The impact of threat to personal control on trust in experts and non-experts communicating
about risk

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Abstract

In the present research we shed light onto processes that may contribute to the decline in trust in experts and other authorities. In a study focusing on the risks of nanotechnology in food, we orthogonally manipulated personal control (high vs low), the expertise of a source communicating about the risks (high vs low) and the extent to which the source communicated with certainty or uncertainty. The main dependent measures were perceptions of ability and trust as well as risk attitudes. The results show perceptions of ability and overall trust were higher for an expert than for a non-expert source, but only when personal control was threatened and the source communicated certainty. When this was not the case, there was no difference in perceived ability or overall trust between the expert and non-expert source. The pattern of results for risk attitudes was similar. Implications for risk communication by experts are discussed.

(150 words)

The impact of threat to personal control on trust in experts and non-experts communicating about risk

Although our society is objectively becoming safer and healthier (Slovic, 1999), public perceptions are often at odds with this. People need to deal with a lack of control over various societal risks such as terrorism, climate change, health and new technologies (Covello, 2011). It is important to note that people generally find uncontrollable risks more problematic than risks over which they do have a sense of control (Timmermans, Henneman, Hirsing, & van der Wal, 2008; van Dongen, Claassen, Smid, & Timmermans, 2013) even if this sense of control is unjustified (McKenna, 1993). As a result of the ubiquitous nature of uncontrollable risks, we live in a society where feelings of uncertainty, risk and unpredictability are inevitable (Beck, 1992) and some have even argued that we live in “the age of anxiety” (Twenge, 2000).

One way in which people can cope with a lack of personal control over risks is by trusting experts and authorities to adequately manage these risks for them (Siegrist & Chetkovich, 2000). As such, one could expect the increased uncertainty about societal risks to be accompanied by an increase in trust in authorities, experts and responsible governmental institutions. The reverse seems to be the case however. A report by the Netherlands Scientific Council for Government Policy (WRR, 2012) argued that large groups within Dutch society are losing trust in the government and in their own ability to exert influence. This report furthermore concludes that about half of the Dutch population has mediocre to poor trust in the government. Trust in other authorities, such as scientists, also appears to be eroding (Rutjens, Heine, Sutton, & van Harreveld, 2018). The notion that trust in experts and authorities’ ability to adequately address societal risks is declining (Giddens, 1990) is illustrated by the erosion of support for nuclear energy in Germany (Wittneben, 2012), underground carbon dioxide storage in The Netherlands (De Best-Walshofer, Daamen, &

Faaij, 2009), and decreased trust in the safety of genetically modified foods (GMOs) throughout Europe (Fresco, 2013). As another example, conspiracy theories regarding vaccinations continue to exert an influence on vaccination rates (Jolley & Douglas, 2014).

Surveying the above observations, there thus appears to be a paradox. On the one hand there is an experienced lack of control among the public regarding several risks (Beck, 1992) and as a consequence a desire to trust experts to adequately manage these risks for them and by providing information about safety and risk (Siegrist & Chetkovich, 2000). At the same time however, across a wide range of risks, there is *less* trust in these same experts to actually do so effectively. In the present research we aim to elucidate the psychological processes underlying this paradox and to provide insight into how risk communication can be made more effective.

Unpacking trustworthiness in the context of risk

To understand the aforementioned paradox, it is important to know what makes a source of risk communication *trustworthy*. Research into trustworthiness has shown that it has three components: *ability*, *benevolence* and *integrity* (Mayer, Davis, & Schoorman, 1995). Ability here refers to the skill set required to adequately manage the risk. Benevolence refers to the extent to which the experts are motivated to protect the public. Integrity refers to whether the experts are driven by a sound set of principles. The latter for example pertains to the question whether or not the expert is honest about the risks and its own intentions. These three components of trustworthiness have shown high meta-analytic correlations with overall trust ($r = .67$, $r = .63$, $r = .62$ respectively) and risk-taking ($r = .38$, $r = .32$, $r = .38$ respectively; Colquitt, Scott, & LePine, 2007).

In risk communication, the emphasis recently seems to be more on this latter component (integrity), for example through transparent communication about risks and uncertainties and about potential disagreements between experts (e.g. Frewer, 2004). Openly

communicating uncertainty about risks is somewhat of a double-edged sword however. First, most people prefer concise and competent communication about whether something is safe or not over transparent information about specific risk numbers (Johnson, 2003). Second, and specifically in relation to the components of trustworthiness, while experts are perceived as more honest (i.e. high in integrity) when they communicate uncertainty, they are also seen as less competent (i.e. low in ability; Johnson & Slovic, 1995).

