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EFFECTS OF SOURCE INFORMATION ON LEARNING AND INTEGRATION OF INFORMATION ON GENETICALLY MODIFIED FOODS

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This study investigated whether source information attached to texts influences multiple-text comprehension about genetically modified (GM) foods—a controversial science topic. Participants in the experiment read two texts from two sources: an expert and/or a layperson. When the two texts presented different attitudes toward GM foods (Experiment 1), expert information facilitated intra-text comprehension. Moreover, expert information was better integrated with other information; when expert information was presented first, later information was less integrated with participants' understanding, and when expert information was presented last, it was more integrated. When the two texts presented common attitudes (Experiment 2), a similar pattern of effects was observed, but the effects were weaker than those in Experiment 1. Thus, expert source information has the potential to affect the comprehension of scientific information, and careful planning is required for effective risk communication.

Key words: source information, multiple-text comprehension, authoritative sources, information integration, risk communication

INTRODUCTION

In modern society, people often need to integrate information from various sources in order to make decisions. Such information is sometimes inconsistent or contradictory, as can be seen in the mass media and on the Internet (Bråten, 2008; Bråten, Strømsø, & Samuelstuen, 2005). Thus, it has become increasingly difficult to make judgments based on multiple sources of information. In this study, we investigated the role of source information on multiple-text comprehension about a controversial topic: genetically modified (GM) food.

Understanding multiple sources of information is difficult, partially because reading multiple texts requires different skills from those needed for reading single texts (Rouet & Britt, 2011; Bråten, Britt, Strømsø, & Rouet, 2011). Sourcing is an important skill for multiple-text comprehension. Sourcing consists of checking and evaluating the source of text before reading the content and using information about the source to interpret the information in the text (Bråten, Britt, et al., 2011; Wineburg, 1991). For example, a person interested in the safety of GM foods may find two or more documents in newspapers,

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books, or websites. Some articles may focus on the safety of GM foods, whereas others might focus on the dangers. Sourcing can help individuals judge which articles are more credible than others. In fact, recent research has shown that source information plays an important role in multiple- and scientific-text comprehension (Brand-Gruwel & Stadtler, 2011; Britt, Perfetti, Sandak, & Rouet, 1999). Bråten, Strømsø, and Britt (2009) reported that students who judged adequately reliable sources of information from multiple texts had better comprehension at both the surface and deep levels of the texts than those who did not. Thus, sourcing skill contributes to the understanding of multiple texts.

Sourcing is useful for not only initial encoding of information, but also evaluating information based on another point of view. Readers in complex society need to organize and integrate multiple pieces of information. One factor that complicates the organization and integration of information is a potential inconsistency in different information regarding an identical topic. In general, readers find it difficult to integrate inconsistent information (Johnson & Seifert, 1994, 1998; Seifert, 2002). When new and potentially inconsistent information is encountered, readers rarely change their previous interpretation, and, instead, persist in their previously constructed understanding. The presence of heterogeneous sources makes readers' judgments difficult and may facilitate a stronger commitment to previously gained understanding. Thus, sourcing is critical in determining which information is selected as the basis for evaluation.

One of the factors affecting sourcing is domain knowledge. Bråten, Strømsø, and Salmerón (2011) suggested that, compared with students with high knowledge, students with low knowledge are likely to rely on superficial features, such as publisher and type of text. Similar findings regarding the relationship between knowledge and sourcing were reported in other studies (Brem, Russell, & Weems, 2001; Stadtler & Bromme, 2007). Thus, when people have poor knowledge for a specialized scientific topic, as is the case with GM food, they tend to rely on superficial information. Among the different aspects of superficial information, author information is easily seen by readers with poor knowledge. For example, risk information from experts is generally more reliable than that from laypersons (Brem et al., 2001; Ferguson et al., 2009). Thus, the author's specialty can influence sourcing activity by the general public who is not familiar with the scientific topic.

This study investigated how source information affects readers' understanding of multiple texts on the controversial scientific topic, GM foods. Given that the general public has some idea about GM foods but does not have very detailed knowledge, author information should influence the understanding of texts about GM foods. The effects of author information are not expected to be simple. GM foods lead to anxiety in people. Specialists in food, biology, and medicine often attempt to explain the foods' safety; however, these expert opinions do not necessarily correspond with each other or with laypersons' opinions. Scientists and government officials could also join with enterprises promoting GM foods and, therefore, discount experts and believable laypersons (Löfstedt & Renn, 1997). In these sorts of situations, there are two or more authors with differing opinions, and it becomes necessary to select credible sources. Strømsø, Bråten, and Britt (2010) examined text comprehension under complex sources with different opinions. They demonstrated that source memory was positively correlated with comprehension performance. Their experiment used seven texts containing partially inconsistent information, which created a naturalistic, but complex, environment. The status of each source was not straightforward, and it might have been difficult to remember the exact source of each text. Therefore, it remains unclear what roles the different sources played in comprehension. We used a simplified situation: the participants read only two texts. These texts were accompanied by explicit author information that indicated their authors' status (expert or layperson). In addition, their opinions of GM foods were positive or negative.

We examined whether the status of the authors who provided opposing information influenced both intra- and inter-text comprehension. Intra-text comprehension refers to the comprehension of a single text, and inter-text comprehension refers to integration across different texts. First, we expected that source information would affect intra-text comprehension. If participants have poor knowledge about GM foods before they read the texts, they should rely on noticeable information (i.e., author information). Previous studies have shown that participants who read difficult science texts tended to agree with experts' opinions stronger than those who read easy texts (Scharrer, Britt, Stadtler, & Bromme, 2012; Scharrer, Bromme, Britt, & Stadtler, 2012). Given that experts convey reliable information in general (Brem et al., 2001; Ferguson et al., 2009), participants should selectively encode more expert information than layperson information. Thus, our first research question was: "Does expert information facilitate intra-text comprehension better than layperson information?"

