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“Listen, did you hear…?” A structural equation model explaining online information sharing on the risks of nanotechnology in food

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ABSTRACT

In order to encourage consumer informed decision making, it is in the interest of risk communicators in the food industry and authorities to facilitate consumer risk information sharing. Focusing on the risks of nanotechnology in food products, this study aimed to develop and test a model that describes the processes that result in the online sharing of risk information on food products. The model was based on the Theory of Planned Behaviour, the Risk Information Seeking and Processing model and the broader risk perception and communication literature. A cross-sectional online survey has been carried out among a representative sample of adults > 18 years of age in the Netherlands (n = 511). Attitude, self-efficacy, and injunctive and descriptive subjective norms in relation to information sharing were measured, as were information need, information seeking, trust, risk perception and anxiety in relation to the application of nanotechnology in food products. Structural equation modelling (SEM) was applied to test the determinants of information sharing behaviour, and their relationships. Results showed that the intention to share information about the risks of nanotechnology in food online was medium-low. The hypothesized model as a whole fitted the data and nine of the fourteen path coefficients were highly significant. Results showed injunctive norms to be the main determinant of information sharing. Attitude and information seeking also contributed to the explanation of the variance in information sharing. Results are put into the perspective of relevant theoretical viewpoints and empirical findings. Implications for food risk communication and the facilitation of informed decision making are discussed.

1. Introduction

Recent years have witnessed a huge number of novel foods being introduced on the market. Driving factors are increasing globalisation, ethnic diversity and a search for new sources of nutrients. These novel foods include new types of food, foods from new sources, new substances used in food as well as new technologies for producing food (EFSA, 2018). Nanotechnology is an example. It is applied in the development of new foods, food packaging and food production (Frewer et al., 2011).

An important question to food risk communicators is how consumers respond to the introduction of products in which nanotechnology is used, and information thereof. There is ample research focusing on consumers' perceptions and willingness to buy (Giles, Kuznesof, Clark, Hubbard, & Frewer, 2015; Siegrist, Cousin, Kastenholz, & Wiek, 2007; Yue, Zhao, Cummings, & Kuzma, 2015) and on the effects of source, message and target group characteristics in risk/benefit communication (Frewer et al., 2016). There is however hardly any research on the communication processes among consumers by means of social media.

In order to better understand food risk information sharing, this study aimed to gain insights in the characteristics of online sharing of food risk information and its determinants. Focusing on the application of nanotechnology in foods and its risks, a model describing the processes that result in the sharing of risk information is developed and evaluated by means of structural equation modelling (SEM). The choice for the application of nanotechnology was motivated by the fact that nanotechnology scores high on the unknown-risk component of the psychometric paradigm (Slovic, 2000) and that current attitudes in the Netherlands are not yet strongly established (Van Giesen, Fischer, & van Trijp, 2018). This implies that this technology is vulnerable to social amplification processes, that nowadays also take place by means of information sharing on social media (Fellenor et al., 2017).

The results of this study are very relevant to risk communicators. Consumer information sharing facilitates well-informed decision making regarding food choices among the general public (Crook, Stephens, Pastorek, Mackert, & Donovan, 2016). Knowledge of information sharing will thus enable risk communicators to encourage informed decision making.

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Food Quality and Preference 76 (2019) 118–132

1.1. Nanotechnology: application, perception and communication

In the Netherlands, the National Institute for Public Health and the Environment recognizes that the application of nanotechnology in the food sector might contribute to a safe, healthy and sustainable diet (Zantinge, van Bakel, van Loon, & Ocke, 2017). How widespread nanotechnology is currently applied in the Netherlands in food, is however largely unknown. Consumers are informed about the benefits of the application of nanotechnology in a food-related context, as well as of its risks. It is nevertheless very hard for Dutch consumers to avoid these risks: only artificially produced nanoparticles have to be mentioned on food labels (Dutch Food and Nutrition Center, 2018).

Consumer perceptions of nanotechnology have been extensively studied (Capon, Gillespie, Rolfe, & Smith, 2015; Conti, Satterfield, & Harthorn, 2011; Frewer et al., 2014; Giles et al., 2015; Priest & Greenhalgh, 2011; Siegrist et al., 2007). This research demonstrated that attitudes toward nanotechnology are moderately positive across many areas of application. Benefits were expected to occur predominantly in relation to medicines and health, and technological development, rather than to agriculture and food. Food-related applications were more likely to raise societal concern when compared to other applications and consumers were found to be hesitant to buy nanotechnology foods or food with nanotechnology packaging. The situation in the Netherlands seems to correspond to the international scene. Knowledge on nanotechnology is low and there has been no large increase in knowledge in recent years. Consumer attitudes are not yet strongly established which suggests that consumer attitudes are vulnerable to incidents (Van Giesen et al., 2018).

Risk and benefit perceptions play an important role in consumer attitudes and acceptance of nanotechnology in foods, as do ethical concerns regarding environmental impact and animal welfare (Bearth & Siegrist, 2016; Frewer et al., 2014; Siegrist et al., 2007). Various factors affect these perceptions, such as perceived control, perceived naturalness, affect, trust in the food industry and confidence in the competence of governmental technology management (Capon et al., 2015; Siegrist et al., 2007; Siegrist, Stampfli, Kastenholz, & Keller, 2008; Yue et al., 2015). The occurrence of a negative incident may crystallise consumer views regarding rejection (Frewer et al., 2014).

Introducing a new product on the market involves providing consumers information on their nutritional value and other qualities. When consumers are faced with such information, they may rely on the affect heuristic in forming their perceptions (Siegrist et al., 2007). If the perceived product characteristics correspond to the dread risk dimension of the psychometric paradigm and if benefit perception is low, consumers may abstain from purchasing the product (Capon et al., 2015; Siegrist et al., 2007). This would make it hard for new products to get accepted. This also means consumers might miss out on their benefits.

It is in the interest of food producers, food authorities ánd consumers, that consumer food choices are based on informed decisions regarding the mostly health-related benefits as well as the potential risks of food products. Informed decision making involves the process of making sense of information in order to generate meaning and understanding. It includes thoughts, emotions and actions (Dervin, 1998; Pirolli & Russell, 2011; Weick, Sutcliffe, & Obstfeld, 2005). Fundamental processes are information seeking, processing and sharing (Berger, 2014). All three processes contribute to enhance consumers taking well-informed decisions on their food choice (Caughron et al., 2013; Hilverda, Kuttschreuter, & Giebels, 2017).

The Internet and social media play an important role here. The Internet has become one of the main sources of food information (Jacob, Mathiasen, & Powell, 2010; Kuttschreuter et al., 2014; Ma, Almanza, Ghiselli, Vorvoreanu, & Sydnor, 2017; Redmond & Griffith, 2006; Tian & Robinson, 2008) and social media provide consumers with an easy-to-use tool to communicate with others (Hamshaw, Barnett, & Lucas, 2018). With the emergence of social media the one-way flow of information from communicator to consumer changed into a dynamic environment that enabled consumers to post, spread and exchange information. Consumers can now not only seek information online, but also post publicly available messages, pictures and videos, and respond to them (Mangold & Faulds, 2009). Consumers do indeed use these features. They value food risk information from family and friends, consult social media for information on food choices and share their insights in food consumption, food preparation and food purchase and concerns regarding new technologies on social media such as Twitter (Barnett et al., 2011; Hamshaw et al., 2018; Kornelis, De Jonge, Frewer, & Dagevos, 2007; Kuttschreuter et al., 2014; Runge et al., 2013; Vidal, Ares, Machin, & Jaeger, 2015).

Online sharing (one-way communication) and exchanging information (two-way interaction) may thus contribute to consumers making sense of food risk information (Caughron et al., 2013). There is evidence that such information sharing and exchanging may subsequently affect consumer behaviour (Erkan & Evans, 2016; King, Racherla, & Bush, 2014). Applying structural equation modelling, Crook et al. (2016) found that the willingness to share healthy heart information positively predicted the intention to engage in these behaviours oneself. Encouraging information sharing might thus be effective in enhancing informed decision making regarding food risks and food choice.

While there is ample research on risk information seeking and processing (Yang, Aloe, & Feeley, 2014), there is as yet hardly any scientific knowledge on the factors that shape online risk information sharing. Most research on information sharing has focused on the impact of information sharing in teams on group performance and showed strong effects (Mesmer-Magnus & DeChurch, 2009; Yang, Kahlor, & Griffin, 2014). Research further concentrated on the characteristics and gratifications of the media channel (e.g. Oh & Syn, 2015), and did not specifically address topic nor content of the shared information.