It thus appears that when communicating about risks, experts are caught between a rock and a hard place: communicating openly about uncertainties can damage their perceived competence, while not doing so can substantially reduce trust by suggesting that they do not take the public seriously. We aim to provide a solution to this dilemma by integrating the literature on risk communication and trust with social psychological insights into the motivation to compensate for threats to personal control.

Compensatory control

Social psychological research has shown that a lack of personal control enhances trust in someone or something who *is* in control, such as a controlling God or a strong government (e.g. Kay, Gaucher, Napier, Callan, & Landau, 2008). The underlying motivation here is the desire to see the world as an orderly and predictable place (Landau, Kay, & Whitson, 2015), which implies that when experiencing a lack of control, we are not only inclined to put our fate in the hands of those who *are* in control, but also to seek compensatory certainty through various other perceptions of order and predictability (e.g. Rutjens, van Harreveld, & van der Pligt, 2010; 2013; Rutjens, van Harreveld, van der Pligt, Kreemers, & Noordewier, 2013; Rutjens, van der Pligt, & van Harreveld, 2010). Along these lines it has for example been found that as a result of a lack of control, people see more illusory patterns in visual noise and believe more in conspiracy theories (Whitson & Galinsky, 2006). Conspiracy theories attribute a number of separate events to one causal factor and as such create a more orderly

and predictable (albeit often less positive) worldview. What is key for risk communication here is that it can thus be argued that people will only compensate for a lack of control about a risk by trusting authorities or experts *if* these provide in this fundamental need for order.

Finding compensatory order in ability and certainty

In terms of where these perceptions of order can be found, Kay and colleagues (2008) argue; “When compensating for lowered levels of personal control, external systems perceived as *competent or able* to effectively meet their goals may also be preferred.” (p. 31 [Italics-added]). In other words, the need for a coherent and orderly perspective leads to *ability* becoming the key component of trustworthiness. Ability (or competence), in turn, is particularly displayed by experts who communicate with *certainty* (Johnson & Slovic, 1995).

Support for the notion that people prefer certain communication when personal control is lacking is provided by Markon, Crowe, and Lemyre (2013), who found that people prefer experts to communicate uncertainties about risks that are perceived as controllable by the person but see little relevance in communicating uncertainties about risks that are beyond their personal control. In the present study we examine downstream effects of this preference for certainty on (components of) trust and risk attitudes.

Trust in non-expert sources of risk communication

While the public has always been exposed to risk communication from non-expert sources (Frewer & Miles, 2003), the proliferation of the media landscape over the last decade has given the public access to unprecedented amounts of information from an unprecedented number of sources. The problem with this information is of course that much of it is not filtered by professional gatekeepers and, as a result, may be inaccurate (Flanagin & Metzger, 2007; Lazer et al., 2019; Metzger et al., 2003). Although trust in expert sources of information still tends to be higher than in non-expert sources (Frewer & Miles, 2003) the impact of information from non-expert sources on potentially important decisions is undeniable. For

example, the majority of adults in the United States have searched for health information online and about one third of them have self-diagnosed with such information (Fox & Duggan, 2013). Theoretical accounts of *when* people are likely to put their faith into the hands of such unfiltered online sources of information point towards cognitive biases driven by the motivation to minimize cognitive effort and time (e.g. Metzger & Flanagin, 2015).

One way in which to minimize the expense of cognitive effort and time when processing information is reducing one's exposure to evaluatively mixed information. Attitudinal ambivalence is associated with more extensive and effortful processing of information (Nordgren, van Harreveld, & van der Pligt, 2006; van Harreveld, Nohlen, & Schneider, 2015) and ambivalent attitude holders are known to engage in biased processing of information to reduce their ambivalence (Itzhakov & van Harreveld, 2018; Nordgren et al., 2006; van Harreveld, van der Pligt, & de Liver, 2009). Along this line of reasoning one could argue that communicating about for example the benefits of a new technology is likely to be more persuasive when it is presented with certainty and evaluatively unequivocal, because this does not enhance ambivalence. However, when communicating the benefits of this same technology while also discussing uncertainty about unknown risks this may actually enhance ambivalence.

On the basis of these insights into the aversive nature of ambivalence and the notion that the motivation to minimize cognitive effort leads people to trust non-expert sources (e.g. Metzger & Flanagin, 2015), one would expect people also to trust non-expert sources more when they communicate with certainty than when they communicate with uncertainty. However, to our knowledge, there is no research that suggests control plays a causal role here, nor is there research that directly relates certainty to trust in non-expert sources.