Second, we expected that source information would influence inter-text comprehension in different ways relative to intra-text comprehension. Once participants have read an opinion from a text, they may adhere to the contents of that text and not accept another opinion from another text (Johnson & Seifert, 1994, 1998; Seifert, 2002). For example, participants who first read a negative opinion about GM foods given by a layperson might be less interested in positive expert information that is subsequently read than those who read the same opinions in the opposite order, which could result in lower integration of one of the texts. However, the specialty of author information may provide an opportunity to overcome this perseverance (Briñol & Petty, 2009; Cialdini & Goldstein, 2004; Tormala, Briñol, & Petty, 2006). Thus, our second research question was: "Does the status of author information affect inter-text comprehension?" The effects of different sources may be dependent on the order of information. If participants first agree with an expert's opinion, they might not feel the need to change their views later. However, the effects of continuing to hold a specific opinion may be weaker when a layperson's opinion is encountered first. Therefore, directions of these effects are worth investigating empirically.

EXPERIMENT 1: CONTRADICTORY VIEWS

Method

Participants. The participants were 1,000 Japanese adults (500 men and 500 women) who had registered to be part of a research panel for the online research company Cross Marketing, Co., Tokyo, Japan;

they were aged 20–79 years (*ns* = 200 in each of the following age groups: 20–29, 30–39, 40–49, 50–59, and 60 and over). All the participants had a junior-college or higher-education background: 31.3% had graduated from junior college, and 60.6% had graduated from a university. Individuals with strong educational backgrounds were selected and invited to participate in the study (from the pool of potential participants registered with the company) because comprehension of controversial scientific topics is complex and requires a high level of academic skills. Nine occupational categories were included: office workers (37.5%), homemakers (18.6%), part-time workers (9.3%), professionals (7.8%), public servants (4.6%), students (3.8%), self-employed workers (3.5%), other jobs (2.8%), and unemployed (12.1%). More than half of the respondents were married (61.6%), and a majority had at least one child (55.6%). The participants performed the experimental task using their PCs via a web-based system in February 2010.

Participation in the study was completely voluntary, and participants had the option to withdraw from the study at any time without having to provide a reason. They provided written, informed consent of their willingness to participate in the study via the online questionnaire provided by the research company. The research company removed any information that could identify the participants prior to passing the collected data to the researchers, and all of the data in this study were anonymized.

Materials and design. Two excerpts were selected from books about GM foods. One excerpt had a negative attitude toward GM foods (Amagasa, 2000), and the other had a more positive attitude and described the potential merits of GM foods (Kawaguchi & Kikuchi, 2001). The negative text was written by an independent journalist (1,554 characters in Japanese; approximately 620 words in English), whereas the positive text was written by two writers with doctoral degrees in science (1,348 characters in Japanese; approximately 540 words in English). The negative text described negative research results regarding the safety of GM foods and stated that there was pressure from a related company to not publish the research. The positive text referred to the same issue, but pointed out the limitations of the research and reminded readers of the intention in the development of GM foods (i.e., a company would not intentionally produce dangerous foods). Table 1 shows a summary of the texts. For the purpose of experimental manipulation, the two texts were presented with fictitious source information; the author information attached to the texts indicated that the passages were written by experts in food and nutrition (e.g., a professor of nutritional science) or by laypersons (e.g., a citizen interested in food safety). The author information was assigned to the two texts independently of content and combined into four patterns: The two texts were supposedly written by (1) two experts, (2) an expert and a layperson, (3) a layperson and an expert, and (4) two laypersons. The source-information order also corresponded to the order of text presentation. The order of presentation for positive and negative texts was randomized between participants.

Two types of comprehension questions were provided for each text. Intra-text questions asked about the facts or opinions in the passages. These items were not identical to the original text, but readers could answer the items according to the contents of either text alone. For example, the original sentence in the longer passage, "(Dr. Pusztai) . . . thought that there were some problems associated with eating GM plants, and he presented his results to warn the public . . ." was paraphrased as, "Dr. Pusztai presented his results to make known the potential risks of [GM] foods." Inter-text questions asked whether the items stated the correct facts or opinions in view of both texts. Such items required the participants to integrate information across different texts; it was not sufficient to extract information from either text alone. For example, when one text said, "The genes introduced in [GM] products often did not work; thus, promoter genes were used to switch the genes on," and the other text said, "The safety of each [GM] food was examined individually," the inter-text question would state, "If the promoter genes have some risks, some problems could also be discovered in potatoes that have already been checked for safety." To answer the question, the participants had to remember facts about both the introduction of the promoter genes and the individual safety check conducted on each food. There were 10 items for each of the two types of questions, and the questions were randomly and equally divided into "true" or "false" sentences[1].

Procedure. The participants performed the task via a web-based survey system. After answering questions about demographic information, a question about attitudes toward GM foods was presented. Participants were asked which was greater—the benefits or the risks of GM foods—and replied using a six-point scale in which 1 = "Benefits substantially greater than risks," 2 = "Benefits slightly greater than risks,"

[1] The number of test items was determined according to previous research on related topics (Bråten & Strømsø, 2009; Gil, Bråten, Vidal-Abarca, & Strømsø, 2010).

