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Effect of visual aids and individual differences of cognitive traits in judgments on food safety

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ABSTRACT

We examined the effect of visual aids on judgments on food safety in conjunction with individual cognitive differences. In this study, participants (nine hundred Japanese women) were presented with explanations of pesticide residue either in written form only or in written form accompanied by a visual aid (functional graph or illustration), and were asked to make judgments on safety for foods that have pesticide residue. Findings through a web-based survey showed that judgments on food safety were highly difficult for laypeople since they had little knowledge of the technical terms used to describe amounts of pesticide residue. We found that although a visual aid showing their functional relationship did not improve understanding of the technical terms, an illustrated visual aid led to both improved understanding and more accurate judgments on safety. We also found that although cognitive traits measured with the subjective numeracy scale (Fagerlin et al., 2007b) and the Cognitive Reflection Test (Frederick, 2005) correlated with judgments on food safety, the judgments were improved with the use of visual aids regardless of cognitive traits. These results show that while not all visual aids enhance understanding of food safety information, appropriately designed visual aids do, and that cognitive traits producing individual differences in judgments on food safety should be taken into account when considering how food safety information should be conveyed.

Introduction

Previous studies have examined how people feel about the safety of foods contaminated by pesticide residue from various perspectives, such as their concerns about pesticide residue in foods (e.g., Eom, 1994; Fu et al., 1999; Roosen et al., 1998; Rimal et al., 2001) and risk judgments about pesticide residue (e.g., Cerroni et al., 2012, 2013). In the present study, we examined laypeople's judgments on food safety based on technical terms for pesticide residue. Imagine the following information:

> Pesticide residue has been detected in grapes. The amount is less than the acceptable daily intake (ADI).

How does a consumer feel about these grapes? Can they be eaten or should they be discarded? It may be highly difficult for laypeople to judge whether the amount of pesticide residue detected in the grapes is sufficient to damage their health if they do not know the definition of ADI. Thus, it is predicted that many laypeople can neither understand this technical information nor make accurate judgments on food safety based on it. In this paper, we discuss how laypeople's understanding of information about pesticide residue can be improved. In particular, we propose visual aids depicting information about pesticide residue and examine their effects.

In the following sections, we shall first review research on risk judgment and cognitive traits pertaining to judgment processes, then report on our own web-based survey study on judgments on food safety for pesticide residue. Through this research, we shall discuss how people's judgments on safety for food contaminated by pesticide residue are improved by visual aids.

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Literature review

Risk judgments and visual aids

In risk-judgment research, many studies have been conducted on how people understand information about probability (for a review, see Manski, 2004). Here, we briefly review some relevant studies on methods of information presentation and their effects on the understanding of probability information. Risk information often entails concepts that are difficult to understand, such as those framed as numerical probabilities, which people are prone to misunderstanding (e.g., Gigerenzer, 2003). Thus, many previous studies have examined how people make judgments based on probability information.

One of the most studied topics in risk judgment is the effect of presentation format on the understanding of probability information. Particularly, many studies have examined the effects of visual aids (for reviews, see Ancker et al., 2006; Garcia-Retamero and Cokely, 2013; Garcia-Retamero et al., 2012; Lipkus, 2007; Lipkus and Hollands, 1999). These studies have shown that although people are not generally good at understanding probability information, their understanding is improved with visual aids.

In the example using the pesticide-residue-related technical term ADI in the preceding section, if laypeople are presented with explanations allowing them to understand the concept of ADI, they may make accurate judgments about the riskiness of the grapes. Specifically, a visual aid may improve laypeople's understanding of technical information about pesticide residue. However, previous studies have shown that not all visual aids are effective for all tasks (e.g., Feldman-Stewart et al., 2000; Schapira et al., 2001). Thus, some visual aids may enhance understanding of technical terms and lead to accurate risk judgments, and others may not.