The present research

In the present research we investigate attitudes towards the application of nanotechnology in food and trust in sources that communicate about this topic. Various studies have examined perceived risk of nanotechnology in food (e.g. Siegrist, Cousin, Kastenholz, & Wiek, 2007; Siegrist, Stampfli, Kastenholz, & Keller, 2008). We investigate how certain vs uncertain risk communication by expert vs non-expert sources under high (vs. low) personal control impact on trust in the source and persuasion by the source's message about the risks of nanotechnology. We formulate the following expectations:

1. Participants will trust expert sources more than non-expert sources and will be more persuaded by them (Frewer & Miles, 2003; Renn & Levine, 1991).
2. Participants will perceive a source as higher in ability (and be more persuaded by it) if it communicates with certainty rather than with uncertainty (Johnson & Slovic, 1995; Metzger & Flanagin, 2015).
3. When personal control is threatened (vs affirmed), trust in an *expert* source will be enhanced if it communicates with certainty (Markon et al., 2013). This pattern is expected to emerge on overall trust, persuasion by the source's message about nanotechnology and perceptions of ability to adequately judge the risks of nanotechnology.
4. Such an effect of control threat and certainty is not expected for perceptions of integrity and benevolence. This is based on Kay et al. (2008), who argue that the need for a coherent and orderly perspective leads to *ability* becoming the key component of trustworthiness in the face of control threats.
5. The aforementioned expected effects of control and certainty are not expected to occur for non-expert sources, as the preference people have for sources that communicate certainty about risks that are beyond personal control concerns *experts* (Markon,

Crowe, & Lemyre, 2013), and Kay and colleagues (2008) argue that control threats enhance trust in external systems that are *competent*.

Pilot Study

Before testing our hypotheses in an experimental study, we conducted a pilot study in which we tested the effectiveness of the manipulations of certainty and source credibility. The manipulation of control threat employed in the experimental study was not pretested as this is an established manipulation (e.g. Rutjens et al., 2013).

Method

Participants and design. 53 Dutch participants (19 men, 34 women) with age ranging from 17 to 39 years ($M = 24.75$, $SD = 4.31$) participated voluntarily in an online study administered through Qualtrics. Participants were recruited via social media and a snow-balling method.

Source expertise. First, participants were told they were to read an article about the application of nanotechnology in food and agriculture. Before doing so however, they were asked to indicate their trust in two different potential sources of this article: the U.N. Food and Agriculture Organization (FAO, expert source) and a food blog (Hungry for healthy food, non-expert source). First, the food blog as a potential source of information about nanotechnology in food was described thus:

“The source of the article is the food blog 'Hungry for Healthy Food'. This article was published on this blog. Since 2014, this blog shares recipes which are healthy, quick and easy to make. Behind 'Hungry for Healthy Food' is someone with a passion for healthy food and healthy lifestyle. The blog started with sharing simple recipes and over time became more and more focused on health. On the blog it is stated that health is inextricably linked to eating behaviour. Therefore good, nutritious and healthy food is important for a body. The blog aims to change people's life into a Hungry for

Healthy food lifestyle and promises that this lifestyle will make them super happy, fit and healthy. The motto of the blog is "Eating healthy isn't a diet, it's a lifestyle".

Participants were then asked: "Imagine that on the food blog 'Hungry for Healthy Food' an article was published about the benefits and risks of nanotechnology in food. To what extent do you find the food blog 'Hungry for Healthy Food' an expert in the context of nanotechnology in food?" Participants were presented with 6 items assessing perceived ability, benevolence and integrity of the blog. For ability, these items were: "The food blog 'Hungry for Healthy Food' is very knowledgeable about the risks and benefits of nanotechnology in food" and "The food blog 'Hungry for Healthy Food' is capable of making accurate judgments about the risks and benefits of nanotechnology in food". For benevolence these items were "The food blog 'Hungry for Healthy Food' would not knowingly do anything to hurt me" and "The food blog 'Hungry for Healthy Food' is concerned about my health". For integrity these items were: "The food blog 'Hungry for Healthy Food' seems to be guided by sound principles" and "The food blog 'Hungry for Healthy Food' seems honest about the risks and benefits of nanotechnology in food". We also measured overall trust with one item: "I trust the food blog 'Hungry for Healthy Food' about the risks and benefits of nanotechnology in food". These items were responded to on scales ranging from *strongly disagree* (1) to *strongly agree* (7) and were adapted from Mayer and Davis (1999) and Ridings, Gefen, and Arinze (2002).