Table 1. Summary of materials

Experiment	Attitude	Source	Claim	Main reasons
1	Negative	Amagasa (2000)	Pusztai's study demonstrated that GM foods can damage human health.	The rats that were fed GM potatoes were impared immune functions and organs. The company that developed GM foods hid the experimental results. Promoters are derived from genes of a virus and can be dangerous to organisms.
1	Positive	Kawaguchi & Kikuchi (2001)	The experimental result by Pusztai is unreliable.	The GM potatoes used in the study had different proteins and sugar from controls. The protein deliverd was originaly harmful to mammals. The developer did not intend to generate harmful foods at all.
2	Negative	Amagasa (2000)	The current standard for testing GM foods in not reliable.	Tests based on the veiw of substantial equivalence is invald. There is a case that the authorized foods harm humans on a large scale. The criterion omits the detection of trace constituents.
2	Negative	Fujiwara (2000)	GM foods must be strictly tested and managed.	Genes are not transferd as freely in nature as genetically modified experiments. GM techniques can make unexpected characteristics in organisms. The current system for testing GM food is insufficient.
2	Positive	Kawaguchi & Kikuchi (2001)	The safety of GM foods is closely reviewed and evaluated.	GM foods are evaluated for safety, compared to respective original foods. Historically, usual foods have not been tested for their safety in scientific ways. Government agencies gradually controled for GM food based on the standards.
2	Positive	Ohtsuka (2001)	The standard for safety of foods is established under practical constraints.	Foods consist of various components, not a single chemical substance. Major components of foods are macromolecules that have complex mechanism. Testing of foods are limited when using large doses and it is difficult to interpret the experimental results.

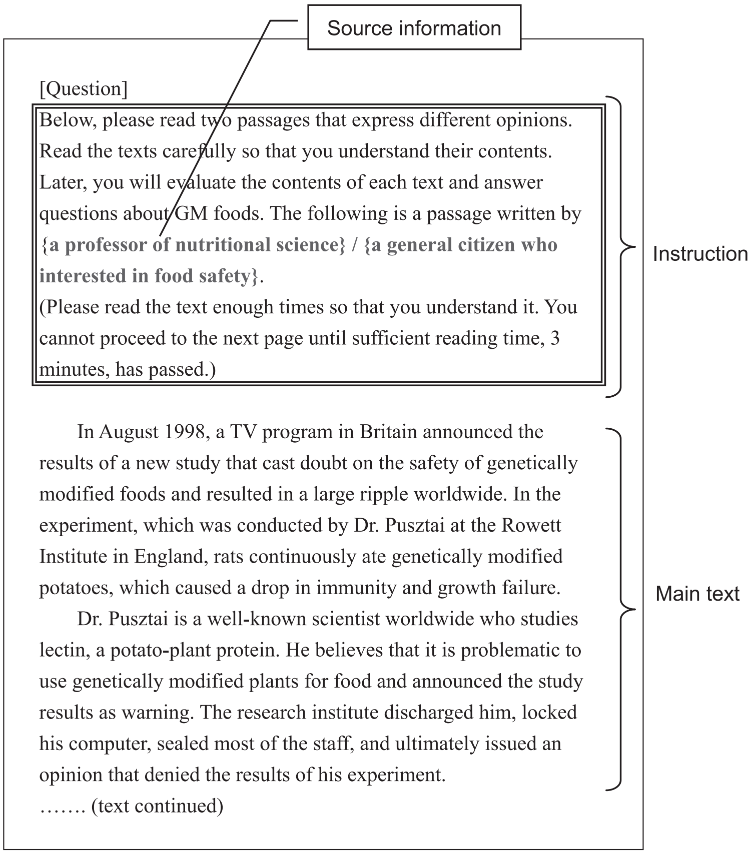

Fig. 1. Example text display. Bold words show author information ("a professor of nutritional science" in this example). The text in the figure has been translated from Japanese into English.

3 = "Benefits and risks are equivalent," 4 = "Risks are slightly more than benefits," 5 = "Risks are substantially greater than benefits," and 6 = "I don't know."

The participants were then asked to read two passages about GM foods and answer two types of comprehension questions. The source information was presented at the top of the page as part of the instructions (e.g., "The text below was written by specialists in food and nutrition. Please read it carefully because a test will follow;" see Fig. 1). The texts were presented one at a time, and the experimental interface did not advance through the texts if they had been shown for less than 3 minutes (but the participants were allowed more than 3 minutes); a pilot study showed that 3 minutes was sufficient for participants to carefully read each passage. Whenever the participants finished reading a text, they were required to summarize the author's opinion about GM foods and the grounds for the author's opinion in one or two sentences. This was intended to encourage the participants to read the texts carefully. Participants who wrote sentences that were too short (i.e., 10 characters or less; at least 9 characters are required to write "GM foods" in Japanese) were discarded from the analysis. The mean length of the sentences was positively correlated with intra-text comprehension scores [$r(998) = .27$, $p < .01$]; thus, participants who wrote very short sentences likely had poor comprehension. However, the overall patterns of intra- and inter-comprehension scores did not change if the "too short" data were included. Data from 419 men and 427 women were analyzed (the expert-expert, expert-layperson, layperson-expert, and layperson-layperson groups included 210, 228, 206, and 202 participants, respectively). After writing the short summaries, the participants were required to rate the credibility of the texts on a five-point scale ("How credible is the content of text that you just read?") and give the reasons for such judgment from the following options: (a) "The passage was convincing;" (b) "The opinion is similar to mine;" (c) "The author appears to be familiar with this topic;" (d) "The author is a 'professor' (i.e., expert) or general citizen (i.e., layperson);" and (e) "Other." They can select as many reasons as they needed. The same reading, summary, and rating processes were repeated for the other text. When the participants finished the two texts, they answered intra- and inter-text comprehension questions. For intra-text questions, the instruction was "You have read two texts about GM food in the previous two sections. Please check the following sentences on whether you think that they contain the same or a different massage based on either one of the texts." For inter-text questions, the instruction was "Please check the following sentences on whether you think that they provide valid arguments based on the two texts you read or invalid ones that either text did not support".

