The effect of knowledge and ignorance assessments on perceived risk

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ABSTRACT

This study investigated the effects of two different types of subjective knowledge assessments on the level of knowledge assessment and risk perception in five risk domains: health, environment, crime, economy, and transport (Appendix 1). The two types of knowledge assessments were regular knowledge assessments and ignorance assessments, in which the participants were asked to assess their lack of knowledge. Furthermore, the effect of the order in which the subjective knowledge assessments and risk assessments were performed was investigated. Four different experimental conditions were used to explore the effects. In the knowledge first condition, all regular knowledge assessments were performed, followed by all risk assessments. In the alternate condition, the participants alternated between the knowledge assessments and risk assessments. In the risk first condition, the participants performed all risk assessments, followed by all knowledge assessments. Finally, in the ignorance first condition, the participants performed all ignorance assessments, followed by all risk assessments. The ignorance assessments indicated higher subjective knowledge ratings than the regular knowledge assessments in the first three conditions. The order in which the regular knowledge assessments were performed had no effect on the risk assessments. However, the ignorance assessments were associated with the lowest risk assessments of all four conditions. The participants may have associated their difficulty finding examples of ignorance with a lack of risk.

Introduction

Risk is commonly seen as a multidimensional construct and appertains to uncertainty and negative consequences (Renn 1998; Slovic, Fischhoff, and Lichtenstein 1982). The perception of risk is an important part of life, and perceiving risks as too low or too high may have a negative impact on a person’s well-being. For example, people perceiving risks as unrealistically low may expose themselves to unnecessary hazards or dangerous situations. In contrast, perceiving risks as unrealistically high may lead to an unnecessarily passive and isolated life, for example, due to a fear of leaving one’s living quarters.

Risk perception is generally influenced by different factors, including the real risk, the risk target (e.g. myself or people in general), factors relating to the cognitive processing of the person making the judgments, such as the effects of heuristics (for example, availability), as well as the values and emotions...
(for example, fear) of the person making the judgments (Sjöberg 2000). In addition, factors relating to the research methodology used in studies will influence research results relating to risk perception. Examples are the formulation of questions when asking about risk and if one or more risks are assessed at the same time; multiple risk judgments tend to reduce the average risk estimates of the specific risks being assessed (Slovic 2000).

The self-assessed extent of one’s knowledge about a risk domain (i.e. subjective knowledge) is a potentially important factor related to risk perception. However, this factor is somewhat under-researched in risk research. Therefore, the present study investigated the effects of two different forms of subjective knowledge assessments on the level of knowledge assessment and on risk perception. The first form of knowledge assessment is a so-called regular knowledge assessment, in which the participants are asked to rate the extent of their knowledge within a certain domain. The second form of knowledge assessment is a so-called ignorance assessment, in which the participants are asked to rate the extent of their lack of knowledge within a certain domain. In addition, we explored whether an order effect is present, by which the participants’ risk assessments were influenced by whether they were preceded by knowledge assessments.

**Objective knowledge and its relationship with risk perception and behavior**

March (1997) suggested that an individual with appropriate knowledge can better avoid risks. Similarly, Smithson (1989, 2) asserted that, ‘Prior to any commitment to decision or actions, almost all Western intellectual traditions direct us to maximize information and/or knowledge, and so reduce uncertainty or ignorance’. However, research studies investigating these ideas have reported mixed results. Some studies have found that greater objective knowledge is associated with more risk behavior and lower risk perception. For example, Jaccard, Dodge, and Guilamo-Ramos (2005) studied the relationship between various variables and teenagers’ (n = 8411) risk of pregnancy over 1 year. Objective knowledge was positively associated with risk behavior, independent of subjective knowledge. In line with this, Sjöberg (2001) found that experts (presumably with more knowledge) evaluated risk hazards (mostly technological) as implying lower risk than laymen and politicians.

Other studies have reported deviating results. For example, Rutkowski and Connelly (2011) found only a weak non-significant correlation between teenagers’ objective risk knowledge of obesity and their physical activity. Baird (1986) studied people who lived near an arsenic-emitting copper smelter and found that their knowledge of the risk hazard was only weakly related to risk tolerance or risk estimates. van der Linden (2015) found that objective knowledge is positively associated with climate risk perception, but only for perception of social risk, not perception of personal risk.

A seldom studied aspect of knowledge that may contribute to risk is ignorance, meaning a lack of knowledge or not heeding knowledge one could have activated. For example, a contributing factor to the so-called planning fallacy (inability to make plans that realistically predict what will happen) may be that people have a deficient ability to imagine different types of events that may occur as the plan unfolds in real time (Buehler, Griffin, and Ross 2002).

Thus, a person’s ignorance can be seen as an epistemic risk, in that it may put that person at risk. Researchers have defined the concept of epistemic risk in different ways. Parascandola (2010, 201) defined epistemic risk as ‘the risk of being wrong’, and Sahlin and Persson (1994, 37) defined it as ‘the risk of not knowing or not knowing enough’. Both definitions may allow for poor accuracy in one’s knowledge to contribute to epistemic risk. However, of the two definitions, the latter may be preferable because it also includes the lack or incompleteness of knowledge, not just erroneous knowledge or conceptions. General taxonomies of sources and types of ignorance have been presented by Rescher (2009) and Faber, Manstetten, and Proops (1992).
Subjective knowledge and perceived risk

In addition to an individual's objective knowledge, their assessment of the level of their knowledge is likely to influence their risk perception and actions. For example, persons believing that they have good knowledge about an unsafe district of town may feel that their superior knowledge will allow them to counteract hazards and, consequently, may assess the real risk to be lower than it is. This in turn may make them more prone to take greater risks in that context, such as walking the streets late at night.