Next, the FAO was described as a potential source of information about nanotechnology in food:

"The source of the article is Food and Agriculture Organization (FAO) of the United Nations. This article was written and published after an expert meeting on the application of nanotechnologies in food and agricultural sectors. The FAO is a specialized agency of the United Nations that leads international efforts in achieving

food security and to defeat hunger. The FAO is a neutral forum and a source of knowledge and information about food. The FAO aims to contribute to public health and sustainable development and does so by helping countries to improve agriculture, ensure good nutrition and (above all) food security. “

Participants were then presented with the same trust items as assessed earlier, but now regarding the FAO instead of the food blog ($\alpha = .72$).

Certainty of communication. Then the article followed, which consisted of a general part of what nanotechnology is and how it is applied in food. Then participants were asked: “Next texts A and B will follow, please indicate the level of certainty of text A and text B.” Both texts entailed a discussion of the health risks of applying nanotechnology in food, but the first text (text A) was framed in certain terms:

“There clearly are several benefits of the possible application of nanotechnology in the food domain. Furthermore, we have not seen any harmful long-term effects of nanotechnology. First of all, there is no evidence that nanotechnology has any adverse effects at all on human health or the environment. Second, no harmful medium to long-term effects have been found in animal testing. The relevant mechanisms of animals are very similar to those of humans, and we can therefore be even more confident that nanotechnology also has no adverse effects on human health. Given the absence of evidence that states otherwise, it can be concluded that the application of nanotechnology in food is safe and not harmful for public health.”

After reading text A, participants were asked “How certain was text A about the presence/absence of risks of nanotechnology?” on a scale from *not certain* (1) to *very certain* (7). They then proceeded with reading (uncertain) text B, which read:

“While there are several potential benefits of the possible application of nanotechnology in the food domain, a disadvantage is that experts do not know much

about the long-term effects of nanotechnology on human health and the environment.

While there is no clear evidence that nanotechnology does have adverse effects, the technology is very novel and long-term effects (or the lack thereof) at this point cannot be ruled out. Animal testing has not indicated immediate health risks, but no statements can be made about potential long-term effects or about whether these effects can be translated to humans. More research into the long-term effects of nanotechnology is therefore required before we can draw any firm conclusions about the consequences of nanotechnology for public health and safety.”

Participants were then asked “How certain was text B about the presence/absence of risks of nanotechnology?” on a scale from *not certain* (1) to *very certain* (7). The final set of items assessed demographics (age, gender, nationality).

Results

Participants had more trust in the FAO than in the food blog ($M = 5.32$, $SD = .49$ vs. $M = 2.73$, $SD = .46$), $t(1,52) = 24.61$, $p < .001$, $\eta_p^2 = .92$. Moreover, participants rated (certain) text A higher in terms of certainty than (uncertain) text B ($M = 5.77$, $SD = 1.20$ vs. $M = 2.23$, $SD = .82$), $t(1,52) = 17.51$, $p < .001$, $\eta_p^2 = .86$. The manipulations of expertise and certainty were therefore deemed useful for application in the main study.

Main study

Method

Participants and design. 407 Prolific Academic participants (110 men, 297 women) with age ranging from 16 to 65 years ($M = 35.52$, $SD = 11.46$) participated in an online study administered through Qualtrics. 322 participants were from the UK, with most of the remaining 85 participants from other West-European countries, exceptions being participants from Canada (8), Australia (4), the United States (1) and Japan (1). A sensitivity power analysis indicates that given this sample size (error probability set at .05; power set at .80) the

required effect size to detect effects was small ($f = .14$; or $\eta_p = .02$). Participants were randomly assigned to conditions in a 2 (control threat/control affirmation) x 2 (expert vs. non-expert source) x 2 (certain versus uncertain message).

Procedure and materials. First, participants were presented with a control-threat (vs. affirmation) manipulation adapted from Rutjens and colleagues (2013). Participants were asked to recall and describe an unpleasant situation over which they lacked (or had) control and to provide three reasons supporting the notion that the future is uncontrollable (or controllable). As a manipulation-check, participants rated three items on 7-point Likert scales (1 = “strongly agree”, 7 = “strongly disagree”). They were asked to rate how much control they experienced in that situation, how unpleasant it was and to rate one item of generalized control (i.e. “Are you the actor in, or the director of, your own life”).

Then, participants were told they were to read an article about the application of nanotechnology in food and agriculture. Depending on source condition (expert vs. non-expert), participants were told that the article was authored by the U.N. Food and Agriculture Organization (FAO, expert source) or by a food blog (Hungry for healthy food, non-expert source). Both sources were described in the same manner as in the pilot study.