Exceptions are studies on organic food (Hilverda & Kuttschreuter, 2018) and climate change (Yang, Kahlor, et al., 2014). The first study was based on the Theory of Planned Behavior (TPB) and the Risk Information Seeking and Processing model (RISP) and applied structural equation modelling. Results showed that attitude and expected outcomes, informational injunctive norms and information seeking significantly predicted online information sharing. The second study included RISP-variables only. Here, too, information sharing behavior was most strongly related to informational injunctive norms and information seeking.

1.2. Hypothetical model of online food risk information sharing

Based on theories and evidence reported in the literature, a hypothetical model was developed that connected potential determinants of online risk information sharing. The determinants in the model originated from two sources: the Theory of Planned Behaviour (Ajzen, 1991) and the Risk Information Seeking and Processing model (Griffin, Dunwoody, & Neuwirth, 1999) that builds on the risk perception literature. The model is visualized in Fig. 1.

The model consists of 14 explicit paths, hypothesizing a direct effect of a variable on another variable. Many more hypotheses are however implicitly tested. These relate to variables that are not directly connected by a path. In these cases, when evaluating the model, the hypotheses are tested that there is no direct effect of variable X on Y (Kline, 2011).

1.2.1. Determinants originating from the Theory of Planned Behaviour

Based on TPB, three proximal behavioural determinants were incorporated in the model: attitude, self-efficacy and subjective norms. These determinants were complemented by a distal determinant: sociability.

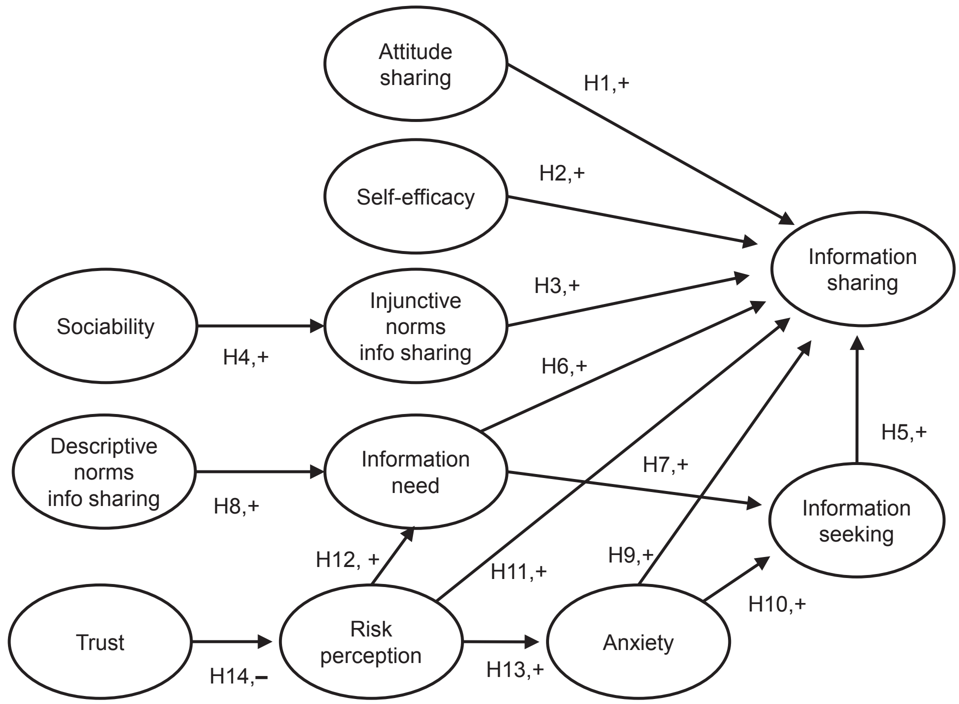

Fig. 1. Hypothesized structural equation model, explaining information sharing. Hx: Hypotheses and their number; + hypothesized relationship positive; − hypothesized relationship negative.

Attitude towards information sharing can be viewed as the result of beliefs regarding outcomes and usefulness of information sharing. Following the literature (Bock & Kim, 2002; He & Wei, 2009; Hilverda & Kuttschreuter, 2018; Hsu & Lin, 2008; Hsu, Ju, Yen, & Chang, 2007; Lin, Featherman, & Sarker, 2013; Papadopoulos, Stamati, & Nopparuch, 2013; Roberts, Hann, & Slaughter, 2006), attitude was hypothesized to be a significant determinant of information sharing: the more positive the attitude, the more the individual would be inclined to share information (H1).

Self-efficacy was understood as the perceived ability to share knowledge by using the Internet. Based on the literature (Hsu et al., 2007; Kankanhalli, Tan, & Wei, 2005; Papadopoulos et al., 2013), a positive effect on information sharing was hypothesized (H2).

Regarding subjective norms, a distinction was made between *injunctive norms* and descriptive norms. Injunctive norms refers to the extent to which individuals feel pressured to engage in a particular behavior and involves the perceived (dis)approval of others, whereas descriptive norms refers to the individual's beliefs about how widespread the behavior is among a reference group (Dixon, Deline, McComas, Chambliss, & Hoffmann, 2015; Kahlor, 2007; Rimal & Real, 2003; Yang, Kahlor, et al., 2014). In both cases, it is the perception of the individual that counts (Rimal & Real, 2003). In line with the literature (Chiu, Hsu, & Wang, 2006; Hilverda & Kuttschreuter, 2018; Lin et al., 2013; Yang, Kahlor, et al., 2014), we hypothesized that injunctive norms were directly positively related to information sharing (H3).

Sociability is a sub-dimension of extraversion. Individuals who score high on this trait, enjoy social interactions and feel positive about talking about their daily lives (Lee & Ashton, 2004). Empirical evidence supports the relationship between sociability and information sharing. Individuals who had a high sense of belonging and liked to engage in online interactions, were more inclined to share their knowledge and ideas (Cheung & Lee, 2012; Chiu et al., 2006; Jacobsen, Tudoran, & Lähteenmäki, 2017). The study on organic food supported these findings and showed that injunctive norms mediated the effect of sociability (Hilverda & Kuttschreuter, 2018). In line with these findings, we hypothesized that sociability positively predicted injunctive norms related to risk information sharing (H4).

1.2.2. Determinants originating from the risk information seeking and processing model

As information seeking and sharing both are activities in a process to make sense of risk information, researchers have used RISP to study consumer risk information sharing (Hilverda & Kuttschreuter, 2018; Yang, Kahlor, et al., 2014). According to RISP, individuals who believe their actual risk knowledge is insufficient to take a well-informed decision will be motivated to gain information and search for it (Griffin et al., 1999; Griffin, Neuwirth, Dunwoody, & Giese, 2004; Griffin et al., 2008; Kahlor, 2010). RISP builds on the extensive risk perception literature and there is ample evidence in support of the model in explaining risk information seeking (Yang, Aloe, et al., 2014). Three variables were taken from the model: information seeking, information need and descriptive norms.

Studies showed that *information seeking* was an important determinant predicting information sharing regarding organic food (Hilverda & Kuttschreuter, 2018) and climate change (Yang, Kahlor, et al., 2014). Following these findings, we hypothesized that information seeking positively predicted information sharing (H5).

There is evidence that individuals who are more interested in a topic and experience a higher *need for information* are more inclined to share information (Hilverda & Kuttschreuter, 2018; Jacobsen et al., 2017; Kahlor, Dudo, Liang, Lazard, & AbiGhannam, 2016; Yang, Kahlor, et al., 2014). We hypothesized information need to have a positive direct effect on information sharing (H6). We also hypothesized an indirect effect on information sharing. The latter was based on RISP that hypothesized that information need positively predicted information seeking (H7 + H5).

According to RISP, information need develops in response to the social environment. Evidence supports this in relation to organic food: the more interest the individual perceived his connections to have in the topic, the higher the individual's information need (Hilverda & Kuttschreuter, 2018). We thus hypothesized the individual's *descriptive norms* regarding the sharing of information on nanotechnology in food to be a significant determinant of his information need (H8).

The risk perception literature identified another three relevant determinants that are also included in RISP: anxiety, risk perception and trust.

There is evidence to suggest *anxiety* may be a significant determinant of information sharing. Both Hilverda and Kuttschreuter (2018) and Yang, Kahlor, et al. (2014) found that anxiety was positively related to information sharing: the more worries and concerns with regard to organic food and climate change respectively, the more the participants were inclined to seek information about these topics and share it with others. We therefore hypothesized that anxiety positively affected information sharing behavior, both directly (H9) and indirectly, through information seeking (H10 + H5).