In this context, it is relevant that much research has shown that people exhibit overconfidence when assessing their knowledge within many different kinds of domains (for reviews see Griffin and Brenner 2004; McClelland and Bolger 1994). However, though people sometimes appear to overestimate their knowledge in real-life contexts, in general, their objective knowledge, and subjective knowledge assessments tend to be positively related. For example, Klerck and Sweeney (2007) cited research reporting correlations between 0.3 and 0.6. In contrast, Jaccard, Dodge, and Guilamo-Ramos (2005) reported a correlation of only 0.10 between objective and subjective knowledge of the risk hazard (pregnancy). The relationship between objective and subjective knowledge may depend on various factors, such as the extent to which media gives representative information about the risk object.

The research exploring the relationship between subjective knowledge and risk perception or risk behavior has shown mixed results. Some studies have found higher subjective knowledge to be associated with lower perceived risk and riskier behavior. For example, Jaccard, Dodge, and Guilamo-Ramos (2005) found that the level of subjective knowledge is positively associated with risky behavior, independent of objective knowledge. Thus, higher estimated knowledge was associated with a higher probability of pregnancy. In line with this, Grasmück and Scholz (2005) studied people living close to an area of contaminated soil and found that participants who assessed their knowledge as higher perceived the risk as lower.

However, other studies have reported the opposite result. Zhu, Wei, and Zhao (2016) investigated residents living close to the site of a nuclear power plant under construction in China. They found that the higher the residents perceived their knowledge to be, the higher they perceived the risks of nuclear power to be. Their explanation was that people with low self-estimated knowledge do not know much and will not perceive much risk (i.e. low risk perception). This result is in line with a study of a large sample of community-dwelling elderly Japanese people, which found a positive correlation of 0.20 between subjective knowledge of depression and perceived risk of developing depression (Imai et al. 2015). Finally, in a literature review of research on climate risk perception, van der Linden (2017) found that subjective knowledge had no explanatory value in risk perception.

An individual’s assessment of their own lack of knowledge is of interest in the context of risk perception. Some studies have shown that people can use their perceptions of their ignorance to their advantage when dealing with judgments and conclusions about their knowledge (Son and Kornell 2010). However, people’s handling of their own ignorance may often be deficient. Taleb (2007) suggested that people tend to search for areas of insufficient knowledge in too narrow of a way. More specifically, he argued that people tend to look for areas of potential ignorance too close to the content domains they are already attending to. If Taleb’s suggestion is correct, the effect of assessing one’s lack of knowledge may not necessarily have the same effects on risk perception as assessing one’s knowledge; therefore, it is of interest to more closely investigate the relationship between knowledge assessments and ignorance assessments.

To the best of our knowledge, no research has looked at the relationship between subjective ignorance and risk perception. However, Sjöberg (2001) studied the effects of trust and beliefs about general ignorance (i.e. the society at large lacks knowledge, not just the person making the assessment). Sjöberg showed that both the public and politicians thought it much more likely that there are unknown effects of nuclear technology than the experts within the field. Furthermore, beliefs concerning general ignorance explained a large proportion of the variance in both personal and societal risk perception. In the present study, we explore the effects of a perceived lack of personal knowledge, which can be considered a form of subjective ignorance, on risk perception.
The present study

Previous studies have focused on the correlation between knowledge assessments and risk perception. We know of no studies that have investigated the effect of performing knowledge assessments on risk perception. However, it seems reasonable to assume that performing a knowledge assessment will activate knowledge in memory, which may affect the perception of risk.

Briefly, given the potential importance of individuals’ assessments of their knowledge in risk perception, the aim of the present study was to investigate how performing different types of knowledge assessments within a certain domain affects perceptions of personal risk within the same domain. As described below, five different risk domains were used in this study. Our focus was to investigate both regular subjective knowledge assessments (How much do you know in area X?) and the impact of performing subjective ignorance assessments (How much knowledge do you lack in area X?). Four experimental conditions reflecting different versions of the order between the two types of knowledge assessment and risk assessments were used: knowledge first, alternate, risk first, and ignorance first.

In the knowledge first condition, the participants carried out all of the regular knowledge assessments first, followed by all of the risk assessments. This condition simulates the order between knowledge and risk perception assessments commonly used in risk research. In the alternate condition, the participants carried out one regular knowledge assessment and then the corresponding risk assessment (i.e. a rating of personal risk in the area covered in the knowledge assessment), alternating knowledge and risk assessments. In the risk first condition, we reversed the order of the judgments compared to the knowledge first condition. Thus, the participants carried out all risk assessments before proceeding to the regular knowledge assessments. This condition can be seen as a control condition in which we checked for the order effect between knowledge assessments and risk assessments in the first two conditions. In the ignorance first condition, the participants performed all of the ignorance assessments, followed by all of the risk assessments.