Then the article followed, which consisted of the same general description of what nanotechnology and how it is applied in food as used in the pilot study. The second part of the article concerned a discussion of the health risks of applying nanotechnology in food and this part differed depending on experimental condition. In the certain condition, participants read text A from the pilot study, which described the lack of health risks associated with nanotechnology in food in *certain* terms (e.g. “Given the absence of evidence that states otherwise, it can be concluded that the application of nanotechnology in food is safe and not harmful for public health.”). In the uncertain condition, participants read text B, which described the lack of health risks associated with nanotechnology in food in *uncertain* terms

(e.g. “More research into the long-term effects of nanotechnology is therefore required before we can draw any firm conclusions about the consequences of nanotechnology for public health and safety.”). Both texts, as well as the general introduction, can be found in the Appendix.

After the three experimental manipulations, participants were presented with the dependent measures. First, they were presented with the three same sets of two items assessing perceived ability ($r = .80, p < .001$), benevolence ($r = .64, p < .001$) and integrity of the source ($r = .53, p < .001$) as used in the pilot study. To examine the extent to which participants were persuaded by the (positive) message from the expert or non-expert source we assessed participants’ attitudes towards nanotechnology. We did this by assessing participants’ agreement with the following items: “I am worried about nanotechnology” (reverse scored), “Overall I support the use of nanotechnology”, “Applying nanotechnology in food production is good”, “I am in favour of applying nanotechnology in food production”, “I find the application of nanotechnology in food production dangerous” (reverse scored). Participants responded to these items on scales ranging from *Strongly disagree* (1) to *Strongly agree* (7). The final attitude item was: “On the issue of nanotechnology, to what extent do you believe the risks outweigh the benefits?” with a scale ranging from *The risks outweigh the benefits* (1) to *The benefits outweigh the risks* (7). All six items were averaged to calculate a risk attitude score ($\alpha = .92$). The final set of items assessed demographics (age, gender, nationality)¹. At the end of the experiment, participants were debriefed about the true nature of the experiment and redirected to Prolific Academic to receive payment of £1.00.

Results

Manipulation check. First, we assessed the results of the manipulation checks for the control threat vs. affirmation conditions and found significant differences on all three measures. Perceived control over the situation was low in the control threat condition than in

the control affirmation condition ($M = 1.93$, $SD = 1.20$ vs. $M = 5.12$, $SD = 1.70$), $F(1,404) = 484.16$, $p < .001$, $\eta_p^2 = .55$. The unpleasantness of the situation was higher in the control threat condition than in the control affirmation condition ($M = 6.00$, $SD = 1.48$ vs $M = 5.53$, $SD = 1.63$), $F(1,404) = 9.16$, $p = .003$, $\eta_p^2 = .02$. Participants saw themselves more as the actor than as the director of their lives in the control threat condition than in the control affirmation condition ($M = 5.16$, $SD = 1.46$ vs $M = 4.36$, $SD = 1.52$), $F(1,404) = 29.20$, $p < .001$, $\eta_p^2 = .07$. The manipulation of control was thus successful.

Trust. We calculated indices of ability, benevolence and integrity by averaging the scores of the two items we administered for each component of trust. As shown in Table 1, all components correlated significantly with each other as well as with the item measuring overall trust and with the composite score of the attitude towards nanotechnology. The positive correlation between the trust indices and attitude is a result of the fact that both sources advocated for the use of nanotechnology in food.

Ability. An ANOVA with all three manipulations as between-subjects factors and perceptions of ability as a dependent measure yielded main effects of the expertise and certainty manipulations. Specifically, the expert source was perceived as higher in ability ($M = 4.83$, $SD = 1.42$) than the non-expert source ($M = 4.01$, $SD = 1.54$), $F(1,406) = 30.87$, $p < .001$, $\eta_p^2 = .07$. Moreover, participants perceived a source with a certain message as higher in ability ($M = 4.91$, $SD = 1.50$) than a source with an uncertain message ($M = 3.94$, $SD = 1.42$), $F(1,406) = 44.84$, $p < .001$, $\eta_p^2 = .10$. Furthermore, there was a 2-way interaction effect of certainty and expertise, $F(1,399) = 13.70$, $p < .001$, $\eta_p^2 = .03$, substantiating our expectation that participants perceive an expert source as higher in ability if it communicates with certainty ($M = 5.59$, $SD = .95$) than if communicates with uncertainty ($M = 4.08$, $SD = 1.42$), $F(1,201) = 15.13$, $p < .001$, $\eta_p^2 = .28$. Although the non-expert source was also perceived as higher in ability when it communicates in certain terms ($M = 4.24$, $SD = 1.64$) than if it

communicates with uncertainty ($M = 3.79$, $SD = 1.42$), $F(1,403) = 4.23$, $p = .041$, $\eta_p^2 = .02$, this effect is clearly less pronounced than that for the expert source.