Results

Attitude. Attitude change to GM food after reading the texts was evaluated by subtracting rating scores before from the score after reading. The value "6 = I don't know" was discarded for calculation; the resulting responses were treated as 5-point scales. The difference scores did not differ in source conditions (*M*s = 0.32, 0.46, 0.45, and 0.35 for expert-expert, expert-layperson, layperson-expert, and layperson-layperson conditions). A two-way analysis of variance (ANOVA) on first (expert or layperson) and second (expert or layperson) sources did not suggest any statistical significance (*F*s < 1).

Credibility ratings. To examine the effects of the manipulation of fictitious source information, credibility ratings were compared between the two source types: expert and layperson (higher points represent higher credibility). When the participants read the first text, they tended to rate the texts assigned to expert sources (M = 3.48, SD = 0.69) as more

Table 2. Frequencies of reasons for credibility and results of chi-square test in Experiment 1

Reasons	Text	Expert-expert	Expert-layperson	Layperson-expert	Layperson-layperson	Chi-squared	*p* value
The text is convincing.	1st text	76 (36%)	70 (31%)	66 (32%)	60 (30%)	2.00	.57
	2nd text	50 (24%)	54 (24%)	67 (33%)	45 (22%)	4.93	.18
The idea is close to your own one.	1st text	52 (25%)	43 (19%)	46 (22%)	37 (18%)	2.63	.45
	2nd text	33 (15%)	33 (14%)	39 (19%)	43 (21%)	1.95	.58
The author is knowlegeable.	1st text	51 (24%)	38 (17%)	54 (26%)	51 (25%)	3.15	.37
	2nd text	39 (19%)	46 (20%)	40 (19%)	47 (23%)	1.16	.76
The author is a "professor" or "general citizen".	1st text	16 (8%)	32 (14%)	43 (21%)	54 (27%)	21.76	<.001
	2nd text	26 (12%)	37 (16%)	38 (18%)	35 (17%)	2.65	.45
Others	1st text	58 (28%)	53 (23%)	49 (24%)	38 (19%)	4.38	.22
	2nd text	92 (43%)	62 (27%)	65 (32%)	49 (24%)	14.60	.002
n		210	228	206	202		

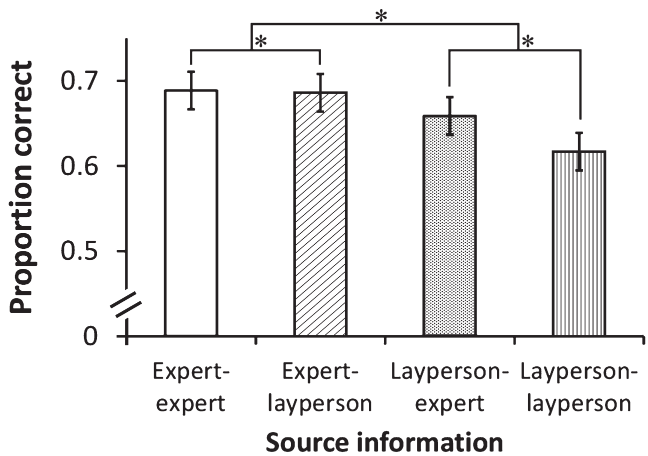

Fig. 2. Mean scores on the intra-text questions for the controversial situation (Experiment 1). All the participants read one negative and one positive text on GM foods. Each condition differed in terms of the source of information for the first and second texts. Error bars indicate 95% confidence intervals. * $p < .05$.

credible than those associated with layperson information, although the difference was not significant ($M = 3.41$, $SD = 0.63$), $F(1, 844) = 2.69$, $p = .10$, $\eta_p^2 = .003$. In addition, when the participants read the second text, this small trend was undetectable (*M*s = 3.29 vs. 3.31 and *SD*s = 0.73 vs. 0.73 for the expert and layperson sources, respectively), $F(1, 844) = .13$, $p = .72$, $\eta_p^2 = .0002$. Therefore, fictitious source information did not seem to change the credibility of the texts themselves. Table 2 shows the frequency of the reasons for credibility that the participants choose. The reasons for credibility rating did not differ between source conditions but according to the status of authors. There were fewer references to author's status when the first text was said to be written by an expert than by a layperson.

Intra-text comprehension. McDonald's (1999) omega for the test scores was 0.50. Although this value was not high, all items correlated similarly with each other (*r*s = .30 to .48)[2]. Mean scores on intra-text questions are displayed in Fig. 2. All means were more than chance level (.50), $t(209) = 16.17$, $p <$ 001 for expert-expert, $t(227) = 16.68$, $p < .001$ for expert-layperson, $t(205) = 13.12$, $p < .001$ for layperson-expert, and $t(201) = 11.80$, $p < .001$ for layperson-layperson conditions. Although the participants in all four groups read the same two texts, the source information attached to the texts affected text comprehension. A two-way ANOVA on first (expert or layperson) and second (expert or layperson) sources was conducted. Information from the first source significantly

[2] Although the reliability coefficients were not so high, it suggests that the test measure more broad concepts. Too higher reliability scores also implies construct behind them is narrow. Thus, a reasonable degree of reliability depends on the scope of construct that was intended to measure. Clark and Watson (1995) suggests of inter-item correlations .40–.50 for narrow constructs such as talkativeness, and .15–.20 for higher-order construct such as extraversion. Given that the test was to measure higher-order comprehension, these moderate inter-item correlations can be appropriate to reflect such higher-order construct.