Risk perception might be a distal driver of information sharing. Evidence suggests risk perception may affect information sharing directly (Hilverda & Kuttschreuter, 2018; Lim, Greenwood, & Jiang, 2016) as well as indirectly (Griffin et al., 2004; Kahlor, 2010; Kuttschreuter, 2006). We therefore hypothesized risk perception to have a positive direct effect on information sharing (H11) as well as indirect effects through information need and anxiety. We allowed for four chains of indirect positive effect: risk perception – information need (H12) – information sharing (H6); risk perception – information need (H12) – information seeking (H7) – information sharing (H5); risk perception – anxiety (H13) – information sharing (H9); and risk perception – anxiety (H13) – information seeking (H10) – information sharing (H5).

Research has identified *trust* to be an important determinant of risk perception: the higher the individual's trust in retail and the competence of authorities and food producers, the lower the individual's risk perception (Siegrist & Cvetkovich, 2000; Viklund, 2003). There is also evidence that trust affects information sharing in a virtual community (Hsu et al., 2007; Liou, Chih, Hsu, & Huang, 2015). It was therefore hypothesized that there was a negative relationship between trust and risk perception regarding nanotechnology in foods (H14) and that trust indirectly affected information sharing through the four chains of indirect effects of risk perception mentioned above.

2. Method

2.1. Participants and procedure

Respondents were recruited during November 2014 and January 2015 by an internationally well-known, ISO 26362-certificated research agency that conducted the research according to ethical standards. A random sample representative of the Dutch population of online media users was drawn from a large panel. Because prior research showed differential response rates for gender and age, the sample was stratified with respect to gender and age. To ensure representativeness regarding gender and age, for each stratum, a predetermined target number of participants that had to be met was thus set. As a total of 97% of the Dutch population uses the Internet (CBS, 2015), age (18–34 years: 26.5%; 35–49 years: 29.1%; 50 + years: 44.4%) and gender distribution of the Dutch population (male: 49.5%; female: 50.5%) were used as reference points. Participants received an online invitation to fill out an online questionnaire, which took about 20 min to complete. The response rate was approximately 65–70%.

The research sample (n = 511) consisted of 251 males (49.2%) and 260 females (50.8%), living in the Netherlands. These percentages did not differ significantly from those for the Dutch population, $\chi^2 = 0.06$, p = .80. Age ranged from 18 to 85 years, with a mean age of 47.5 years.

The sample consisted of 140 participants between 18 and 34 years of age (27.4%), 121 participants between 35 and 49 years of age (26.2%), and 250 participants who were 50 years or above (48.9%). This distribution differed slightly from the Dutch population, χ^2 (2) = 7.67, $p = .02$, in a way that individuals between 35 and 49 years of age were underrepresented.

There was a broad range in educational level and household composition, and the participants lived across the country in areas of various degrees of urbanization. Most participants (81%) indicated that they were primarily responsible for doing the grocery shopping in the last month, while almost all participants (96%) had gone grocery shopping in the last month. A vast majority of the participants (90%) prepared dinner at least once a week, with 29% being responsible for this on a daily basis.

2.2. Instruments

Participants were asked about their responses when encountering information about the risks of nanotechnology in food (Appendix A). To create awareness of the potential risks and benefits a description was provided, highlighting a number of important risks and benefits associated with nanotechnology in foods. It was for example explained that nanotechnology could help to better preserve products and design tasty low caloric foods, but that it might also lead to nanoparticles entering the body, to accumulate in cells and to result in DNA-damage. Constructs were measured by a set of single item indicators. The exceptions were attitude and trust that were both conceptualised to consist of four components that were measured by a set of items. Here four component scores were used as indicators.

2.2.1. Outcome variable: online information sharing

Online information sharing about the risks of nanotechnology in food was measured by 8 items that were designed for the purpose of this study. Participants indicated the likelihood that they would share an interesting message, stating that there were risks attached to eating products created by a procedure that involved the use of nanotechnology (7-point scale, $\alpha = 0.97$). Items referred to two modes of online information sharing: publicly (4 items) and privately (4 items). Factor analysis showed that all the items loaded on 1 factor with an eigenvalue larger than 1 that explained 81% of the variance. Factor loadings ranged from 0.83 to 0.94. This means the scale was uni-dimensional and that all items loaded highly on the scale.

2.2.2. Determinants

Attitude toward information sharing was conceptualized to consist of four components (Bandura, 1997; Hsu et al., 2007): a general evaluation of the usefulness of information sharing (4 items), reciprocity (3 items), social effects (3 items) and self-evaluation effects (3 items). Items were derived from scales available in the literature (Chiu et al., 2006; Hsu & Lin, 2008; Hsu et al., 2007) and measured on a 7-point scale. The reliability of the components was good. Cronbach's alpha was $\alpha = 0.97$ for the usefulness of sharing, $\alpha = 0.93$ for reciprocity, $\alpha = 0.92$ for social effects and $\alpha = 0.96$ for self-evaluation effects. Factor analysis showed that all components were unidimensional and that the items loaded highly on this one factor. For the usefulness of sharing, we found 1 factor with an eigenvalue > 1 explaining 92% of the variance, and factor loadings ranging from 0.94 to 0.98. For reciprocity, too, there was 1 factor with an eigenvalue > 1 explaining 88% of the variance, and factor loadings ranging from 0.92 to 0.95. For social effects, again, 1 factor with an eigenvalue > 1 explaining 86% of the variance and factor loadings ranging from 0.92 to 0.95 was found. The same held for self-evaluation effects: 1 factor with an eigenvalue > 1 explaining 92% of the variance and factor loadings ranging from 0.95 to 0.97.

In structural equation modelling it is recommended to use a small number of indicators per latent variable, and to combine indicators into subscales if there are many indicators for a particular construct (Kenny, n.d.-b). In the analyses, the scores for the four components were therefore included instead of the 13 individual items. The reliability of the composite scale consisting of the four component scales was good ($\alpha = 0.88$). In factor analysis, 1 factor with an eigenvalue > 1 explaining 75% of the variance was found; factor loadings ranged from 0.83 to 0.92. The composite scale was thus unidimensional, and all four component scales loaded highly on this composite scale.

Self-efficacy related to information sharing was measured by four statements regarding the participant's perceived ability to successfully share information through the Internet (7-point scale; $\alpha = 0.93$). Items were derived from Kuttschreuter et al. (2014) and adapted to the current purpose. Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 84% of the variance. Factor loadings ranged from 0.89 to 0.95. This means the scale is unidimensional and that all items loaded highly on the scale.

Injunctive norms regarding information sharing were measured by four items. Participants were asked to indicate to what extent their social environment expected them to share information about the risks of food products (7-point scale; α = 0.97; adapted from Yang, Kahlor, et al. (2014)). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 91% of the variance. Factor loadings ranged from 0.94 to 0.97. This means the scale was unidimensional and that all items loaded highly on the scale.

Sociability refers to the tendency to enjoy conversation, social interaction and parties. Low scorers generally prefer solitary activities and do not seek out conversation, whereas high scorers enjoy talking, visiting, and celebrating with others. Items were derived from the respective Hexaco facet scales and adapted to the current purpose (4 items; 7-point scale; α = 0.88; adapted from De Vries, Ashton, and Lee (2009)). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 75% of the variance. Factor loadings ranged from 0.76 to 0.93. This means the scale was unidimensional and that all items loaded highly on the scale.

Information seeking was measured by four items regarding the participants' inclination to search for information about nanotechnology in food products and the risks involved herein (7-point scale; α = 0.95; items based on Hilverda and Kuttschreuter (2018) and adapted to the current purpose). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 86% of the variance. Factor loadings ranged from 0.87 to 0.95. This means the scale was unidimensional and that all items loaded highly on the scale.

Information need was measured by four items probing to what extent the participants would like to know more about the application of nanotechnology in food (7-point scale; α = 0.96; based on Kuttschreuter et al. (2014)). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 90% of the variance. Factor loadings ranged from 0.94 to 0.96. This means the scale was unidimensional and that all items loaded highly on the scale.

Descriptive norms regarding information sharing were measured by four items asking the participants to what extent people in their social environment were interested in information on food products created by a procedure that involved the use of nanotechnology (7-point scale; α = 0.98; items based on Hilverda and Kuttschreuter (2018) and adapted to the current purpose). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 94% of the variance. Factor loadings all rounded to 0.97. This means the scale was unidimensional and that all items loaded highly on the scale.

Anxiety was measured by asking the participants to what extent they experienced four emotional states when thinking about the risks of eating foods in which nanotechnology was used (7-point scale; α = 0.95; items adapted from Kuttschreuter (2006) and Yang et al. (2014)). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 88% of the variance. Factor loadings ranged from 0.92 to 0.95. This means the scale was unidimensional and that all items loaded highly on the scale.

Risk perception was measured by four statements regarding the negative consequences of eating foods in which nanotechnology was used (7-point scale; α = 0.97; items based on Hilverda and Kuttschreuter (2018) and adapted to the current purpose). Factor analysis showed that the items loaded on 1 factor with an eigenvalue larger than 1 that explained 90% of the variance. Factor loadings ranged from 0.95 to 0.96. This means the scale was unidimensional and that all items loaded highly on the scale.