This two-way interaction was however entirely qualified by a significant three-way interaction between the control, certainty and expertise manipulations, $F(1,399) = 10.26$, $p = .001$, $\eta_p^2 = .03$. An analysis of the simple interactions revealed that the interaction between certainty and expertise was only significant in the control threat condition, $F(1,208) = 26.11$, $p < .001$, $\eta_p^2 = .11$ ($F < 1$ in the control affirmation condition). Subsequent analysis of the simple, simple main effects showed that (within the control threat condition) perceptions of ability were higher for the expert source than for the non-expert source if the information was presented in certain terms, $F(1,103) = 57.07$, $p < .001$, $\eta_p^2 = .36$. When the information was not presented in certain terms however, there was no difference in perceived ability of the expert and non-expert source ($F < 1$). The relevant means of ability for each of the experimental conditions is presented in Figure 1. These results support our main hypothesis regarding ability.

Benevolence. An anova with all three manipulations as between-subjects factors and perceptions of benevolence as a dependent measure revealed only one main effect of the certainty manipulation. A source was perceived as higher in benevolence if it communicated with certainty ($M = 5.28$, $SD = 1.22$) than when it communicated with uncertainty ($M = 4.97$, $SD = 1.29$), $F(1,405) = 6.32$, $p = .012$, $\eta_p^2 = .02$. No other main or interaction effects emerged on perceptions of benevolence.

Integrity. An ANOVA on perceptions of integrity as a dependent measure revealed main effects of the expertise and control manipulations. Specifically, the expert source was perceived as higher in integrity ($M = 5.29$, $SD = 1.15$) than the non-expert source ($M = 4.95$, $SD = 1.18$), $F(1,406) = 8.37$, $p = .004$, $\eta_p^2 = .02$. Control threat also led to lower perceptions of

integrity ($M = 5.00$, $SD = 1.15$) than control affirmation ($M = 5.25$, $SD = 1.20$), $F(1,406) = 4.84$, $p = .028$, $\eta_p^2 = .012$. There were no other main or interaction effects.

Overall trust. For overall trust, the pattern of results was similar to the results for ability, although less pronounced. Again, there was a main effect of expertise, where participants showed more trust in the expert source ($M = 4.86$, $SD = 1.39$) than the non-expert source ($M = 4.06$, $SD = 1.58$), $F(1,406) = 29.04$, $p < .001$, $\eta_p^2 = .07$. Again, there was a significant two-way interaction between the expertise and certainty manipulations, where participants had more trust in an expert source if it communicated with certainty ($M = 5.10$, $SD = 1.27$) than if communicated with uncertainty ($M = 4.63$, $SD = 1.46$), $F(1,201) = 6.02$, $p < .001$, $\eta_p^2 = .03$. No such effect emerges when for the non-expert source ($F < 1$).

The three-way interaction between the control, certainty and expertise manipulations that was significant for the ability ratings did not reach significance levels on overall trust, but there was a trend, $F(1,399) = 2.80$, $p = .095$, $\eta_p^2 = .01$. Further probing this interaction through analysis of the simple interactions revealed that the interaction between certainty and expertise was only significant in the control threat condition, $F(1,208) = 8.75$, $p = .003$, $\eta_p^2 = .04$, ($F < 1$ in the control affirmation condition).

Subsequent analysis of the simple, simple main effects showed that (within the control threat condition) trust was higher for the expert source than for the non-expert source if the information was presented in certain terms, $F(1,103) = 26.78$, $p < .001$, $\eta_p^2 = .21$. When the information was not presented in certain terms however, there was no difference in perceived ability of the expert and non-expert source, $F(1,105) = 1.25$, $p = .266$. The relevant means on trust for each of the experimental conditions is presented in Figure 2.

Risk attitudes. As indicated in Table 1, the composite risk attitude score correlates significantly with all indices of trust. This was to be expected, as the certain and uncertain messages were positive about the application of nanotechnology and source credibility and

persuasion have been related to each other (e.g. Renn & Levine, 1991). The results for risk attitudes showed that participants were more positive about nanotechnology after reading a certain message ($M = 4.42$, $SD = 1.33$) than after reading an uncertain message ($M = 3.90$, $SD = 1.19$), $F(1,405) = 27.52$, $p < .001$, $\eta_p^2 = .04$.