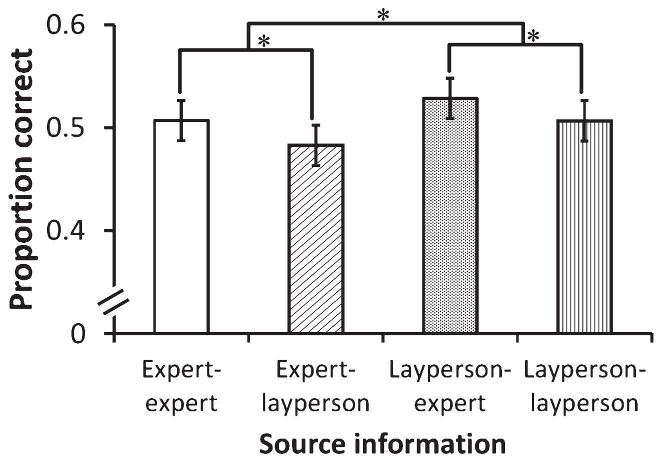

Fig. 3. Mean scores on the inter-text questions for the controversial situation (Experiment 1). All the participants read one negative and one positive text on GM foods. Each condition differed in terms of the source of information for the first and second texts. Error bars indicate 95% confidence intervals. * $p < .05$.

influenced intra-text scores, $F(1, 842) = 19.28$, $p < .001$, $\eta_p^2 = .022$, showing that an expert source facilitated intra-text comprehension compared to a layperson source for first text. In addition, the second source showed a similar effect, $F(1, 842) = 3.90$, $p = .048$, $\eta_p^2 = .005$. The interaction between the first and second sources was marginally significant, $F(1, 842) = 3.04$, $p = .08$, $\eta_p^2 = .004$. This interaction was due to small differences when the first text was presented with the expert source. Thus, the intra-text scores suggest that expert-source information increases readers' comprehension of each text, compared to layperson-source information.

Inter-text comprehension. McDonald's (1999) omega for the test scores was 0.47. All items correlate each other similarly (rs = .31 to .44). Fig. 3 shows the mean scores on the inter-text questions. Only the mean score for layperson-expert condition was significantly different from chance, $t(205) = 2.69$, $p = .007$. The scores for the expert-layperson condition approached significance, $t(227) = 1.79$, $p = .07$ and those for the other condition were not distinguishable from chance, $t(209) = 0.69$, $p = .49$ for expert-expert and $t(201) = 0.73$, $p = .46$ for layperson-layperson conditions. Although the scores did not reach the level of chance in some groups, this does not show that the participants fails to comprehend text. Only participants who integrate contents from two text can answer the inter-text test correctly. Thus, participants who understand but does not integrate texts may stay in the chance. Their intra-text scores suggest that they understand well for single texts. Similar to the intra-text-score analysis, a two-way ANOVA was conducted. Information from the first source influenced integration across different texts, $F(1, 842) = 5.15$, $p = .02$, $\eta_p^2 = .006$. When the participants read expert information first, they tended to integrate the information across texts with different opinions less than when they read the layperson information first. This suggests that the participants did not accept the information from the second text when they read the experts' opinion first. In contrast, expert information in the second text encouraged the participants to integrate the texts relative to when layperson information was presented as the second text, $F(1, 842) = 5.26$, $p = .02$, $\eta_p^2 = .006$. The participants showed greater integration of information containing different opinions when the second, conflicting opinion was identified as an expert than as a layperson. The interaction between the two sources was not significant, $F(1, 842) = 0.02$, $p = .90$, $\eta_p^2 < .000$. These results suggest that both the first and second source manipulations contributed to inter-text comprehension. However, the first source facilitated integration across texts when it was by a layperson, but the second source facilitated integration when it was by an expert. Finally, neither gender nor participant age substantially contributed to their intra- and inter-text comprehension. Correlations among gender or age and test scores were small ($|r| < .10$).

Discussion

The results of Experiment 1 demonstrated the effects of source information on both intra- and inter-text comprehension. When encoding information from each text, the participants learned more from an expert than from a layperson; they can select information from potentially useful sources for encoding, and then remember the contents of the text attached with the sources. Moreover, the participants selectively integrated information across multiple texts. They were more affected by expert information. That is, they were less likely to correctly answer the questions including both texts when the experts' information was given first, whereas they were more successful in answering the inter-text questions when expert information was identified with the second text.

An unexpected result was that the credibility rating was less affected by source information irrespective of effects on understanding. The correlations between credibility ratings and intra- and inter-text comprehension were very low (rs = –.01, 00, –.06, and .01 for first- and second-text intra-comprehension, and first-and second-text inter-comprehension, respectively), probably because of the controversy inherent in the texts used for this experiment. In Experiment 1, the two texts always presented different opinions: one text presented a negative opinion about GM foods, and the other presented a more positive view. In these sorts of controversial situations, the participants might be skeptical about both texts and unable to decide their own attitude toward food safety. As a result, they may not have been confident enough to judge the credibility of the texts; this was reflected in their credibility ratings of the second text. Specifically, the participants who read the layperson's text first might have been less confident about their attitude toward GM foods. Therefore, participants in the layperson-expert condition might tend to seek credible information; such a tendency would facilitate greater integration of the two texts.

EXPERIMENT 2: COORDINATIVE VIEWS

The results of Experiment 1 suggest that author information influences intra- and inter-text comprehension for multiple texts. In Experiment 2, we investigated whether the results depended on the presence of conflicting opinions: one opinion stated that GM foods pose health risks, whereas the other stated that GM foods do not contain risks greater than ordinary foods. When participants notice conflicting information in texts, they would pay more attention to source information and be likely to evaluate it. Braasch, Rouet, Vibert, and Britt (2012) confirmed this hypothesis by eye movement recording experiments. They showed that participants gazed longer at inconsistent information compared to consistent information when they read text. Additionally, they subsequently recalled more inconsistent sources than consistent sources. Thus, the results of Experiment 1 may also have been mediated by the presence of conflicting opinions in the experimental texts. In Experiment 2, we used two experimental texts with similar opinions: both were negative or both were positive with respect to GM foods. Without conflicting opinions, the participants would have no preference to both expert and layperson information. Thus, they should receive text information similarly irrespective of the status of the authors. Alternatively, according to the discrepancy-induced source comprehension hypothesis (Braasch et al., 2012), the participants should rely more on either expert or layperson information.