As previous research has shown that risk perception is domain-dependent (Blais and Weber 2006; Byrnes, Miller, and Schafer 1999), we studied the same four experimental conditions in five different risk domains: health, crime, environment, economy, and transport. These domains were chosen in order to achieve a broad representation of risk domains. However, the central focus of the current study was not differences in risk perceptions between different domains, though these results are also presented.

Hypotheses

Four hypotheses were tested. The first hypothesis concerns differences between the regular knowledge assessments and ignorance assessments, and the last three hypotheses concern differences in the risk assessments.

Hypothesis 1: We expected that the ignorance first condition, expressed in terms of knowledge rather than in terms of lack of knowledge, would be associated with higher knowledge assessments than the other conditions. The reason for this hypothesis is that people may look too narrowly for possible lack of knowledge.

Hypothesis 2: We expected that the regular knowledge assessments in the knowledge first and alternate conditions would lead to knowledge activation, and that this knowledge activation would make the participants aware of their knowledge. Therefore, the knowledge activation in these conditions caused by the regular knowledge assessments would lead to a stronger effect on the risk assessments compared to the risk first condition (the control condition).

Hypothesis 3: We also expected that the effect of the regular knowledge assessments on the risk assessment would be stronger in the alternate condition than in the knowledge first condition, because each risk assessment is performed closely with each knowledge assessment.

Hypothesis 4: In line with hypothesis 1, we expected that, because the participants in the ignorance first condition may not look broadly enough for what they do not know, they may miss potential areas of ignorance, which will increase the effect on the risk assessments compared to the other conditions.
For hypotheses 2, 3, and 4, we assumed that the participants would respond in a homogeneous manner with respect to the direction of the effect of the different forms of knowledge assessments on the risk assessments. Thus, we did not expect the impact of the different forms of knowledge assessment to cancel out over the participants due to heterogeneity in their responses. Given the specific aims of our study and that the results in previous research have been mixed, we did not pose any hypothesis for the correlation between the level of the knowledge assessments and risk assessments, but these correlations are reported as a general background to our other results.

Method

Participants

The participants were recruited via a company called CINT, which provides panel data. CINT recruits its participants on commonly available websites, such as sites for large daily newspapers, and can provide researchers with community-based samples. For this study, CINT was asked to provide participants that are representative of the Swedish population with respect to gender and age by using a stratified random sampling technique. Closer investigation of the collected demographic data confirmed that these requirements had been met. Each participant in the study was reimbursed 1 Swedish crown for each minute they participated (approx. 0.1 USD). As the mean time to complete the survey was 19 min, the mean reimbursement for the participants was 19 SEK (approx. 2.3 USD). The final sample consisted of 342 participants (172 men, 166 women, 1 other, 3 were missing gender information). The mean age was 46.1 years (SD = 16.7, range 18 to 80 years).

Design

Four between-subjects conditions were used: the knowledge-first condition, the alternate condition, the risk-first condition, the ignorance-first condition with 83, 84, 87, and 88 participants in the respective conditions.

Materials

The knowledge and risk assessments were performed for five different domains: health, crime, environment, economy, and transport. Each domain was represented by five items. Thus, each participant made 25 knowledge and 25 risk assessments. In the first three conditions, the knowledge assessments were formulated as: ‘How much knowledge do you have about the possible risks associated with X?’ The scale ranged from 1 (no knowledge) to 10 (all knowledge). In the ignorance first condition, the participants were asked to assess their lack of knowledge as follows: ‘How large do you assess your lack of knowledge to be with respect to the risks associated with X?’ The scale ranged from 1 (no lack of knowledge) to 10 (total lack of knowledge).

The formulation of the items for the risk assessments was based on the items used by Sjöberg (2001): ‘How big a risk is it for you personally to be hurt or in other ways be affected negatively by X?’ The scale ranged from 0 (non-existent) to 7 (very large risk).

Procedure

The participants were assigned randomly to one of the four conditions. In the knowledge first condition, the participants performed all 25 regular knowledge assessments first, followed by the 25 risk assessments. In the alternate condition, the participants performed 25 cycles of one regular knowledge assessment directly followed by one associated risk assessment. The regular knowledge and risk assessments were alternated in order to have each knowledge assessment directly connected to the associated risk assessment. In the risk first condition, the participants performed all 25 risk assessments
first, followed by the 25 regular knowledge assessments. In the ignorance first condition, the participants performed all ignorance assessments, in the form of lack of knowledge assessments, followed by the 25 risk assessments. Finally, all participants answered a number of scales measuring individual differences which were part of a larger study and not presented here. They also provided information regarding gender, age, occupation, and level of education.

Results

In order to compare the ignorance assessments to the regular knowledge assessments in the other three conditions, the values of the ignorance assessments were transformed to reflect knowledge rather than lack of knowledge. Using the logical assumption that all possible knowledge = knowledge + lack of knowledge, we transformed the values for the ‘lack of knowledge’ assessments; 10 on the ‘lack of knowledge’ scale (total lack of knowledge) was translated to 1 on the knowledge scale (no knowledge), 9–2, 8–3, etc., until 1 (no lack of knowledge) was translated to 10 (all knowledge). Thus, in the text below and the analyses, for all knowledge assessments, including the ignorance assessments, low values indicate less self-rated knowledge and high values indicate more self-rated knowledge. Notably, this transformation is logical in nature and the associations between knowledge and lack of knowledge are not necessarily symmetrical. Descriptive statistics regarding the knowledge and risk assessments for each condition are provided in Table 1.