Trust was conceptualised to consist of four components. It was measured by asking the participants to what extent they agreed that food products sold in supermarkets were safe to eat (3 items; α = 0.92; 1 factor with eigenvalue > 1 explaining 87% of the variance, factor loadings ranging from 0.91 to 0.94) and to what extent they believed that three organizations that play a role in the safe keeping of the food supply were competent and could be relied upon. Items were based on De Jonge, Van Trijp, Jan Renes, and Frewer (2007) and adapted to the current purpose. The respective organisations were the Netherlands Food and Consumer Product Safety Authority (4 items; alpha = 0.95; 1 factor with eigenvalue > 1 explaining 88% of the variance, factor loadings ranging from 0.93 to 0.96), the main consumer organization in the Netherlands ('De Consumentenbond'; alpha = 0.94; 1 factor with eigenvalue > 1 explaining 86% of the variance, factor loadings ranging from 0.91 to 0.94), and food producing companies (4 items; 7-point scale; alpha = 0.93; 1 factor with eigenvalue > 1 explaining 83% of the variance, factor loadings ranging from 0.88 to 0.93).

As it is recommended to have a small number of indicators per latent construct in structural equation modelling (Kenny, n.d.-b), the four component scores were included in the analyses as indicators of trust instead of the 15 individual items. The reliability of this composite scale consisting of the four component scales was good (4 component scales, α = 0.95; 1 factor with eigenvalue > 1 explaining 86% of the variance, factor loadings ranging from 0.82 to 0.88). The composite scale was thus unidimensional, and all four component scales loaded highly on this composite scale.

2.3. Analysis

Instruments were first checked for internal consistency and dimensionality. Correlations between the determinants and information sharing were then calculated. Structural equation modelling was subsequently applied to assess the plausibility of the model (AMOS 19).[1] Parameters were estimated based on the maximum likelihood method. In specifying the measurement model, items were allowed to load on one latent construct only. Two-step modelling was used (Kline, 2011): the measurement model (CFA) was tested first, followed by a full structural model that included both the measurement model and the structural model. To reduce model complexity and increase parsimony (West, Taylor, & Wu, 2015), insignificant paths were identified and removed. It was then checked that these paths could indeed be removed from the model without any meaningful effect on the model's fit and the obtained regression coefficients. The sample size (n = 511) far exceeded the minimum number of 200 participants suggested by Koran (2017) and Jackson, Voth, and Frey (2013) in the case of models like ours with approximately 12 factors, 4 indicators per factor and factor loadings exceeding of 0.80.[2]

[1] Structural equation modelling is an advanced statistical technique that evaluates whether a hypothesized model fits observed data. It assumes linear relationships between the variables and combines factor analysis and multiple regression. In evaluating the model, the free parameters are estimated based on the criterion of minimalisation of the difference between the observed data matrix and the reproduced data matrix. This difference is evaluated on the basis of fit statistics such as RMSEA. This means that the interpretation of the results of an analysis is based on two questions: 1) does the model as a whole fit the data? and 2) is the respective path coefficient significant? It is thus quite possible that the model as a whole fits the data, while specific path coefficients are not significant. Formula's can be found in Kenny (n.d.-a) and West, Taylor, and Wu (2015).

[2] There is a vast literature on the minimum sample size in CFA-analyses. Consensus is that rules of thumb are inadequate. Statistical research in this area showed the minimum sample size to be dependent on the number of factors in the model, the number of indicators per factor and the magnitude of the average factor loadings (Jackson et al., 2013; Koran, 2017; Myers, Ahn, & Jin, 2011; Wolf, Harrington, Clark, & Miller, 2013). For models like ours with approximately 12 factors and 4 indicators per factor, a minimum number of 200 participants is suggested in case of factor loadings of 0.80 on average (Jackson et al., 2013; Koran, 2017). As the average factor loading in our study exceeds 0.80, our sample size (n = 511) far exceeds the minimum number of 200 participants suggested by Koran (2017) and Jackson et al. (2013).

Table 1
Means, standard deviations, and Pearson correlations between determinants and information sharing (n = 511).

	Constructs	Mean	sd	Correlations										
				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1.	Online information sharing	3.12	1.57	1.00										
2.	Attitude	3.84	1.22	0.57**	1.00									
3.	Self-efficacy	5.08	1.42	0.06	0.23**	1.00								
4.	Injunctive norms	2.93	1.51	0.67**	0.62**	0.03	1.00							
5.	Sociability	4.81	1.11	0.13**	0.25**	0.29**	0.20**	1.00						
6.	Information seeking	4.03	1.46	0.47**	0.48**	0.15**	0.44**	0.24**	1.00					
7.	Information need	4.91	1.43	0.34**	0.43**	0.22**	0.28**	0.23**	0.68**	1.00				
8.	Descriptive norms	3.68	1.43	0.52**	0.52**	0.10*	0.53**	0.17**	0.57**	0.54**	1.00			
9.	Anxiety	3.64	1.60	0.27**	0.30**	0.00	0.23**	0.06	0.22**	0.29**	0.20**	1.00		
10.	Risk perception	4.40	1.30	0.18**	0.25**	0.07	0.15**	0.08	0.21**	0.39**	0.20**	0.62**	1.00	
11.	Trust	4.41	1.19	−0.02	0.07	0.03	0.03	0.19**	0.08	−0.02	−0.08	−0.21**	−0.26**	1.00

**Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed).

3. Results

3.1. Information sharing and its determinants

Results showed that online information sharing was medium-low (M = 3.12, SD = 1.57) and that participants were more inclined to share information privately (M = 3.34; SD = 1.65) than publicly (M = 2.89; SD = 1.60). The participants were most likely to share information by email (M = 3.73; SD = 1.86) or to forward a link (M = 3.35; SD = 1.83), and least likely to write a message (M = 2.74; SD = 1.63) or post a link (M = 2.83; SD = 1.66) on a public blog.

Table 1 shows the means, standard deviations and Pearson correlations of the variables. Overall, the attitude toward information sharing was slightly below the middle of the scale (M = 3.84, SD = 1.22). The general evaluation regarding the usefulness of information sharing was in the middle of the scale (M = 4.03, SD = 1.64). Reciprocity dominated the outcome expectations (M = 4.15, SD = 1.63), followed by self-evaluation (M = 3.71, SD = 1.39) and social outcomes (M = 3.40, SD = 1.25). The participants were thus most inclined to share information online because they anticipated to receive information in return, to a lesser extent to feel good about themselves, and the least to gain respect or maintain social relationships.

The participants felt quite able to share information online (M = 5.08, SD = 1.42). They enjoyed engaging with others (M = 4.81, SD = 1.11). The perceived interest in information on nanotechnology in food among their social environment was slightly below the middle of the scale (M = 3.68, SD = 1.43) and the participant felt little pressure to share information on food risks (M = 2.93, SD = 1.51). They expressed an interest in learning more about nanotechnology in food themselves (M = 4.91, SD = 1.43); the tendency to seek such information was however in the middle of the scale (M = 4.03, SD = 1.46).

Risk perception was slightly above the middle of the scale (M = 4.40, SD = 1.30). This also held for trust (M = 4.41, SD = 1.19). This combination might perhaps explain why anxiety was slightly below the middle of the scale (M = 3.64, SD = 1.60).

3.2. Relationship between information sharing and determinants

There were strong correlations between information sharing and the TPB-variables attitude ($r = .57$ $p \le 0.0005$) and injunctive norms ($r = 0.67$; $p \le 0.0005$): the more positive the attitude and the more the participant felt that (s)he was expected to share information about the risks of nanotechnology in foods, the more inclined (s)he was to share such information. There was no significant relationship with self-efficacy.

High positive correlations were found between information sharing and descriptive norms ($r = 0.52$, $p \le 0.0005$), information need ($r = 0.34$, $p \le 0.0005$) and information seeking ($r = 0.47$, $p \le 0.0005$). The higher the perceived interest in food risk information among connections, the higher the participant's information need, information seeking and the intention to share information online.

The correlations between information sharing and the evaluation of risks were the weakest. There were significant positive correlations with risk perception ($r = 0.18$, $p \le 0.0005$) and anxiety ($r = 0.27$, $p \le 0.0005$): the higher risk perception and anxiety, the more the participants were inclined to share information. The correlation with trust was not significant.

Table 2
Model fit of the measurement model, the structural model and the reduced structural model (n = 511).