Cognitive traits pertaining to judgments

To further this discussion, an examination of individual cognitive differences is indispensable in order to examine whether visual aids improve understanding of risk information regardless of individual cognitive traits. Many studies on risk judgments based on probability information have examined individual differences in terms of numeracy. Numeracy refers to the ability to understand and utilize concepts such as mathematics or probability. Numeracy is believed to play an important role in the context of risk judgment based on probability information in that such judgments require people to use numerical information or make calculations (e.g., Ancker and Kaufman, 2007; Fagerlin et al., 2007a; Keller and Siegrist, 2009; Okamoto et al., 2012; Pachur and Galesic, 2013; Peters, 2008; Peters et al., 2006, 2007a, 2007b; Peters and Levin, 2008; Nelson et al., 2008; Reyna and Brainerd, 2008; Reyna et al., 2009).

In the present study, we examined individual differences in cognitive traits measured with the Cognitive Reflection Test (CRT) in addition to numeracy. The CRT (Frederick, 2005) is a measure of cognitive traits related to intuitive or reflective traits in the thinking processes, composed of three questions (we shall describe the details in the Methods section). Frederick (2005) showed that CRT scores correlate with time and risk preferences. After this original work, it was found that CRT scores had correlations with various measures of decisions and judgments (e.g., Cokely and Kelley, 2009; Koehler and James, 2010; Oechssler et al., 2009; Toplak et al., 2011). Since cognitive traits measured with the CRT are involved in a wide range of decisions and judgments, such traits may affect judgments on food safety. Furthermore, we can assume that cognitive traits measured with the CRT are among the most important human thinking traits. Previous studies have argued that human thinking is generally explained by two processes: Systems 1 and 2 (Kahneman, 2011). Frederick (2005) argued the relationship between these thinking processes and cognitive traits measured with the CRT: A high score indicates a reflective thinking trait, and a low score, contrarily, indicates an intuitive thinking trait. Thus, we predict that the wide variance in individual differences of judgments on food safety can be explained in terms of cognitive traits measured with the CRT.

Goals of the present study

To summarize, we set two goals for the present study. The first was to explore the effects of visual aids on the understanding of technical information about pesticide residue. The second was to examine individual differences among participants in numeracy and cognitive traits measured with the CRT. In particular, we were interested in examining whether the effects of visual aids on participants' understanding of technical terms were related to these cognitive traits.

Our predictions about the effects of visual aids and cognitive traits on judgments on food safety are summarized as follows: Not all visual aids would improve people's understanding of technical information, and only appropriately formatted visual aids would enhance people's understanding (we shall describe these predictions in more detail in the Methods section).

In the present study, participants were required to understand the rather complicated numerical relationship between three technical terms. Thus, we predicted that cognitive traits measured by numeracy and CRT would both be related to judgments on food safety. Risk judgment research has shown that people with high numeracy make more accurate judgments than those with low numeracy. Although our task was judgments on food safety, not risk judgments, we believed that numeracy would remain relevant. In order to understand a rather complicated numerical relationship, deliberate or analytical thinking is necessary. Thus, we predicted that participants with high CRT scores (reflective trait) would make more accurate judgments than those with low CRT scores (intuitive thinking trait). As to the interaction between visual aids and cognitive traits (i.e., the effectiveness of a visual aid varies depending on an individual's cognitive trait), we did not have specific predictions. Thus, we shall discuss this issue based on the results of the present survey.

Methods

Participants

Nine hundred Japanese women participated in the study. For each age from 30 to 49, forty-five participants were recruited (December 11–12, 2012)[1] on the web and randomly assigned to one of three treatments. Participants were given a specific amount of cash-equivalent points that could be used for online shopping in Japan once they completed all of the tasks.

The participant pool for the present study was determined based on the results of a large sample survey done in Japan (589 men and 611 women aged 20–69),[2] which revealed that the percentage of women who daily or occasionally cook was as high as 80.7% in the unmarried group and 98.5% in the married group, whereas that of men was only 60.0% in the unmarried group and 47.9% in the married group. These statistics suggest that women

[1] When a participant did not complete all tasks, her data was not collected. We continued recruitment of participants until the number of participants reached nine hundred.

[2] We referred to the following web pages: http://www.dentsu.co.jp/news/release/2011/pdf/2011112-0928.pdf. http://www.garbagenews.net/archives/1832766.html.