Method

Participants. One thousand and six hundred Japanese adults (800 men and 800 women; *n*s = 320 in each of the following age groups: 20–29, 30–39, 40–49, 50–59, and 60–69) who registered with the same research panel as in Experiment 1 participated in the experiment. The inclusion criteria were the same as in Experiment 1, and none had participated in that experiment. Of the participants, 30.7% had graduated from junior college and 61.4% from a university. They had the following occupations: office workers (33.3%), homemakers (19.8%), part-time workers (10.3%), students (7.9%), professionals (6.2%), self-employed workers (5.2%), public servants (3.6%), other jobs (3.2%), and unemployed (10.6%). More than half of the respondents were married (61.6%), and the majority had at least one child (53.6%). The survey was conducted in September 2011.

Materials and design. New excerpts about GM foods were selected to provide two negative (Amagasa, 2000; Fujiwara, 2000; the texts were 1,453 and 1,428 characters in Japanese, approximately 580 and 570 words in English) and two positive (Kawaguchi & Kikuchi, 2001; Ohtsuka, 2001; the texts were 1,657 and 1,547 characters in Japanese, approximately 660 and 620 words in English) opinions. Each participant was assigned to a negative- or positive-text group and one of the four source-information groups employed in Experiment 1. Intra- and inter-text questions were created in the same manner as in Experiment 1.

Procedure. The procedure for this experiment was the same as in Experiment 1. Data from 1,400 participants (667 men and 733 women) who wrote more than 10 characters of summary on each of the texts were analyzed. The mean length of sentences produced were correlated with their intra-text comprehension scores [$r(1598) = .34$, $p < .01$]; participants who wrote sentences that were too short were considered to have comprehended less of the content of the texts than those who wrote longer sentences.

Results

Attitude. Similar to Experiment 1, the difference scores in attitude to GM food before and after reading the texts did not differ for source conditions (*M*s = 0.07, 0.14, 0.00, 0.18, 0.63, 0.73, 0.54 and 0.53 for positive expert-expert, expert-layperson, layperson-expert, layperson-layperson and negative expert-expert, expert-layperson, layperson-expert, layperson-layperson conditions). A 2 (opinion) × 2 (first-source information) × 2 (second-source information) ANOVA was conducted. Only an opinion factor significantly affected participants' attitude, $F(1, 1117) = 79.99$, $p < .001$, $\eta_p^2 = .064$, suggesting that two negative texts facilitated negative attitude. No other effect reached statistical significance (*F*s < 2.24).

Credibility ratings. To examine the potential effects of source on text perception, a 2 (opinion: negative vs. positive) × 2 (source information: expert vs. layperson) ANOVA was conducted on the ratings for the first texts. Two main effects were significant: opinions, $F(1, 1396) = 53.75, p < .001, \eta_p^2 = .037$, and sources, $F(1, 1396) = 7.61, p < .01, \eta_p^2 = .005$. Negative texts were rated as more credible than positive ones, and an expert source made the texts more credible than a layperson source. The interaction between opinion and source was not significant, $F(1, 1396) = 1.63$, $p = .20$, $\eta_p^2 = .001$. Evaluations for the second texts were similar: two main effects were significant: opinions, $F(1, 1396) = 79.59$, $p < .001$, $\eta_p^2 = .053$, and sources, $F(1, 1396) = 4.15$, $p = .04$, $\eta_p^2 = .003$, but the interaction was not, $F(1, 1396) = .62$ $p = .43$, $\eta_p^2 = .000$. The reasons for credibility varied with condition. Table 3 shows the frequency of the reasons for credibility that the participants choose. The author's status was selected as a reason for credibility more often for texts by a layperson than an expert, as in observed in Experiment 1. Moreover, more participants were convinced the text by the expert compared to the layperson. Thus, the effects of source information seemed to be stronger in Experiment 2 than Experiment 1.

Intra-text comprehension. McDonald's (1999) omega for the test scores were 0.50 and 0.63 for negative and positive texts, respectively. An extreme low correlation was observed for one item in negative texts ($r = .06$; rs = .28 to .54 for the other items). Because the exclusion of the item did not change the results of statistical tests, only results that included all items were reported below. For positive texts, no item greatly increased the value if dropped and all items correlated similarly with each other (rs = .39 to .51). The mean scores on intra-text questions are displayed in Fig. 4. All means were more than chance level (.50), in the cases of positive texts, $t(179) = 15.69, p < .001$ for expert-expert, $t(168) = 14.25$, $p < .001$ for expert-layperson, $t(177) = 15.59$, $p < .001$ for layperson-expert, and $t(162) = 13.05$, $p <$ 001 for layperson-layperson conditions; in the cases of negative texts, $t(171) = 26.70$, $p < .001$ for expert-expert, $t(182) = 24.78$, $p < .001$ for expert-layperson, $t(174) = 22.19$, $p < .001$ for layperson-expert, and $t(179) = 25.42$, $p < .001$ for layperson-layperson conditions. A 2 (opinion) × 2 (first-source information) × 2 (second-source information) ANOVA was conducted. Overall, the strongest effect was opinion, $F(1, 1392) = 93.88$, $p < .01$, $\eta_p^2 = .063$, suggesting superior comprehension for texts with negative opinions. The apparent pattern suggested a 2-way interaction, although this pattern was only marginally significant, $F(1, 1392) = 2.88$, $p = .09$, $\eta_p^2 = .002$. Therefore, the effects of expert information appeared to be weak but in the same direction as those in Experiment 1, at least for negative opinions.