Differences in subjective knowledge level between the two different types of knowledge assessments

In order to investigate hypothesis 1, where we expected differences between the different types of knowledge assessments (regular assessments and ignorance assessments), a mixed ANOVA was performed with the between-subjects variable of condition (knowledge first vs. alternate vs. risk first vs. ignorance first) and the within-subjects variable of knowledge domain. The results showed that there were significant differences between the conditions, with the knowledge first condition having the highest mean scores for knowledge assessments, followed by the alternate and risk first conditions, and finally the ignorance first condition having the lowest scores. Further analysis revealed that the differences were particularly pronounced in the crime and environment domains, with the participants in the knowledge first condition rating their knowledge higher than in the other conditions. However, it is important to note that the associations between knowledge and risk perception were not necessarily symmetrical, and the correlations were stronger in some domains than in others.
ignorance first) and the within-subject variable of domain (environment, health, crime, economy, and transport). There was a significant difference between conditions regarding the knowledge assessments \( F(3, 338) = 3.27, p = 0.021, \) generalized \( \eta^2 = 0.02 \). As seen in Figure 1, the ignorance first condition had the highest knowledge assessments of all conditions. Games–Howell post hoc analyses calculated a significant difference between the ignorance first condition and the alternate and risk first conditions only (\( p < 0.05 \)). Thus, supporting hypothesis 1, the participants in the ignorance first condition gave higher knowledge assessments than the participants in the alternate and risk first conditions.

We also found a significant difference in knowledge assessments between domains \( F(3.64, 1229.77) = 113.23, p < 0.001, \) generalized \( \eta^2 = 0.12 \). As seen in Figure 1, the highest knowledge assessments were

### Table 2. Correlations for the relation between the knowledge assessments and risk assessments for each condition and risk domain.

| Condition          | Knowledge first | Risk first | Alternate | Ignorance first\(^1\) |
|--------------------|----------------|------------|-----------|------------------------|
| Health             | .23*           | .11        | .01       | -.10                   |
| Crime              | .23*           | .16        | .23*      | -.39**                 |
| Environment        | .20            | .07        | .32**     | -.10                   |
| Economy            | .32**          | .28*       | -.14      | .05                    |
| Transport          | .27*           | -.20       | .16       | -.17                   |

\(^* p < .05; ** p < .01.\)

\(^1\)For the ignorance-first condition the knowledge assessments were made on a scale ranging from 1 = 'No lack of knowledge' to 10 = 'Total lack of knowledge'. In the table these are reversed so that 1 = 'No knowledge' and 10 = 'Total knowledge', etc.

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**Figure 1.** Level of knowledge assessments for each of the five risk domains.
given for the domains health, crime, and transport. The post hoc analyses using LSD showed a significant difference between all domains \((p \leq 0.001)\), with the exception of environment and economy, which did not differ significantly in the level of knowledge assessment. We found no significant interaction effect between domain and condition \((F(10.92, 1229.77) = 113.23, p = 0.111)\).

The effect of knowledge assessments on risk assessments

In order to investigate hypotheses 2, 3, and 4 where we expected differences in risk assessments, a mixed ANOVA was performed with the between-subjects variable condition (knowledge first vs. alternate vs. risk first vs. ignorance first) and the within-subject variable domain (environment, health, crime, economy, and transport). We found a significant difference between conditions regarding the risk assessments \((F(3, 338) = 14.21, p = 0.045, \text{generalized } \eta^2 = 0.01)\). As seen in Figure 2, the ignorance first condition had the lowest risk assessments of all conditions. Games–Howell post hoc analyses calculated a significant difference between the ignorance first condition and the condition with the highest risk assessment, the alternate condition \((p < 0.05)\), only. Thus, the results do not support hypotheses 2 and 3 because there was no difference in risk assessment between the knowledge first, alternate, and risk first conditions. However, the analysis did show some support for hypothesis 4 because the ignorance first condition had significantly lower risk assessments than the alternate condition.

We also found a significant difference in risk assessments between domains \((F(3.51, 1187.79) = 73.83, p < 0.001, \text{generalized } \eta^2 = 0.09)\). As seen in Figure 2, the highest risk assessments were given for the domains health, crime, and environment. The post hoc analyses using LSD showed a significant difference between all domains \((p \leq 0.006)\), with the exception of economy and transport, which did not significantly differ in the level of risk assessment.

Figure 2. Level of risk assessments for each of the five risk domains.
We also found a significant interaction effect between domain and condition \( (F(10.54, 1187.79) = 2.28, p = 0.011, \text{generalized } \eta^2 = 0.01) \). As seen in Figure 2, this interaction effect is explained to a large extent by the result that the risk first condition varied in relation to the other three conditions, which had a stable order with respect to the level of risk assessment in each of the five risk domains.

**Discussion**

This study investigated how subjective knowledge assessments are related to the perception of personal risk in five different domains. The main contribution of the study is that we specifically investigated how different types of subjective knowledge assessments affect risk perception. The effects of both regular knowledge assessments and a form of ignorance assessments, lack of knowledge assessments, were investigated. These findings are first discussed below. Then, we briefly discuss the correlation between subjective knowledge assessments and risk perceptions, as well as risk domain effects.