More importantly, similar to the ratings of ability and overall trust, a three-way interaction between control, certainty and expertise emerged, $F(1,399) = 4.07$ $p = .044$, $\eta_p^2 = .01$. An analysis of the simple interactions revealed that the interaction between certainty and expertise was only significant in the control threat condition, $F(1,208) = 8.33$, $p = .003$, $\eta_p^2 = .14$ ($F < 1$ in the control affirmation condition). Subsequent analysis of the simple, simple main effects showed that (within the control threat condition) attitudes were more positive (more persuasion) after reading the message from the expert source than after reading the message from the non-expert source if the information was presented in certain terms, $F(1,103) = 5.99$. Subsequent analysis of the simple, simple main effects showed that (within the control threat condition) perceptions of ability were higher for the expert source than for the non-expert source if the information was presented in certain terms, $F(1,103) = 57.07$ $p = .016$, $\eta_p^2 = .06$. When the information was not presented in certain terms however, there was no difference in attitudes between those exposed to a message from an expert source and those exposed to a message of a non-expert source, $F(1,105) = 2.60$ $p = .11$. The relevant means on attitude towards the application of nanotechnology in food for each of the experimental conditions is presented in Figure 3.

Discussion

The fact that people in modern society have to come to terms with a large number of risks that are beyond their personal control should provide fertile ground for a solid trust in experts and authorities' ability to manage risks and provide guidance. The reverse seems to be the case however (Giddens, 1990), as illustrated by the erosion of support for nuclear energy

(Wittneben, 2012), underground carbon dioxide-storage (De Best-Waldhober, Daamen, & Faaij, 2009), GMOs (Fresco, 2013), and vaccinations (Jolley & Douglas, 2014), to name but a few examples. In the present research we shed light onto some of the psychological processes that may contribute to this decline by integrating the psychological literature on control with that on risk and trust and conducting a study in which we examined the interplay of these three variables on trust and risk attitudes.

Our results show that, in line with our predictions, perceptions of ability and overall trust were only higher for an expert source than for a non-expert source if a lack of personal control was salient and the expert source communicated certainty. When this was not the case, there was no difference in perceived ability or overall trust between the expert and non-expert source. The pattern of results for risk attitude was largely similar: participants were only more persuaded by a message from an expert source than a non-expert source if these same preconditions (a lack of control and certain communication) were met. No such pattern was observed for the remaining components of trust (benevolence and integrity), underlining the unique importance of ability in the context of a lack of control (cf. Kay et al., 2008) and the notion that this ability is inferred when an expert source communicates with certainty (cf. Johnson & Slovic, 1995).

All in all, we found empirical support for the notion that when people experience a lack of control, they are driven towards experts for guidance, arguably as a means to achieve compensatory control. However, only experts who display ability provide in this need (cf. Kay et al., 2008) and such ability is only inferred when an expert communicates with certainty (cf. Johnson & Slovic, 1995). In line with our expectations, non-experts do not meet these requirements, which is in line with work showing that control threats drive the individual towards experts (cf. Kay et al., 2008) as well as work documenting the importance ascribed to

experts communicating with certainty, particularly when a risk is perceived as uncontrollable by the person (Markon, Crowe, & Lemyre, 2013).

These findings are particularly relevant given the fact that in the communication about risk by experts, the focus seems to be especially on transparent communication about risks and uncertainties and about potential disagreements between experts (e.g. Frewer, 2004). The present research shows that openly communicating uncertainty about risks can however have detrimental consequences for trust and for acceptance of risk communication, if people perceive to lack personal control.

Psychological research distinguishes various kinds of uncertainty (Proulx, Inzlicht, & Harmon-Jones, 2012), such as the lack of control examined in the current study, but also ambivalence and mortality salience. While control threats enhance the desire to see the world as orderly and predictable, risks *can* also be associated with a different kind of uncertainty: mortality salience (e.g. health risks). Terror management theory (Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989) argues that when people become aware of their mortality and vulnerability to death, feelings of existential anxiety arise. Crucially, control threats and mortality salience have been argued to hold different motivational consequences (Shepherd, Kay, Landau, & Keefer, 2011). Specifically, thinking about mortality does *not* necessarily increase desire for order and predictability, but it does enhance the need to affirm important values and beliefs (Rosenblatt et al., 1989). For example, mortality salience increases the importance of perceived fairness and honesty (van den Bos & Miedema, 2000). According to this line of reasoning, when thoughts about the potential lethal consequences of a risk are relatively salient, people should be more susceptible to open communication about uncertainties about the risk, which could be more in line with people's motivation towards affirming honesty values. We hope the present research inspires further research into how

different kinds of uncertainty that may result of risk impacts on how effective communication about that risk is.

A potential limitation of the present research is that our manipulation of control threat was independent from the risk we investigated. An approach in which the control that is threatened (vs. affirmed) is directly associated with the risk is clearly more ecologically valid. However, we believe our approach has a benefit outweighing this. The control manipulation employed here does not contaminate the risk perception itself and allows us to examine the role of control in a more objective way.