Inter-text comprehension. McDonald's (1999) omega for the test scores were 0.65 and 0.69 for negative and positive texts, respectively. Low correlations were observed for two items in negative texts (rs = .13 and .15; rs = .42 to .56 for the other items). Because the exclusion of the items did not change the results of statistical tests, only results that included all items were reported below. For positive texts, no item greatly increased the value if dropped and all items correlated similarly with each other (rs = .36 to .52). Performance on integration is displayed in Fig. 5. All means were more than chance level (.50), in the cases of positive texts, $t(179) = 8.19, p < .001$ for expert-expert, $t(168) = 5.68$, $p < .001$ for expert-layperson, $t(177) = 8.57$, $p < .001$ for layperson-expert, and

Table 3. Frequencies of reasons for credibility and results of chi-square test in Experiment 2

Reasons	Text	Expert-expert	Expert-layperson	Layperson-expert	Layperson-layperson	Chi-squared	*p* value
Positive texts							
The text is convincing.	1st text	48 (27%)	35 (21%)	16 (9%)	29 (18%)	16.56	<.001
	2nd text	58 (32%)	45 (27%)	37 (21%)	41 (25%)	5.50	.14
The idea is close to your own one.	1st text	28 (16%)	25 (15%)	29 (16%)	28 (17%)	0.33	.95
	2nd text	25 (14%)	24 (14%)	21 (21%)	22 (13%)	0.43	.93
The author is knowlegeable.	1st text	43 (24%)	50 (30%)	42 (24%)	39 (24%)	1.49	.68
	2nd text	50 (28%)	38 (22%)	55 (31%)	43 (26%)	3.63	.30
The author is a “professor” or “general citizen”.	1st text	30 (17%)	25 (15%)	51 (29%)	39 (24%)	10.78	.01
	2nd text	26 (14%)	35 (21%)	44 (25%)	48 (29%)	7.55	.06
Others	1st text	56 (31%)	55 (33%)	53 (30%)	44 (27%)	1.73	.63
	2nd text	49 (27%)	45 (27%)	50 (28%)	36 (22%)	2.71	.44
n		180	169	178	163		
Negative texts							
The text is convincing.	1st text	57 (33%)	50 (27%)	30 (17%)	38 (21%)	9.98	.02
	2nd text	75 (44%)	66 (36%)	56 (32%)	53 (29%)	4.81	.19
The idea is close to your own one.	1st text	57 (33%)	51 (28%)	42 (24%)	44 (24%)	2.91	.41
	2nd text	38 (22%)	45 (25%)	41 (23%)	33 (18%)	1.96	.58
The author is knowlegeable.	1st text	48 (28%)	54 (30%)	50 (29%)	58 (32%)	1.12	.77
	2nd text	55 (32%)	51 (28%)	62 (35%)	64 (36%)	1.90	.59
The author is a “professor” or “general citizen”.	1st text	26 (15%)	23 (13%)	46 (26%)	49 (27%)	14.94	.002
	2nd text	26 (15%)	40 (22%)	37 (21%)	44 (24%)	4.86	.18
Others	1st text	32 (19%)	38 (21%)	31 (18%)	30 (17%)	1.18	.76
	2nd text	31 (18%)	29 (16%)	24 (14%)	23 (13%)	1.67	.64
n		172	183	175	180		

$t(162) = 5.40$, $p < 001$ for layperson-layperson conditions; in the cases of negative texts, $t(171) = 18.98$, $p < .001$ for expert-expert, $t(182) = 18.15$, $p < .001$ for expert-layperson, $t(174) = 20.30$, $p < .001$ for layperson-expert, and $t(179) = 19.40$, $p < 001$ for layperson-layperson conditions. Similar to the intra-text questions, the participants showed superior

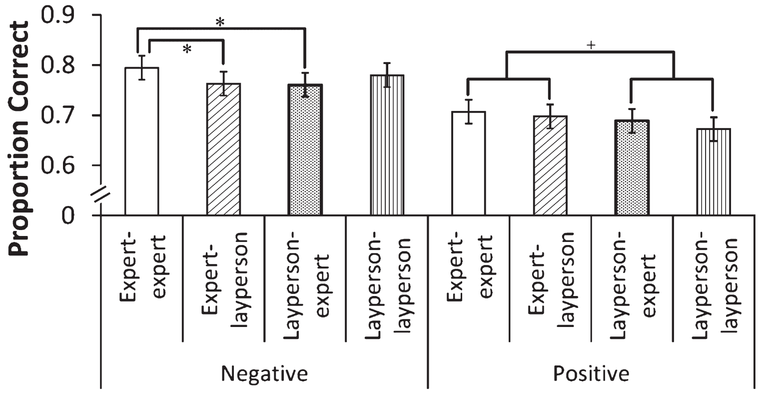

Fig. 4. Mean scores on the intra-text questions for the non-controversial situation (Experiment 2). One group read two negative texts on GM food, and another group read two positive texts. Each condition differed in terms of the source of information for the first and second texts. Error bars indicate 95% confidence intervals. * $p < .05$, $^{+}p < .10$.

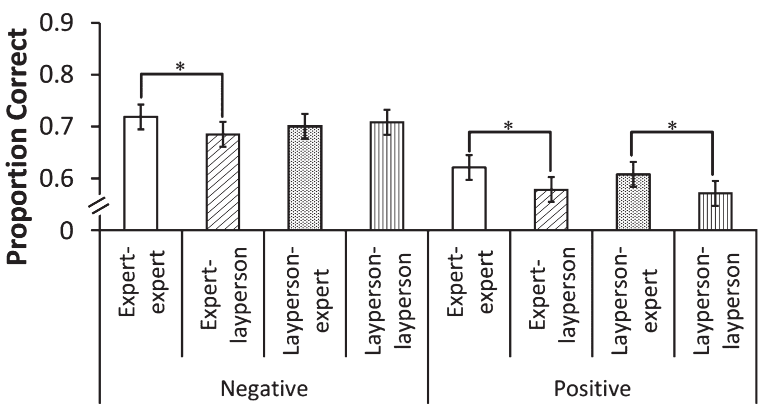

Fig. 5. Mean scores on the inter-text questions for the non-controversial situation (Experiment 2). One group read two negative texts on GM food, and another group read two positive texts. Each condition differed in terms of the source of information for the first and second texts. Error bars indicate 95% confidence intervals. * $p < .05$.

performance for negative texts compared to positive ones, $F(1, 1392) = 158.50$, $p < .001$, $\eta_p^2 = .102$. The second-source factor also reached conventional significance, $F(1, 1392) = 9.23$, $p = .002$, $\eta_p^2 = .006$, suggesting that presenting expert information as the second text encouraged the participants to integrate more information from both texts, even if the valence of the opinion was already familiar. Finally, both gender and participant age were weakly related to intra- and inter-text comprehension. Correlations among them were small ($|r| < .03$).