**Difference between the two different types of knowledge assessment**

Our first hypothesis was confirmed because the ignorance first condition was the condition with the highest knowledge assessments (when we reversed the lack of knowledge scale to the corresponding knowledge scale). This result is in line with Taleb's (2007) suggestion that people may look too narrowly for instances of their ignorance, if they look at all. Searching too narrowly for a lack of knowledge may contribute to inflating a person's assessments of how much they know. This suggested a higher difficulty generating examples of a lack of knowledge compared to examples of knowledge, which is also in line with suggestions by Nickerson (1998) and others that humans are naturally oriented toward seeking positive, rather than negative, instances of knowledge. Another factor contributing to the level of the participants' ignorance assessments may have been the disfluency (Oppenheimer 2008) possibly experienced when they attempted to identify examples of ignorance. Such a disfluency effect is similar to what may have caused the results of Schwarz et al. (1991). In that study, the participants were asked to give 6 or 12 examples of when they had been assertive. The participants, who were asked to give 12 examples of when they had behaved assertively, later reported perceived themselves to be less assertive than participants who were asked to give 6 examples. Due to the difficulty coming up with 12 examples, this group of participants may have attributed the difficulty of retrieval (disfluency) as a sign that there were not that many examples of them being assertive.

However, it should be remembered that in the ignorance-first condition the participants gave ratings of lack of knowledge and that we transformed these ratings to knowledge ratings by reversing the scale. One may argue that that reversal of the scale for the ignorance assessments is not valid because reporting a low lack of knowledge does not necessarily mean high knowledge, just as research has shown that the attitude of liking is functionally not necessarily the opposite of disliking (e.g. Jordan 1965; Pittinsky, Rosenthal, and Montoya 2011). However, we think that this transformation is legitimate for the purpose of making the knowledge assessment ratings in the ignorance first condition comparable with the corresponding ratings in the other three conditions because it is reasonable to argue that all possible knowledge is made up of actual knowledge and potential knowledge, for which there is a lack of knowledge. Notably, the participants' functional psychological state when they made ignorance assessments was to consider their lack of knowledge, not their own knowledge. Some participants may have felt it embarrassing to admit a lack of knowledge, and this may have made them report less lack of knowledge (interpreted here as higher knowledge ratings). Even if this contributed to some participants' ratings of their lack of knowledge, our transformation to knowledge values still seems reasonable for the purpose of comparisons.

Furthermore, two previous studies reported results that support the legitimacy of such a transformation. Allwood and Granhag (1996) asked students for knowledge assessments of general knowledge areas using two different kinds of framing: 'Of all the existing knowledge in area [x] I consider that I hold...' or 'How much of the existing knowledge in area [x] do you not know?' Both groups gave their
ratings on similar scales, with 0 meaning ‘no knowledge’ and 10 meaning ‘all knowledge’. The two framings gave very similar results, suggesting that the framing of the knowledge assessments had no effect. Similarly, in a study of undergraduates and individuals with at least a PhD degree, Hansson, Buratti, and Allwood (2017) found comparable estimations of known or not known knowledge. In contrast to the present study, the actual scales used for the knowledge assessments in both of those previous studies were similar for both types of assessment questions. The reason why the present study showed differences between the two types of knowledge assessments and the previous studies did not, may be because the studies explored different types of knowledge and risk domains. We suggest that future research explore this issue further.

**The effect of knowledge assessments on risk assessments**

Hypothesis 2 was not confirmed because the knowledge assessments in the knowledge first condition and alternate condition did not lead to significantly different risk perceptions than the risk first condition. In this context, the risk first condition acted as a control condition in that it reflected the level of risk ratings without the activation of knowledge, which is likely to have occurred in the other two conditions. Furthermore, as can be seen in Figure 2, the results showed that the risk first condition was the most unstable in relation to the other three conditions when compared over the five risk domains. This suggests that the activation of knowledge, which likely occurred in the other two conditions, may have acted to some extent to stabilize the risk ratings. Future research should explore the replicability of these findings and, given that they replicate, investigate the mechanisms behind them.

In general, these results attest to the absence of clear effects of the activation of knowledge before rating risk, possibly due to risk ratings already activating the relevant knowledge available to the risk assessor. This result is noteworthy because if this result is correct, it suggests a certain robustness of the risk perception results in studies in which participants are asked for subjective knowledge ratings before they give risk ratings (e.g. Grasmück and Scholz 2005; Imai et al. 2015; Jaccard, Dodge, and Guilamo-Ramos 2005; Zhu, Wei, and Zhao 2016).

We included the alternate condition in order to study whether the immediate activation of risk-relevant knowledge before the risk assessment influences their level. However, although the alternate condition had higher risk perceptions than the knowledge first condition consistently across the five domains, the difference was very small and not significant; thus, hypothesis 3 was not confirmed. Notably, the knowledge assessments in the two conditions did not differ, except possibly in the economy domain, but in that domain the risk ratings were very similar.