	Thresholds for acceptable fit	Measurement model	Structural model	Reduced structural model
χ^2 *(df)*	–	2835.81 *(1023)*	3355.82 *(1054)*	3365.05 *(1059)*
χ^2/df	< 3.00–5.00	2.772	3.184	3.178
RMSEA	< 0.05-0.08	0.059	0.065	0.065
GFI	> 0.90	0.793	0.762	0.761
CFI	> 0.90	0.941	0.924	0.924
TLI	> 0.90	0.934	0.919	0.919
NFI	> 0.90	0.910	0.894	0.894

3.3. Model testing

Two-step modelling was used to test the model (Kline, 2011).

3.3.1. The measurement model

Meeting the most commonly used criteria (Raykov, Tomer, & Nesselroade, 1991), the measurement model proved to have a good fit[3] (see Table 2). The Root Mean Square Error of Approximation (RMSEA) was 0.059, indicating an acceptable to good fit (Kline, 2011), as did the normed chi-square of 2.78 (Bollen, 1989; Kline, 2011). The Comparative-Fit Index (CFI) was 0.94, the Tucker-Lewis Index (TLI) was 0.93 and the Normed-Fit Index (NFI) was 0.91; all larger than the 0.90 Marcoulides and Schumacker (2013) and Bollen (1989) proposed as a cut-off point for a good fit. There were two fit indices indicating a poor fit. The chi-square statistic, $\chi^2(1205) = 2835.81$, was significant and

[3] To improve model fit, for information sharing and anxiety the error terms of two indicators were allowed to covary ($r = 0.60$ and $r = 0.80$ respectively). These relaxations in the measurement model error made sense semantically. After these relaxations, the measurement model fitted well, and significantly better than the model without the relaxations, $\chi^2_{difference}$ (2) = 656.11, $p \le 0.001$.

Table 3
Factor loadings, composite reliability estimates and average variance extracted (n = 511).

Constructs		Standardized factor loadings	Composite reliability	Variance extracted
1.	Online information sharing (8 items)	0.80–0.94	0.97	0.78
2.	Attitude (4 items)	0.72–0.93	0.89	0.67
3.	Self-efficacy (4 items)	0.83–0.95	0.94	0.79
4.	Injunctive norms (4 items)	0.91–0.97	0.97	0.88
5.	Sociability (4 items)	0.64–0.96	0.89	0.68
6.	Information seeking (4 items)	0.77–0.97	0.94	0.81
7.	Information need (4 items)	0.92–0.94	0.96	0.87
8.	Descriptive norms (4 items)	0.95–0.97	0.98	0.92
9.	Anxiety (4 items)	0.82–0.98	0.94	0.81
10.	Risk perception (4 items)	0.92–0.94	0.96	0.87
11.	Trust (4 items)	0.85–0.93	0.95	0.82

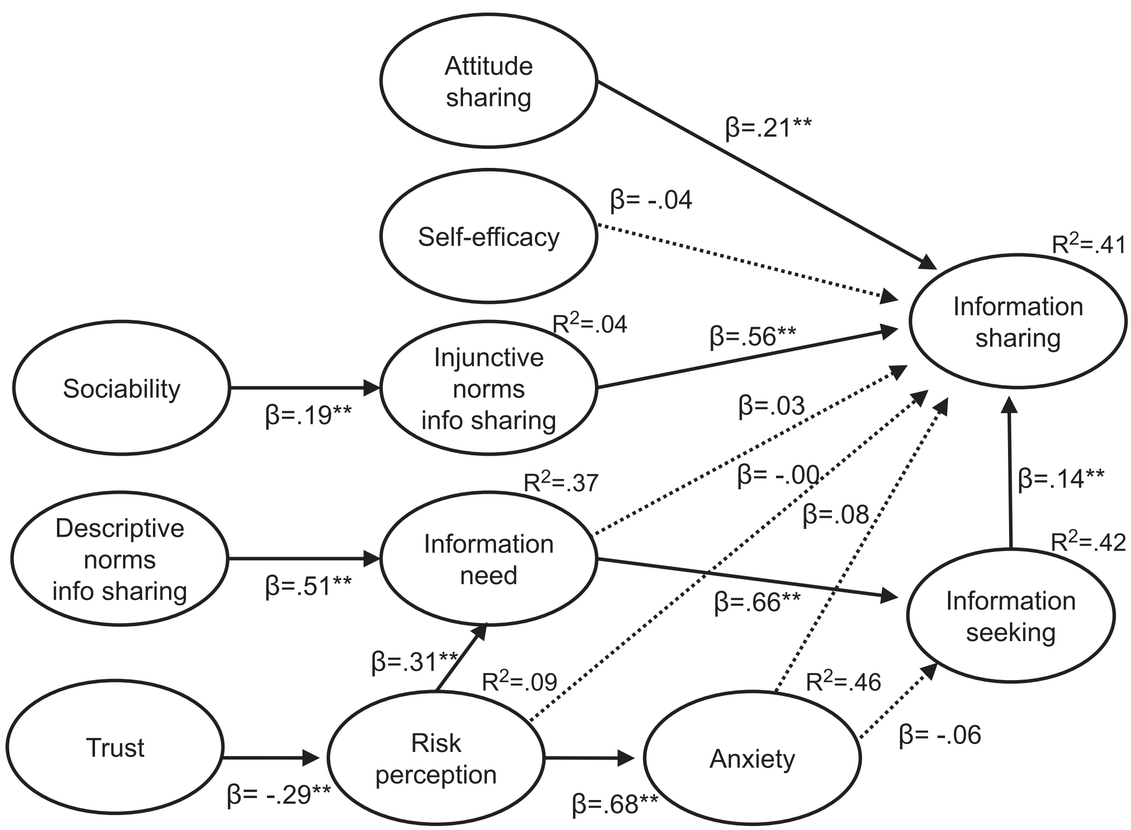

Fig. 2. Results of testing the structural model: standardised path coefficients (β) and squared multiple correlations (R^2). $^{**}p \leq 0.01$, $^{*}p \leq 0.05$ Solid arrow (⟶): significant path; dashed arrow (--▸): insignificant path.

the value of the goodness-of-fit index (GFI), a transformation of the chi-square, of 0.79 fell below the acceptability threshold. This was to be expected as the chi-square test and the GFI are highly dependent on sample size (Fornell & Larcker, 1981). Considering the large sample, these goodness-of-fit measures were less applicable and the obtained values provided no evidence for a poor model fit.

Convergent validity, assessed on the basis of CFA-factor loadings, reliability and average variances extracted (Hair, Black, Babin, Anderson, & Tatham, 2006), was good (Table 3). Standardized factor loadings ranged between 0.64 and 0.98, and exceeded the satisfactory threshold of 0.70, only one coefficient excepted (Chin, 1998). Cronbach's alpha's and the composite CFA-reliabilities were all above the cut-off point of 0.70. The average variances extracted (AVE) in the CFA were between 0.67 and 0.92, exceeding the acceptability value of 0.50 (Fornell & Larcker, 1981).

Discriminant validity was assessed by comparing the Pearson correlations between the constructs (Table 2) with the square root of the AVE's obtained in the CFA (Table 3). All square roots of AVE were larger than the inter-construct correlations, pointing to satisfactory discriminant validity (Chin, 1998). Given that our constructs were highly reliably measured, high levels of multicollinearity were tolerable (Grewal, Cote, & Baumgartner, 2004). Multicollinearity was nevertheless assessed by examining the correlations between the constructs. Correlations varied between $r = \leq 0.01$ and $r = 0.68$, and none of the 55 correlations approached the threshold for multicollinearity of 0.85 proposed by Hair et al. (2006) or exceeded the threshold of 0.80 suggested by Tabachnick and Fidell (2001). The discriminant validity was therefore considered to be fine.

The constructs were thus reliably measured and the measurement model met the requirements for testing the full structural model.

3.3.2. The structural model

The full model was tested; please see Fig. 2 for the explained variance in all dependent variables and the standardized path coefficients.

Table 4
Standardized covariances between exogenous predictors (n = 511).

Constructs		Standardized covariances				
		1.	2.	3.	4.	5.
1.	Attitude	1.00				
2.	Self-efficacy	0.19**	1.00			
3.	Sociability	0.26**	0.33**	1.00		
4.	Descriptive norms	0.49**	0.10*	0.15**	1.00	
5.	Trust	0.09	0.03	0.18**	−0.11*	1.00

**Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed).

The fit of the model as a whole was first evaluated (Table 2). RMSEA was 0.065, indicating an acceptable to good fit. CFI and TLI were both 0.92, and the NFI was 0.89, all almost equal to or exceeding the threshold of 0.90. The normed chi-square of 3.18 also pointed to a good model fit. The chi-square statistic, $\chi^2(1054) = 3355.82$, was significant, however, and GFI was 0.76, which was to be expected as we found the same results in testing the measurement model. The fit of the full structural model as a whole was therefore considered to be good.