Discussion

In Experiment 2, the effects of source on intra- and inter-comprehension were weak compared to those in Experiment 1. Thus, the presence of conflicting opinions contributed to the effects of source information to a certain extent, but did not eliminate the effects. This is not only consistent with the discrepancy-induced source comprehension hypothesis (Braasch et al., 2012), but also extends the theory. For example, the effects of intra-text comprehension were found in only the expert-expert source condition when both texts presented negative opinions toward GM foods. This condition is thought to indicate that all experts agree that GM foods are dangerous. In addition to experts' consensus, the opinion that GM foods are dangerous will be in accord with common sense. Thus, people might be likely to trust experts in such an "ideal" condition without discrepancy. For inter-text comprehension, the participants appeared to integrate information from an expert when the expert's text was provided after another text. This pattern was similar to that in Experiment 1, suggesting that expert information was effective to integration across different texts. This may be because expert information appealed to the participants' common sense.

General Discussion

This study suggests that source information affects both intra- and inter-text comprehension. The same texts that were associated with different author information were encoded and integrated differently. Our first research question was, "Does expert information facilitate intra-text comprehension better than layperson information?" The results of Experiments 1 and 2 were consistent with the assumption that an expert source is superior in intra-text comprehension. This superiority was clearer in the presence of conflicting opinions (Experiment 1) than common opinions (Experiment 2). Our second research question was, "Does the status of source information affect inter-text comprehension?" A number of answers were possible. Later expert information was more integrated with other information than a layperson source (Experiment 1, 2).

The present results suggest that adding texts with author information affected comprehension. The results support and extend the results of Strømsø et al. (2010) demonstrating that source information contributed to intra- and inter-text comprehension. Simplified source information in the present study was sufficient to influence some part of comprehension, at least. Moreover, it is important to show that the status of authors is an actual factor for comprehension. People seem to value expert information, even regarding controversial topics such as GM foods (Brem et al., 2001; Ferguson et al., 2009; cf. Löfstedt & Renn, 1997).

The superiority of an expert source in intra-text comprehension was stronger when the texts had conflicting opinions versus when they had similar opinions. One reason is that people want to actively select information based on sources in complex situations (Scharrer, Britt, et al., 2012; Scharrer, Bromme, et al., 2012). Thus, an environment consisting of only common opinions may make people feel that it is less important to actively seek additional information. In more realistic conflicting situations, people actively seek additional information in order to make appropriate judgments, which results in stronger source effects.

For inter-text comprehension, the order of information played a critical role in integrating information across different texts. When the participants received expert information first, they agreed with it and tended not to accept the second, conflicting opinion. Interestingly, the participants did not challenge the contents of the second opinion, and they did not integrate it with their knowledge. This is consistent with the integration difficulty observed in previous research (Johnson & Seifert, 1994, 1998; Seifert, 2002). However, another interpretation is possible. When a layperson's opinion is presented first, the reverse process occurs: people who receive information from a layperson tend not to be satisfied with it and continue to seek additional information. The exact mechanism for "locking-in" expert information requires further investigation.

The source effects observed in the present study did not depend on participants' attitude to genetically modified organism (GMO) or credibility for the texts. This generality of source effects by author's specialty has some practical implications. The potential influence irrespective of audience's attitude is useful for science communication to the public. Even the people who suspects public information may accept some parts of opinions by expert (Brem et al., 2001; Ferguson et al., 2009). On the other hand, the fact that credibility judgment is independent from other factors may indicate that people are blind to the content of text. Further investigation of mechanism of the source effect is an important issue of future research.

The sample in this study included a broad range of ages and a variety of occupations. Although these demographics provided a fair representation of the general public, the criterion of having a relatively strong academic background and access to the Internet was not representative. The participants in this study, therefore, were above-average readers. To improve the generalizability of the current results, it is important to extend the research to populations with more diverse educational backgrounds. In addition, further investigation that addresses other types of texts and topics is necessary.

Another limitation should be mentioned for the present experimental paradigm. The participants summarized each text and judged its author's credibility when they finished reading it. Thus, some difference from the first text (e.g., the source and opinion) may be emphasized and influence any effects of reading the second text. In addition, asking an attitude question immediately before reading may influence participants' memory and comprehension. In such a circumstance, they can be likely to persist in their previous attitude in the face of disconfirmation (Lord, Ross, & Lepper, 1979). The mechanism of source effects observed in the present study need to be examined in more detail.

The findings of this study imply that explicit source information has a viable effect on the understanding of scientific information and sometimes interferes with the integration of information from other sources. The size of the effects were small by conventional statistical standards. However, there was about a 5% difference for mean intra-text scores between expert-first and layperson-first conditions (Experiment 1). If the 5% difference in the mean scores represents the 5% of the public who misunderstand science information, this percentage is considerable enough to not exclude the possible effects of source information. Therefore, we believe that communication about risks will be more effective if explicit labels identifying the source as expert are attached to the information. However, because expert source information can block integration with information from other sources, information labelled as "by experts" should be treated carefully.

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