As expected in hypothesis 4, we found that the ignorance first condition was related to the risk assessments. The risk assessments were lowest in this condition compared to the other three conditions. However, the difference in risk perception was only significant between the alternate condition and the ignorance first condition. Thus, making participants focus on their lack of knowledge was associated with them giving lower risk assessments. The reason for the low risk assessments in this condition is not clear, but we speculate that it may not be the level of the ignorance assessments per se, but rather the experienced quality of the processes when assessing their ignorance; the instruction to look for lack of knowledge and having difficulty finding such examples may have had the simple effect of making the participants feel that the rated risk was low. However, we did not investigate the mechanisms underlying the result and, therefore, we caution against drawing any conclusions with respect to the mechanisms involved. Future studies should explore exactly what mechanism is behind the lower risk assessments in the ignorance first condition.

**General relationship between subjective knowledge assessments and risk assessments**

Our results indicate a positive, albeit small, correlation between the level of subjective knowledge ratings and the level of risk perceptions for several of the domains in the first three conditions (i.e. knowledge first, alternate, and risk first conditions). In the ignorance first condition there was a tendency for the
correlations to be negative, significantly negative in the crime domain. Thus, in the first three conditions higher regular knowledge ratings were associated with higher risk assessments. These results are in line with those of Zhu, Wei, and Zhao (2016) and Imai et al. (2015), who found a positive relationship between subjective knowledge assessment and risk perceptions. This positive relationship could be due to, for example, participants activating many concrete examples of risks, which may have created the impression that the risk level was high. This would also explain why the alternate condition had the highest risk perception, as the knowledge activation occurred before each specific risk judgment.

However, other studies have found other relationships between subjective knowledge and risk assessments. For example, van der Linden (2017) reviewed research on climate risk assessments and concluded that there was no clear relationship between subjective knowledge and risk perception. Given the mixed results for the relationship between subjective knowledge and risk perception, whether subjective knowledge ratings should be used at all in this context or in risk research in general is in question. Despite the mixed results, we would argue that it may be premature to abandon the use of subjective knowledge assessments in risk research. One reason is the recent study by Frey et al. (2017), who studied risk preference using 39 risk-taking measures of three kinds: frequency measures (mostly self-reported), objective behavioral performance measures, and self-reported propensity measures. The results showed an advantage for self-reported propensity measures over the two other types of measures with respect to their convergence with one another and their test–retest reliability across 6 months, especially compared to the behavioral measures. Thus, before giving up on subjective knowledge assessments in risk research, we would argue that more research is needed to achieve a better understanding of what factors influence the relationship between subjective knowledge and perceived risk in different risk domains.

**Effect of risk domain on risk perception**

As in previous research on risk perception, the subjective knowledge assessments and risk assessments differed between the different domains. Thus, characteristics of the specific risk domains are likely to influence perceived risk. This could be due to the participants imagining themselves as having higher control in the health domain than in the environment and transport domains (compare Sjöberg 2000). In addition, the results showed an interaction between experimental condition and risk domain. Thus, compared to the risk first condition, the risk assessments were affected differently by the knowledge assessments in the different risk domains. For example, as shown in Figure 2, the perceived risk in the health domain was lower after knowledge ratings but higher in the environment and transport domains after knowledge ratings compared to the risk first condition. However, further research is needed in this context, as the specific risk items used may have influenced these results.

**Limitations**

As in all research, this study has various types of limitations. First, although our sample was representative of the Swedish population with respect to gender and age, the sample only included Swedish people and we do not know if it was fully representative with respect to education. These considerations hamper the generalizability of our findings. Second, the risk perceptions we studied were perceptions of personal risk. In general, risk research has found that people perceive risks as lower for themselves than for others, at least for dangers that can be judged as being possible to control (Sjöberg 2000; Slovic 2000; Weinstein 1987, 1989). For example, Sjöberg (2000) reported that risk was assessed similarly for ‘myself’ and ‘others’ in domains in which the participants are likely to think that they have less control, such as risks pertaining to the ozone layer and the greenhouse effect. Moreover, personal and societal risk may be influenced by different factors. For example, in climate risk research, van der Linden (2015) found that personal risk is not affected by objective knowledge, but societal risk is. We speculate that, if we had asked our participants to assess the risk for others, the level of perceived risk would generally have been higher, except possibly for some of the items in the travel and environment domains for
which perceived control may have been less. However, our findings relating to differences between
the experimental conditions are likely to have been the same.

Another limitation of this study is that our risk items, similar to other risk studies (Finucane et al. 2000;
Flynn, Slovic, and Mertz 1994; Olofsson and Rashid 2011; Rivers, Arvai, and Slovic 2010; Sjöberg 2001),
were quite general and not tied to specific situations. However, in many situations it is quite natural to
consider this type of more abstract risk, such as considering insurance or thinking about engaging in
a specific category of action (e.g. using your bicycle more regularly for getting to work).

Conclusions and future directions

The present study had at least three notable findings. Firstly, the order in which the regular knowledge
assessments were performed generally had no effect on the level of the knowledge assessments or
the risk assessments. This finding may have important implications for risk research, as it suggests that
asking for regular knowledge assessments may not impact the assessments themselves. Secondly,
when participants rated their lack of knowledge, these ratings, when transformed to knowledge ratings,
were higher than the regular knowledge ratings performed by the participants in the other conditions.
Thirdly, the participants who performed ignorance assessments gave lower risk assessments than the
participants who performed regular knowledge assessments. These last two findings suggest that asking
people to consider their lack of knowledge in a risk area may not always be helpful for increasing their
risk awareness. For example, asking a person with an unhealthy lifestyle to assess their lack of knowledge
about the risks associated with not exercising may not increase their risk awareness about the potential
harm of not exercising. However, asking people to consider their lack of knowledge may help them
moderate their risk perception in areas in which there are reasons to think that their risk perception is
exaggerated. An example is when people estimate the risk of being the victim of uncommon types of
criminal activities, such as violent assaults.