Table 4 shows the standardized covariances between the exogenous predictors. A high positive correlation was found between descriptive norms and attitude ($r = 0.49$): the higher the perceived interest in food risks in the social environment, the more positive the attitude toward online information sharing. There were also significant but weak correlations between sociability and attitude ($r = 0.26$) and self-efficacy ($r = 0.33$): the more the participant interacted with his connections, the more positive the attitude toward information sharing and the higher the perceived ability to share information online.

The model was found to explain 41% of the variance in information sharing. The model further explained 42% of the variance in information seeking and 37% of the variance in information need. With regard to the risk-related variables, the model explained 46% of the variance in anxiety and 9% of the variance in risk perception. Sociability explained a mere 4% of the variance in injunctive norms.

The standardized indirect, direct and total effects of the determinants are reported in Table 5. The direct effect reflects the direct effect of a particular variable on information sharing, whereas the indirect effect reflects the effect of all the mediating chains of a particular determinant on information sharing combined (Kline, 2011).[4]

Two of the three variables originating from TPB contributed most to the explanation of the variance in information sharing: injunctive norms (total effect = 0.56) and attitude (total effect = 0.21). Two variables originating from the RISP model, information seeking (total effect = 0.14) and information need (total effect = 0.12), contributed to a lesser extent.

Injunctive norms, that was significantly dependent on sociability (H4; $\beta = 0.19$, $p \leq 0.001$), had the largest direct effect on information sharing (H3; $\beta = 0.56$, $p \leq 0.001$, direct effect = 0.56). Attitude had the second largest direct effect (H1; $\beta = 0.21$, $p \leq 0.001$, direct effect = 0.21), whereas self-efficacy had no significant direct effect (H2; $\beta = -0.04$, $p > .05$, direct effect = −0.04). The results thus indicate that both injunctive norms and attitude directly affected information sharing.

Information seeking had the third largest direct effect (H5; $\beta = 0.14$, $p \leq 0.01$, direct effect = 0.14). It was significantly predicted by information need (H7; $\beta = 0.66$, $p \leq 0.001$). The hypothesized direct effect of information need on information sharing (H6) was not significant, however ($p > .05$). Information need contributed thus mostly indirectly to information sharing. Information need in turn was significantly predicted by descriptive norms (H8; $\beta = 0.51$, $p \leq 0.001$) and risk perception (H12; $\beta = 0.31$, $p \leq 0.001$). Though the total effect of descriptive norms on online information sharing was low, information need and information seeking were proven to be relevant mediating variables.

Table 5
Standardized indirect, direct and total effects of determinants on information sharing (n = 511).

	Indirect effects	Direct effects	Total effects
Attitude	–	0.21	0.21
Self-efficacy online sharing	–	−0.04	−0.04
Injunctive norms	–	0.56	0.56
Sociability	0.11	–	0.11
Information seeking	–	0.14	0.14
Information need	0.09	0.03	0.12
Descriptive norms	0.06	–	0.06
Anxiety	−0.01	0.08	0.07
Risk Perception	0.09	−0.00	0.09
Trust	−0.03	–	−0.03

– Effect not included in the model.

The variables that relate to the individual's evaluation of the risks involved hardly contributed to explaining the online sharing of risk information. Risk perception that reflected the level of trust in food safety and food safety organisations (H14; $\beta = -0.29$, $p \leq 0.001$), had no significant direct effect on information sharing (H11, $p \geq 0.05$). It did have a significant effect on anxiety (H13; $\beta = 0.68$, $p \leq 0.001$); anxiety however did not add to the prediction of information seeking (H10, $p > .05$) and information sharing (H9, $p > .05$). The results thus indicated that while risk perception might have elicited feelings of anxiety, these feelings did not stimulate the participants to seek and/or share information on the risks of nanotechnology in food. These behaviours are instead instigated by a need for information resulting from higher levels of risk perception and lower levels of trust.

To check that the insignificant paths can indeed be removed from the model without any meaningful effect on the fit of the structural model, the structural model was reduced by removing the five insignificant paths and then re-evaluated. The fit of this reduced structural model barely differed from that of the structural model (Table 2) and did not significantly differ from that of the structural model ($\chi^2(5) = 9.23$, $p \geq 0.10$). There further was hardly any difference in the size of the remaining path coefficients and the squared multiple correlations (Fig. 3).[5]

4. Discussion

The introduction of novel foods involves informing consumers of their nutritional value and other qualities, including potential risks. In deciding whether to purchase a product, consumers have to make sense of such sometimes contradictory information. Information sharing, information seeking and information processing are three important means in this process (Caughron et al., 2013; Miranda & Saunders, 2003; Yang, Kahlor, et al., 2014). Information seeking and processing have been thoroughly investigated (Yang, Aloe, et al., 2014), but

[4] The significance of such chains cannot be statistically determined (Kline, 2015). Rule of thumb is that, if all the path coefficients in a chain are significant at a certain level, the whole chain of paths (indirect effect) can be taken as statistically significant (Kline, 2015). In structural equation modelling, the indirect effect of an exogenous variable provides information on its combined effect through all the possible chains of mediating variables on the dependent variable (here: information sharing), whereas the path coefficients provide information on the effect of variable A on variable B.

[5] To facilitate comparison with the results of the structural model, in the reduced model, the path from self-efficacy to information sharing was removed. The concept "self-efficacy" was kept, as completely removing it from the reduced model would have affected the number of degrees freedom (df = 1059 versus df = 885) which would have hindered comparison.

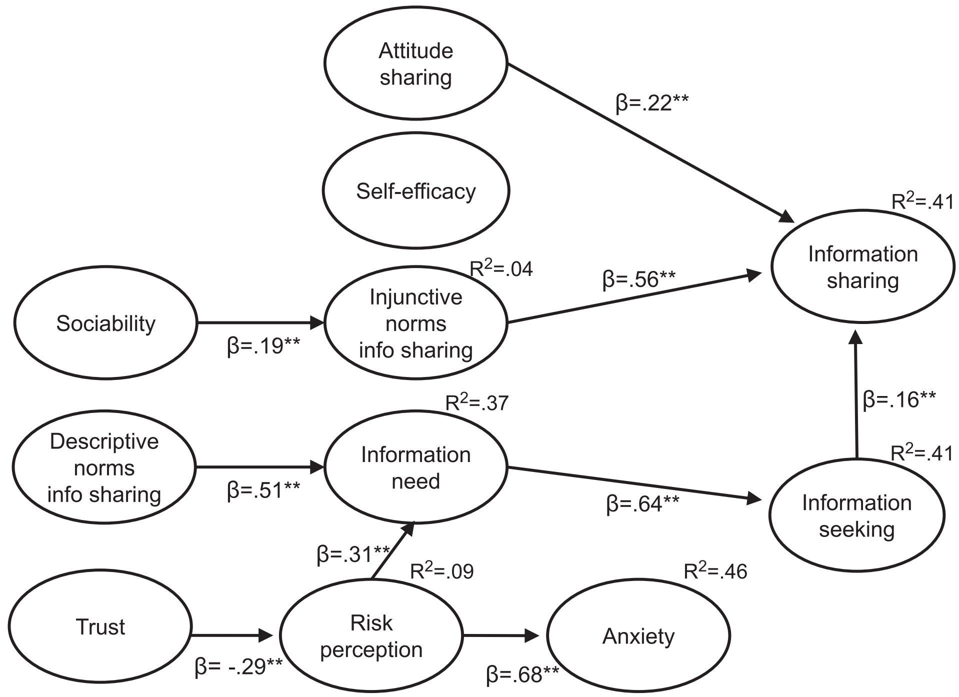

Fig. 3. Results of testing the reduced structural model: standardised path coefficients (β) and squared multiple correlations (R^2). $^{**}p \leq 0.01$, $^{*}p \leq 0.05$.

studies on communication processes among consumers by means of social media are scarce. Knowledge of consumer information sharing behaviour is however very relevant to risk communicators as it enables them to facilitate well-informed decision making regarding food choice among the general public (Crook et al., 2016).

The current study aimed to better understand the processes that result in the online sharing of food risk information. Focus was on nanotechnology in foods. A model was developed based on the Theory of Planned Behavior (Ajzen, 1991) and the Risk Information Seeking and Processing model (Griffin et al., 1999), and on empirical findings in the broader risk perception and communication literature, including two studies on information sharing (Hilverda & Kuttschreuter, 2018; Yang, Kahlor, et al., 2014).

Data were collected on a sample of Dutch Internet users that was representative for the Dutch online population with regard to gender and included consumers from a broad range in educational level and household composition. Given sample size, the slight difference with respect to age was hardly meaningful. Constructs were reliably measured.

