapter 2 and 5. Thank you Diana Ayi Wong for your help with the eye-tracking studies. I am happy you started a PhD and that we keep sharing ideas and stories.

Thank you Manohar Kashmira for your help in creating the Matlab scripts for the eye-tracking studies and of course for all other support. Ian and Jan Simpson, thank you so much for your editing help on various chapters of this thesis. Anne Marike Lokhorst, thank you for your coaching in the final stage of my PhD.

Dear fellow MCB, ECH, RME PhDs: what would a PhD have been without you guys?. I am happy we had so many joint dinners and meetings! Dear MCB colleagues, thanks for the great time at MCB. I guess most of you, like me, will never forget the sailing day out. I would like to thank a few people in particular here: Thanks Ellen and Liesbeth for all practical assistance, and Ivo for the good moments while teaching together. Colin, being colleagues and sharing a house proved to work out perfectly. I will definitely miss the 'life of a PhD student' discussions at home, but above all, the dinners and movie nights. Gerben, it was great to have our weekly social psychology meetings, being in the same phase of our PhDs. Grace, Kunalai and the 'little Africans,' thanks for sharing cultures. Robert, thanks for the chit chats in our office.

Nidhi and Workneh, what a trio we are... Friendship has no borders and I am truly blessed to have friends like you. I am very happy and thankful that you are my paranymphs and that you were and are always there for me. Now that the three of us have finished our PhD journeys, I hope many other journeys will follow for this amazing trio.

Dear JDM friends, thank you for the inspiring talks and discussions during the JDM workshop (Berlin), SPUDM (Barcelona), the EADM summer school (Bonn), SJDM (Long Beach), and the attitude symposium (Konstanz). But above all I would not have wanted to miss all the fun. Thanks guys for your support from a distance, and for still being in touch.

Besides in my PhD, affect and "*E-motion*" played an important role in my free time as well (more than cognition). Especially while sailing the Wednesday evening regattas on board "*E-motion*". Thanks, Henk Kuiper, and E-motion crew members, for your support and the great moments together.

Dear friends! Thanks for your support and friendship, not to forget our fun activities to make sure I also took time to relax. While writing this PhD thesis I realize once again how blessed I am to have so many lovely friends out there, who are always willing to help and listen to me. Dear scouts and RA13 board, the big difference between scouting and academia is the level of seriousness /spontaneity. I am glad I explored both sides of the continuum during this PhD – thanks to you.

Last, I would like to thank the most important people in my life:
Mama and Papa, thanks for being there for me: Papa for your advices and life lessons during the difficult times of this PhD, Mama for the mental support (en 'energiepakketjes'). Without your unconditional support it would have been much harder! Reinout, I am happy you are always there for me. Above all I cherish the many fun activities we had (and will have), together with Annelieke! Oma, I am happy you have been part of this whole PhD process, always supporting me. Fam. Haemers, thank you for the warm home and support.

Angelo, there are no words to describe how happy I am with your endless help and support, being there for me in every possible way! Especially in the difficult times, when a big hug makes up for everything else, and puts things into perspective. You taught me the most important lesson during this PhD: "everything will be fine"!

– And, this is the result..

About the author

Roxanne van Giesen studied social psychology at Tilburg University and graduated in 2010 with a (research) master degree in social and behavioural sciences. During her (research) master she specialized in social and economic psychology.
In 2011 Roxanne started working at the Marketing and Consumer Behaviour group at Wageningen University, which resulted in the current PhD thesis. Her PhD research focussed on consumer attitude formation, applying this to the case nanotechnology. During her PhD she followed specialized courses in consumer behaviour and judgement and decision making. Roxanne presented her work at several national and international conferences.

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Roxanne van Giesen
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research methods: From topic to proposal	WASS	2011	4
Writing PhD Research proposal	WASS	2011	4
Masterclass nanotechnology and nanomaterials	NanoHouse	2012	2
EDEN Doctoral seminar consumer behaviour	EIASM, Brussel, Belgium	2012	5
6th Annual decision making workshop	Max Planck Institute Berlin, Germany	2013	1.5
2nd Judgment and decision making summer school	Max Planck Institute Bonn, Germany	2014	5
'Puppy's, needles and attitude formation: How different (un)familiar attitude objects are mentally processed'	Associatie van Sociaal-Psychologische Onderzoekers (ASPO), Utrecht	2012	1
'Understanding the role of cognition and affect on consumer attitude formation toward (un)familiar attitude objects'	Subjective probability, utility and decision making conference (SPUDM 24), Barcelona, Spain	2013	1
'Understanding the role of cognition and affect on consumer attitude formation toward (un)familiar attitude objects'	WASS PhD Day	2013	1
' Feeling and thinking: How do we form attitudes toward things we don't know?'	Society for Judgment and Decision Making (SJDM), Long Beach (LA), USA	2014	1
'Understanding consumer opinions toward nanotechnology'	NanoCity conference, Utrecht	2014	1
'Tracing attitude expressions toward unfamiliar attitude objects: An eye-tracking approach'	Symposium integrating research on attitudes and preferences, Konstanz, Germany	2014	1

Roxanne van Giesen
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan (continued)

Name of the learning activity	Department/Institute	Year	ECTS*
B) General research related competences			
Introduction course	WASS	2011	1
PhD Series: Consumer behaviour	MCB / ECH / RME	2011-2014	3
Project and time management	WGS	2011	1.5
Improve your writing	WGS	2013	1.8
Techniques for writing and presenting scientific papers	WGS	2014	1.2
Scientific publishing	WGS	2014	0.3
C) Career related competences/personal development			
Teaching and supervising thesis students	DO	2011	1
Supervising five master thesis projects	WUR, MCB	2012-2013	1
Lecturer Consumer Behaviour	WUR, MCB	2011-2015	1
Teaching assistant Social Psychology	WUR, MCB	2011-2012	1
Mobilising your scientific network	SSG	2013	1
Career perspectives	WUR	2014	1.6
Total			**42.9**

*One credit according to ECTS is on average equivalent to 28 hours of study load

Abbreviations:
DO stands for Educational Staff Development group (Docenten Ondersteuning)
ECH stands for Economics of Consumers and Households group
EIASM stands for European Institute for Advanced Studies in Management
SSG stands for Social Science Group
MCB stands for Marketing and Consumer Behaviour group
RME stands for Research Methodology group
WASS stands for Wageningen School of Social Sciences
WGS stands for Wageningen Graduate Schools
WUR stands for Wageningen University and Research centre

Financing organization:
The research described in this thesis was funded by NanoNextNL, a micro and nanotechnology innovation consortium of the Government of the Netherlands and 130 partners from academia and industry. More information on www.nanonextnl.nl

Publisher:
Ridderprint BV, Ridderkerk

Graphic design, cover design, and art work:
Angelo Haemers