Practical applications of these findings would be aided by improved knowledge about the underly-
ing mechanisms that contribute to why ignorance assessments seem to give lower risk assessments. In
general, further research should study how regular knowledge assessments and ignorance assessments
are carried out. It would be of special interest to study people’s lack of knowledge assessments, such as
with respect to how fluently the search process is experienced and how people search for knowledge
gaps, including what type of strategies they use in order to identify knowledge gaps. Instructing the
participants to allow more time for their lack of knowledge assessment and asking them to think aloud
(Ericsson and Simon 1980; Fox, Ericsson, and Best 2011) may also be informative.

Notes

1. Data from 16 participants with more than five missing data points were excluded.
2. Because the assumption of sphericity was not met, Greenhouse–Geisser corrections are reported.
3. Fisher’s least significant difference test.
4. Because the assumption of sphericity was not met, Greenhouse–Geisser’s corrections are reported.

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References

Allwood, C. M., and P. A. Granhag. 1996. “Considering the Knowledge You Have: Effects on Realism in Confidence Judgements.” European Journal of Cognitive Psychology 8: 235–256.

Baird, B. N. R. 1986. “Tolerance for Environmental Health Risks: The Influence of Knowledge, Benefits, Voluntariness, and Environmental Attitudes.” Risk Analysis 6: 425–435.

Blais, A.-R., and E. U. Weber. 2006. “A Domain-Specific Risk-Taking (DOSPERT) Scale for Adult Populations.” Judgment and Decision Making 1: 33–47.

Buehler, R., D. Griffin, and M. Ross. 2002. “Inside the Planning Fallacy: The Causes and Consequences of Optimistic Time Predictions.” In Intuitive Judgment: Heuristics and Biases, edited by T. Gilovich, D. Griffin, and D. Kahneman, 250–270. New York, NY: Cambridge University Press.

Byrnes, J., D. Miller, and W. Schafer. 1999. “Gender Differences in Risk-Taking: A Meta-Analysis.” Psychological Bulletin 125: 367–383.

Ericsson, K. A., and H. A. Simon. 1980. “Verbal Reports as Data.” Psychological Review 87: 215–251.

Faber, M., R. Manstetten, and J. L. R. Proops. 1992. “Humankind and the Environment: An Anatomy of Surprise and Ignorance.” Environmental Values 1: 217–241.

Finucane, M. L., P. Slovic, C. K. Mertz, J. Flynn, and T. A. Satterfield. 2000. “Gender, Race, and Perceived Risk: The ‘white Male’ Effect.” Health, Risk & Society 2: 159–172.

Flynn, J., P. Slovic, and C. K. Mertz. 1994. “Gender, Race, and Perception of Environmental Health Risks.” Risk Analysis 14: 1101–1108.

Fox, M. C., K. A. Ericsson, and R. Best. 2011. “Do Procedures for Verbal Reporting of Thinking Have to Be Reactive? A Meta-Analysis and Recommendations for Best Reporting Methods.” Psychological Bulletin 137: 316–344.

Frey, R., A. Pedroni, R. Mata, J. Rieskamp, and R. Hertwig. 2017. “Risk Preference Shares the Psychometric Structure of Major Psychological Traits.” Science Advances 3: e1701381.

Grasmück, D., and R. W. Scholz. 2005. “Risk Perception of Heavy Metal Soil Contamination by High-Exposed and Low-Exposed Inhabitants: The Role of Knowledge and Emotional Concerns.” Risk Analysis 25: 611–622.

Griffin, D., and L. Brenner. 2004. “Perspectives on Probability Judgment Calibration.” In Blackwell Handbook of Judgment and Decision Making, edited by D. J. Koeleher and N. Harvey, 177–199. Oxford: Blackwell.

Hansson, I., S. Buratti, and C. M. Allwood. 2017. “Experts’ and Novices’ Perception of Ignorance and Knowledge in Different Research Disciplines and Its Relation to Belief in Certainty of Knowledge.” Frontiers of Psychology 8: 377. doi:10.3389/fpsyg.2017.00377.

Imai, H., K. Okumiyi, E. Fukutomi, T. Wada, Y. Ishimoto, Y. Kimura, W. L. Chen, et al. 2015. “Association between risk perception, subjective knowledge, and depression in community-dwelling elderly people in Japan.” Psychiatry research 227: 27–31.

Jaccard, J., T. Dodge, and V. Guilamo-Ramos. 2005. “Metacognition, Risk Behavior, and Risk Outcomes: The Role of Perceived Intelligence and Perceived Knowledge.” Health Psychology 24: 161–170.

Jordan, N. 1965. “The Asymmetry of ‘Liking’ and ‘Disliking’: A Phenomenon Meriting Further Reflection and Research.” Public Opinion Quarterly 29 (2): 312–322.