Structural equation modelling (SEM) was used to analyse the data. This statistical technique evaluates to what extent the data fits a theoretical model with hypothesized directional effects (Kline, 2011). As the data are cross-sectional, the fit indicates whether the obtained data is consistent with a specified theoretical model (Kline, 2011). It is not decisive evidence that the model is correct; other models may also fit. The capabilities of SEM to formalize and implement causal inference are currently however indispensable (Bollen & Pearl, 2013).

4.1. Discussion on the results of testing the model

Testing our model provided valuable insights in the processes that lead to food risk information sharing. The fit statistics in the SEM-analyses showed that both the CFA-model and the structural model as a whole had acceptable to good fits. Nine of the fourteen hypothesized paths were found to be highly significant. The model explained 41% of the variance in information sharing. This is identical to the 41% reported in the SEM-study on organic food (Hilverda & Kuttschreuter, 2018) and comparable to the approximately 50% in the study on climate change where regression analyses were conducted (Yang, Kahlor, et al., 2014).

Injunctive informational norms, i.e. the individuals' perception of the expectations within their social environment, had a very strong direct effect on information sharing. This is in line with results observed by Hilverda and Kuttschreuter (2018), Lin et al. (2013), and Yang, Kahlor, et al. (2014). Hsu and Lin (2008), however, did not find such an effect. This can perhaps be attributed to their focus on information sharing among blog-users, whereas our participants would not easily engage in blogging.

The attitude toward information sharing had the second strongest direct effect on information sharing. This significant effect is in line with previous studies (He & Wei, 2009; Hilverda & Kuttschreuter, 2018; Hsu et al., 2007; Lin et al., 2013; Roberts et al., 2006). The relationship between attitude and information sharing was less strong than the relationship between injunctive norms and information sharing. Here, our results differ from those observed in most studies in the food domain using TPB, where mostly a stronger relationship between attitude and behavioural intention is observed than between injunctive norms[6] and behavioural intention (Hagger, Chan, Protogerou, & Chatzisarantis, 2016). There is however an important difference in the outcome variable. The behaviours in the other studies in the food domain relate to the intention to stick to a healthy diet (McDermott et al., 2015) or to consume alcohol (Cooke, Dahdah, Norman, & French, 2016), whereas our study focused on information sharing behaviour. Online information sharing is of course a form of social interaction and it is thus hardly surprising that injunctive norms are a decisive factor determining the consumers' level of social media interactions.

The topic of the interaction might also play a role. Although a stronger effect of injunctive norms than attitude was also found in the study on organic food (Hilverda & Kuttschreuter, 2018), this difference was not as pronounced as in the current study. This can perhaps be attributed to the fact that the attitude in society toward organic

[6] The meta-analyses by Cooke et al. (2016), McDermott et al. (2015) and Hagger et al. (2016), focus on "subjective norms" and make no distinction between injunctive and descriptive norms. Definitions suggest the analyzed studies measured injunctive norms.

products is more positive than toward the application of nanotechnology in food. This might be reflected in consumers encountering more information on risks and less on benefits in the case of nanotechnology than in the case of organic products. If consumers perceive their social connections to be more interested in (disquieting) information on risks than in (soothing) information on benefits, the injunctive norms regarding information sharing may have a stronger effect on consumers' information sharing behaviour. This is worth further investigating.

Information seeking was the third variable with a significant direct effect on information sharing. This direct effect is in line with the literature (Hilverda & Kuttschreuter, 2018; Yang, Kahlor, et al., 2014). The exact relationship between information seeking and sharing is not yet clear, however. The model hypothesizing a causal path from seeking to sharing fitted just as well as one hypothesizing a path from sharing to seeking, and as one hypothesizing common error variance in information sharing and seeking.

While empirically none of the models is any better than the other two, theoretically the model postulating a direct influence of information seeking on information sharing seems most plausible. As argued by Veinot (2009), information behaviour is often a collaborative effort. In her view, knowledge acquisition frequently results from a process in which information need motivates information seeking and the subsequent sharing of the collected information with others. This suggests that the fitted model is most plausible: the higher the information need regarding nanotechnology in foods, the more (joint) information seeking and the more information sharing. The finding that information need did not have a direct effect, but only an indirect effect on information sharing through information seeking, supports this reasoning.

One might further reason that information sharing might result in a renewed information need and subsequent information seeking. Unfortunately, current statistical packages do not allow to test such non-recursive models in a cross-sectional study. Further experimental research is indicated to entangle the relationships between information need, information seeking and information sharing.

Contrary to expectations based on the literature (Hsu et al., 2007; Kankanhalli et al., 2005; Papadopoulos et al., 2013), self-efficacy did not have a direct effect on information sharing. An explanation might be that almost the full Dutch population has access to the Internet and that at least 70% is active on social media (CBS, 2013, 2015). The average score on information sharing self-efficacy, that is amply above the mean of the scale, supports this explanation.

We further did not find a direct effect of risk perception and anxiety on information sharing, though there was a small indirect effect for risk perception, mediated by information need and information seeking. These findings suggest that, in the case of nanotechnology in food, it is not negative emotions such as anxiety, resulting from the perception of risks, that instigate information seeking and sharing. Attempts by consumers with a high risk perception to make sense of the situation seem more likely: how come food products that they perceive to be potentially hazardous are nevertheless introduced onto the market? These consumers may experience a lack of information and engage in information seeking and sharing to cognitively reconcile these inconsistencies in collaboration with their social connections.

An important question is what relationships, if any, the model did not explain and how these relationships can be understood. The modification indices showed a substantive residual correlation between injunctive norms and attitude. This relationship can perhaps be explained by the theory of social proof (Cialdini, 2001; Griskevicius, 2008). This theory states that if people don't know how to act, they rely on the views of others and do what other people do. In the context of information sharing: a high level of injunctive norms implies that the individual's connections perceive the shared information to be relevant and beneficial to them. And, following the theory of social proof, if information sharing is beneficial to the consumer's social connections, then information sharing would also be beneficial to the consumer him/herself. This would imply that injunctive norms determine the outcome expectancy of information sharing, and that outcome expectancy and attitude might be mediators in the relationship between injunctive norms and information sharing behaviour. The finding in the current study that reciprocity dominated the outcome expectations, supports this reasoning. Further support comes from findings by Wood, Read, Palfai, and Stevenson (2001) who observed that the effect of peer pressure on students' drinking behaviour was mediated by the expected outcomes of drinking.

A final note on the model relates to TPB and RISP as the theoretical background. In these models, beliefs regarding the outcomes of particular behaviours and perceived expectations in the social environment are considered to be important determinants of behaviour. This constitutes an instrumental approach to information sharing: individuals share information in order to achieve a particular objective. Individuals might, however, also share information just for the purpose of expressing their emotions (Baker & Moore, 2008). It would be worthwhile to investigate to what extent food risk information sharing is motivated by a longing to express emotions.

4.2. Generalizability

A relevant question is, of course, to what extent the model, visualized in Fig. 3, is generalizable to other food-related risks and to other categories of risk. The model was developed and tested for the application of nanotechnology. Evidence suggests that the model may be applicable to a wider range of food-related technologies. The model holds for two quite different foods risks: nanotechnology in foods as well as organic products (Hilverda & Kuttschreuter, 2018). This suggests that, though the level of information sharing and the injunctive and descriptive norms might be different, the underlying structure of the factors affecting information sharing is similar.

Consumer views are, however, ambivalent to slightly negative in the case of nanotechnology in food and positive in the case of organic products. This raises the question to what extent the model would also hold for negatively perceived food technologies. According to the RISP-model, the higher risk perception, the higher the consumer's need for information and the higher the intention to share information (Griffin et al., 2004; Hilverda & Kuttschreuter, 2018; Kahlor, 2010; Kuttschreuter, 2006; Lim et al., 2016). This suggests that, in the case of food technologies for which risk perception is high, there might be a stronger (combined direct and indirect) effect of risk perception on information sharing.

The question is also whether the model would also hold for other categories of risk, such as those to which individuals are involuntarily exposed, such as contaminated tap water. Future research is indicated to investigate to what extent our model is applicable in other contexts and whether the estimated coefficients are of similar size as the ones found in the present study.

Another relevant question that requires further investigation is to what extent the results are generalizable to other countries. In the Netherlands, almost the full population has access to the Internet and the majority is actively using social media (CBS, 2013, 2015). It is for instance quite possible that in countries where the use of social media is less popular, self-efficacy in relation to information sharing would have a significant effect on information sharing.

Another relevant question for further investigation is to what extent our model holds for various specific social media channels. In our study, information sharing was operationalised in terms of the frequency in which consumers would make use of some eight ways to share information online. Evidence suggests that the motives to share information depend on the specific social media channel: enjoyment, altruism, social engagement and reciprocity were more important motives among Facebook users than among Twitter users (Oh & Syn, 2015). Some channels might thus be used more often to share information in the hope to achieve a particular objective in return, while other channels might be more frequently used to maintain relationships or to express emotions.