On the basis of the present research we certainly do not wish to suggest that experts should be less open about any uncertainties surrounding a risk. Such lack of openness can in itself be very damaging to public trust, which subsequently can be difficult to restore (Thomas, 1998). However, we do believe it is important to be *aware* of the consequences communicating uncertainty can have for trust in experts. Future research should investigate how to circumvent these consequences without being untruthful. A firm and clear communication about what the risks and benefits is perhaps an approach worth investigating.

While there has always been a general tendency to trust expert sources more than non-experts (Frewer & Miles, 2003), we are now exposed to an unprecedented amount of information from an increasing number of sources. Much of this information is not filtered by professional gatekeepers and may be inaccurate (Flanagin & Metzger, 2007) but is continuously vying for attention with information from more reliable sources. In an age of media proliferation and misinformation, we believe insight into who we trust (and why) is more important than ever.

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Footnotes

1. For exploratory purposes we also measured Personal Need for Structure (PNS; Van den Berg & van Winsum-Westra, 2010) with a 4-item version (e.g. “I enjoy having a clear and structured mode of life”) on 7-point Likert scales ranging from strongly disagree (1) to strongly agree (7). Likewise, we measured how much people thought they knew about nanotechnology and the extent to which they saw themselves as religious. As all these measures were of limited relevance to the current purposes, we did not examine their relation to the focal variables and manipulations.

Table 1. Correlation matrix

	Ability	Benevolence	Integrity	Trust	Attitude
Ability	-	.35*	.46*	.61*	.35*
Benevolence		-	.64*	.55*	.44*
Integrity			-	.67*	.40*
Trust				-	.48*
Attitude					-

Note. * $p < .001$

Figure 1: Ability ratings by condition (3-way interaction between Control, Source expertise and Certainty)

Note. * $p < .001$

Figure 2: Overall trust ratings by condition (3-way interaction between Control, Source expertise and Certainty)

Note. * $p < .001$

Figure 3: Attitudes towards nanotechnology in food by condition (3-way interaction between Control, Source expertise and Certainty)

Note. * $p < .001$

Appendix: Texts used for the manipulation of certainty

General part (for both conditions):*What is nanotechnology?*

Nanotechnology is a technology dealing with nanoparticles. Particles on the nanoscale are too small to see with the naked eye. Nanotechnology is perceived as one of the key technologies of the twenty-first century, which allows for various innovations, for example in the food domain. Food products may have additional benefits (e.g. better solubility of vitamins, longer shelf-life, cancer prophylaxis) without altering product-specific properties like aroma, taste, appearance or texture.

Using nanotechnology in food

One example of a possible application of nanotechnology in the food domain is the addition of nanoparticles to bread. Nanocapsules containing fish oil could be integrated in bread. The nanocapsules are designed to break open only when they have reached the stomach. Therefore, the unpleasant taste of the fish oil can be avoided. The advantage is that bread contains omega-3 fatty acids, which are important for human health.

Another example of a possible application concerns tomatoes. A nanotechnology coating protects tomatoes from humidity and oxygen and coated tomatoes can have longer shelf life. Another advantage would be that tomatoes can be harvested when they are ripe, resulting in tastier tomatoes.

A final example concerns juice. The body converts beta-carotene in vitamin A, which is important for the human body. Beta-carotene can be split in small particles, and then it can be encapsulated in starch. This new material could be added to juices. Advantages are that beta-carotene can be dissolved in water and the body can absorb it better. Moreover, the shelf life of juices with beta-carotene is longer.

Condition-specific part, uncertain condition:*Nanotechnology and safety*

While there are several potential benefits of the possible application of nanotechnology in the food domain, a disadvantage is that experts do not know much about the long-term effects of nanotechnology on human health and the environment. While there is no clear evidence that nanotechnology does have adverse effects, the technology is very novel and long-term effects (or the lack thereof) at this point cannot be ruled out. Animal testing has not indicated immediate health risks, but no statements can be made about potential long-term effects or about whether these effects can be translated to humans. More research into the long-term effects of nanotechnology is therefore required before we can draw any firm conclusions about the consequences of nanotechnology for public health and safety.

Condition-specific part, certain condition:*Nanotechnology and safety*

There clearly are several benefits of the possible application of nanotechnology in the food domain. Furthermore, we have not seen any harmful long-term effects of nanotechnology. First of all, there is no evidence that nanotechnology has any adverse effects at all on human health or the environment. Second, no harmful medium to long-term effects have been found in animal testing. The relevant mechanisms of animals are very similar to those of humans, and we can therefore be even more confident that nanotechnology also has no adverse effects on human health. Given the absence of evidence that states otherwise, it can be concluded that the application of nanotechnology in food is safe and not harmful for public health.