Klerck, D., and J. C. Sweeney. 2007. “The Effect of Knowledge Types on Consumer-Perceived Risk and Adoption of Genetically Modified Foods.” Psychology & Marketing 24: 171–193.

van der Linden, S. 2015. “The Social-Psychological Determinants of Climate Change Risk Perceptions: Towards a Comprehensive Model.” Journal of Environmental Psychology 41: 112–124.

van der Linden, S. 2017. “Determinants and Measurement of Climate Change Risk Perception, Worry, and Concern.” In Oxford Encyclopedia of Climate Change Communication, edited by M. Nisbett, 1–53. Oxford: Oxford University Press.

March, J. G. 1997. “Understanding How Decisions Happen in Organizations.” In Organizational Decision Making, edited by Z. Shapiro, 9–32. New York: Cambridge University Press.

McClelland, A. G. R., and F. Bolger. 1994. “The Calibration of Subjective Probability: Theories and Models 1980–94.” In Subjective Probability, edited by G. Wright and P. Ayton, 453–482. Oxford: Wiley.

Nickerson, R. S. 1998. “Confirmation Bias: A Ubiquitous Phenomenon in Many Guises.” Review of General Psychology 2: 175–220. doi:10.1037/1089-2680.2.2.175.

Olofsson, A., and S. Rashid. 2011. “The White (Male) Effect and Risk Perception: Can Equality Make a Difference?” Risk Analysis 31: 1016–1032. doi:10.1111/j.1539-6924.2010.01566.x.

Oppenheimer, D. M. 2008. “The Secret Life of Fluency.” Trends in Cognitive Sciences 12: 237–241.

Parascandola, M. 2010. “Epistemic Risk: Empirical Science and the Fear of Being Wrong.” Law, Probability and Risk 9: 201–214. doi:10.1093/lpr/mqg005.

Pittinsky, T. L., S. A. Rosenthal, and R. M. Montoya. 2011. “Liking is Not the opposite of Disliking: The Functional Separability of Positive and Negative Attitudes toward Minority Groups.” Cultural Diversity and Ethnic Minority Psychology 17: 134–143.

Renn, O. 1998. “Three Decades of Risk Research: Accomplishments and New Challenges.” Journal of Risk Research 1: 49–71.

Rescher, N. 2009. Ignorance (on the Wider Implications of Deficient Knowledge). Pittsburgh, PA: University of Pittsburgh Press.

Rivers, L., J. Arvai, and P. Slovic. 2010. “Beyond a Simple Case of Black and White: Searching for the White Male Effect in the African-American Community.” Risk Analysis 30: 65–77. doi:10.1111/j.1539-6924.2009.01313.x.
Rutkowski, E. M., and C. D. Connelly. 2011. “Obesity Risk Knowledge and Physical Activity in Families of Adolescents.” Journal of Pediatric Nursing 26: 51–57.
Sahlin, N. E., and J. Persson. 1994. “Epistemic Risk: The Significance of Knowing What One Does Not Know.” In Future Risks and Risk Management, edited by B. Brehmer and N.-E. Sahlin, 37–62. Dordrecht: Kluwer Academic.
Schwarz, N., H. Bless, F. Strack, G. Klumpp, H. Rittenauer-Schatka, and A. Simons. 1991. “Ease of Retrieval as Information: Another Look at the Availability Heuristic.” Journal of Personality and Social Psychology 61: 195–202.
Sjöberg, L. 2000. “Factors in Risk Perception.” Risk Analysis 20: 1–12.
Sjöberg, L. 2001. “Limits of Knowledge and the Limited Importance of Trust.” Risk Analysis 21: 189–198.
Slovic, P. 2000. “Do Adolescent Smokers Know the Risks?” In The Perception of Risk, edited by P. Slovic, 364–371. London: Earthscan.
Slovic, P., B. Fischhoff, and S. Lichtenstein. 1982. “Why Study Risk Perception?” Risk Analysis 2: 83–93.
Smithson, M. 1989. Ignorance and Uncertainty: Emerging Paradigms. New York: Springer-Verlag.
Son, L. K., and N. Kornell. 2010. “The Virtues of Ignorance.” Behavioural Processes 83: 207–212. doi:10.1016/j.beproc.2009.12.005.
Taleb, N. N. 2007. The Black Swan: The Impact of the Highly Improbable. New York: Penguin.
Weinstein, N. D. 1987. “Unrealistic Optimism about Susceptibility to Health Problems: Conclusions from a Community-Wide Sample.” Journal of Behavioral Medicine 10: 481–500.
Weinstein, N. D. 1989. “Optimistic Biases about Personal Risks.” Science [0036-8075] 246 (4935): 1232–1233.
Zhu, W., J. Wei, and D. Zhao. 2016. “Anti-Nuclear Behavioral Intentions: The Role of Perceived Knowledge, Information Processing and Risk Perception.” Energy Policy 88: 168–177.

Appendix 1
The five risk domains, with their five specific knowledge areas:
Health: Stress burnout, overweight, smoking, vaccine/influence, physical exercise.
Crime: Skimming, burglary, mugging, identity theft, fraud.
Environment: Contaminated drinking water, greenhouse effect, radon, genetically modified food, nuclear power.
Economy: Investment funds, business investment, gambling on horses, house investment, poker games.
Transport: Car travel, airplane travel, train travel, boat travel, bicycling.