4.3. Implications for risk communication

By enabling online consumer information sharing, social media have substantially changed the way individuals interact with each other. This online consumer information sharing and exchanging might be very useful to food risk communicators. Nowadays, food risk communication often aims to enhance informed decision making regarding food choice. Public online information exchange stimulates consumer sense-making and thus assists consumers in making well-informed decisions. Encouraging information sharing is thus a risk communication strategy that is very relevant to the food risk communication.

Risk communicators should appreciate the features enabled by the web 2.0 in communicating about the benefits and risks of nanotechnology in a food-related context. Though social media should be used as a complementary and not a stand-alone channel, they have great potentials in risk communication, such as the targeting of individuals who are otherwise hard to reach (Kuttschreuter et al., 2014; Overbey, Jaykus, & Chapman, 2017; Rutsaert et al., 2014). An option to facilitate consumer information exchange would be to allow consumers to react to information posted on one's website. Another option would be to be active on social media oneself and respond publicly to individual consumer comments (Veil, Buehner, & Palenchar, 2011). These responses might subsequently reach other consumers who are interested in the topic.

The decisive role of perceived injunctive norms suggests another potentially effective strategy to enhance consumer information sharing regarding nanotechnology in a food-related context: activities aimed at the group level rather than at the individual level. In addition to posting information on social media as Facebook and Twitter, risk communicators could for instance try to identify communities where food-related issues are debated and try to start a conversation there on the risks and benefits of nanotechnology in food. The aim would be to initiate a group discussion that pressures group members to engage and contribute to the discussion by sharing their information. The risk communicators could then join the conversation, help consumers to identify incorrect information and fake news, and to reach a well-informed decision (Veil et al., 2011). Potential extreme negative comments that might elicit unwarranted anxiety or distrust, could be addressed by strategies similar to the ones advocated by the WHO in the case of the anti-vaccine lobby (Schmid, MacDonald, Habersaat, & Butler, 2018; WHO, 2016).

These social media strategies might be productive as well as efficient as they correspond to the current way consumers are interacting with each other.

5. Conclusion

Facilitating consumer information sharing is a useful strategy to encourage consumer informed decision making. Focusing on the risks of nanotechnology in food products, this study evaluated a model that connected potential determinants of online risk information sharing identified in the literature and described the processes resulting in the online sharing of food risk information. Both the model specified on the basis of the literature and a more parsimonious model that included the significant paths only (West et al., 2015), provided an adequate to good fit with the data. Informational injunctive norms, attitude to information sharing and information seeking were the main determinants of information sharing.

Acknowledgement

We would like to thank the Netherlands Food and Consumer Product Safety Authority for funding this study.

Appendix A

Scales, items, dimensionality and reliability of the constructs (n = 511)

Measures		Characteristics	
		Scale	Structure & reliability
1.	*Sharing of risk information* If I encounter an interesting message saying that eating food products in which nanotechnology has been applied has risks, I would… 1. Post the link to this message on a forum of a specific target group, for example pregnant women or people with chronic diseases 2. Share the message with someone I know well via email 3. Share the message with a good friend via Skype or another chat 4. Forward the link to this message to my friends 5. Post a link to this message on a public forum about food 6. Post the message on a blog that is available to everybody 7. Write a post on a public blog 8. Post a link to this message on a website about food that is publicly available	7-point Likert scale from 1 = *very unlikely* to 7 = *very likely*	Unidimensional scale, α = 0.97
2.	*Attitude*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scales,
	A. – General attitude towards sharing If I encounter an interesting message on food risks… 1. I think it's useful to share the information 2. I think it's wise to share the information 3. I think it's helpful to share the information 4. I think positive about sharing the information		α = 0.97
	B. – Outcome expectancy beliefs: Reciprocity effects When I share information on food risks… 5. I'll receive information in return 6. Other people will tell me what they know about these risks too		α = 0.93

	7. I expect that other people share such information with me in the future		
	C. – Outcome expectancy beliefs: Social effects		
	When I share information on food risks…		α = 0.92
	8. I'll gain respect		
	9. This is beneficial for my relationship with family members		
	10. This has positive consequences for my reputation		
	D. – Outcome expectancy beliefs: Self-evaluation effects		
	When I share information on food risks…		α = 0.96
	11. This makes me feel good		
	12. I'll feel satisfied		
	13. I'll feel that I'm doing something important		
	Composite scale of 4 components		α = 0.88
	A. *General attitude towards sharing*		
	B. *Outcome expectancy beliefs: Reciprocity effects*		
	C. *Outcome expectancy beliefs: Social effects*		
	D. *Outcome expectancy beliefs: Self-evaluation effects*		
3.	*Self-efficacy*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.93
	1. I am capable to share information via online media with others 2. I know what to do to share a message publicly on the Internet 3. I am capable to safely share information online with my friends 4. It takes me little effort to share a message online		
4.	*Injunctive norms*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.97
	1. I am expected to share information on the risks of food 2. Most people in my social environment expect me to share information on the risks of food products 3. My friends expect me to share information on possible food risks 4. My family expects me to share information on possible food risks		
5.	*Sociability*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.88
	1. I like to tell to my friends what I've done 2. I enjoy having a lot of people around to talk to 3. I like to talk about what I've experienced 4. I enjoy talking with others about what I've experienced		
6.	*Information seeking*	7-point Likert scale from 1 = strongly disagree to 7 = strongly agree	Unidimensional scale, α = 0.95
	I'm inclined to search for information about…. 1. The disadvantages of food products in which nanotechnology has been applied 2. The way you prepare food products in which nanotechnology has been applied, while benefitting most 3. How to prepare food products in which nanotechnology has been applied the best 4. The way to deal best with the possible risks of food products in which nanotechnology has been applied		
7.	*Information need*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.96
	1. I would like to know more about the way in which I can recognize food products in which nanotechnology has been applied 2. I would like to learn more about the advantages and disadvantages of nanotechnology in food products 3. I would like to know more about the laws that apply to the use of nanotechnology in food products 4. I would like to learn more about the most important differences between food products in which nanotechnology has been applied and those for which that is not the case		
8.	*Descriptive norms*	7-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.98
	1. My friends are interested in information on the risks of food products in which nanotechnology has been applied 2. People in my social environment are interested in the risks of food products in which nanotechnology has been applied 3. My friends are interested in the risks of food products in which nanotechnology has been applied 4. In my social environment people are interested in the risks of food products in which nanotechnology has been applied		
9.	*Anxiety*	7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale α = 0.95
	When I think about the risks of eating food products in which nanotechnology has been applied, I feel.. 1. Anxious 2. Worried 3. Afraid 4. Concerned		
10.	*Risk perception*	7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scale, α = 0.97
	1. I think that food products in which nanotechnology has been applied are bad for my health 2. I think that there are many risks attached to food products in which nanotechnology has been applied 3. I think that food products in which nanotechnology has been applied have many disadvantages		

	4. I think that food products in which nanotechnology has been applied are dangerous for my health		
11.	*Trust*	7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*	Unidimensional scales, α = 0.92
	A. – Retail		
	1. I rely that food products that are for sale in supermarkets are adequately checked		
	2. I have complete confidence in the safety of the food products that are for sale		
	3. Food products for sale in supermarkets are safe to eat		
	B. – NVWA (Dutch Food Safety Authority)		α = 0.95
	1. The NVWA is competent in ensuring that the food products in the Netherlands are safe to eat		
	2. The NVWA takes adequate measures to improve the consumer's health		
	3. When the NVWA claims that a food product is safe, I can rely on it		
	4. When the NVWA claims that a product is safe to eat, I can be sure of it		
	C. – Consumentenbond (Consumer organisation)		α = 0.94
	1. The 'Consumentenbond' is competent in ensuring that the food products in the Netherlands are safe to eat		
	2. The 'Consumentenbond' takes adequate measures to improve the consumer's health		
	3. When the 'Consumentenbond' claims that a food product is safe, I can rely on it		
	4. When the 'Consumentenbond' claims that a product is safe to eat, I can be sure of it		
	D – Food producing companies		α = 0.93
	5. Food companies are competent in ensuring that the food products in the Netherlands are safe to eat		
	6. Food companies take adequate measures to improve the consumer's health		
	7. When food companies claim that a food product is safe, I can rely on it		
	8. When food companies claim that a product is safe to eat, I can be sure of it		
	Composite scale of 4 components		
	A. *Retail*		α = 0.95
	B. *NVWA (Dutch Food Safety Authority)*		
	C. *Consumentenbond (Consumer organisation)*		
	D. *Food producing companies*		

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