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The Impact of the 2011 East Japan Earthquake and Subsequent Nuclear Accident: A Preliminary Interview Study among South Korean People[1]

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The present study examined the impact of the 2011 East Japan earthquake and subsequent nuclear accident on people in a neighboring country using a semi-structured interview. Twenty Korean women participated in 5-member group interview sessions conducted in Seoul regarding changes in attitudes and behaviors following the 2011 disasters. The results showed that most participants were afraid of radiation exposure from Fukushima. More than half the participants expressed a negative reaction to having a nuclear power plant in their country. Some participants stopped purchasing cosmetic products and food from Japan. In addition, almost all participants estimated that panic would occur in a future national emergency. These reactions indicated anxiety and mistrust about the risk of exposure to radiation in South Korea even one year after the events. We believe that the occurrence of a nuclear accident after a great earthquake and tsunami and repeated coverage of the event by the media reinforced the terrible nature of the events which led to prolonging residents' fear and anxiety.

Key words: Fukushima nuclear accident, fear and anxiety, acceptance of nuclear power, rebound effect of attitude, panic myth

Introduction

The 2011 East Japan earthquake and subsequent nuclear accident (2011 Japan disasters) are considered one of the world's largest disasters. After the events, tons of goods, encouraging messages and even volunteers flowed into Japan to support the recovery of the affected areas. However, some reactions outside the nation shook the Japanese economy and slowed the process of recovery in Japan. For instance, the number of foreign visitors to Japan fell compared to the previous year (Japan Tourism Agency, 2011). Several countries also prohibited the importation of water and agricultural products from Japan (Chibber, 2012, February 21). These reactions imply that the 2011 East Japan disaster and subsequent nuclear accident had a strong impact not only on people in Japan, but also on people living in other countries.

In research on the effects of a single dramatic disaster on people in distant countries, the

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most famous case study is the nuclear accident in 1986 at Chernobyl, Ukraine. Several opinion polls reported that there was a large increase in risk perception of nuclear power, antinuclear behavioral intentions, reduction of pronuclear attitudes and lack of trust in authorities after the incident among people who lived far away from the accident location, such as in Western Europe, Asia and the USA (Eiser, Spears & Webley, 1989; McDaniels, 1988; Midden & Verplanken, 1990; Peters, Albrecht, Hennen & Stegelmann, 1990; Rankin, Melber, Overcast & Nealey, 1981; Renn, 1990; Sjöberg & Drottz, 1987; Sjöberg & Sjöberg, 1990; Tsunoda, 2001). It can then be inferred that despite the small number of nuclear accidents that have occurred, their impact on risk perception of the whole nuclear industry is significant. However, these changes in attitudes in other countries after a single accident are expected to rebound. In other words, these attitudes tend to revert to pre-accident patterns over time (Rosa, & Dunlap, 1994). It is possible that the attitude about nuclear energy that was reported after the accident may not be based on stable cognitive representation, and may be indicative of "pseudo-opinions", opinions that did not exist prior to the time that a question was asked but fluctuate in a short period of time depending on the current situation (Lindell & Perry, 1990; Prati & Zani, 2012).

Furthermore, the media also influence people's perception of the disaster by repeatedly portraying images of the catastrophe, which causes increased frequency of thoughts about the disaster (Feldman & Lindell, 1989). In most stories, human behavior in the media and movies is somehow irrational. The story that was shown in the media encourages people to think that something similar will happen in a real-life situation. This phenomenon is the so-called panic myth (Clarke, 2002; Perry & Lindell, 2003; McEntire, 2006). As a consequence of these two functions of media, people imagine hazardous outcomes during emergency situations that bear no relationship to real outcomes.

A previous study on the impact of the 2011 East Japan disasters reviewed a similar tendency to what was found from at Chernobyl. Goodfellow, Williams and Azapagic (2011) pointed out that many countries were re-evaluating their nuclear plan and considering alternative energy. In fact, Visschers and Siegrist (2013) reported that in Switzerland, the acceptance and perception of nuclear power as well as trust related to nuclear power stations were more negative after the incident. Also, Kessides (2012) showed that 62% of the respondents to a survey carried out in 24 countries including France, UK, USA, Japan and Spain opposed nuclear power generation. Twenty-six percent reported that they had changed their opinion due to the events that occurred at the Fukushima Daiichi power plant. Currently, only a few countries, including China, South Korea and India, have major nuclear power construction projects (Kessides, 2012). For the effects on people's lifestyle, our previous interview study was conducted among Taiwanese citizens (Wiwattanapantuwong, Lee, Honda & Abe, 2011). The results obtained seven months after the incidents indicated that the Taiwanese people were still suspicious about the level of radiation in the area and the remaining risk from the nuclear accident. Specifically, 69% of the participants were worried about continuing radiation from Fukushima, 42% stopped purchasing imported goods from Japan, 96% felt reluctant to visit Japan and 52%

were concerned about a nuclear accident occurring in Taiwan. We can conjecture that the Fukushima nuclear accidents also generated anxiety about the radiation plume in neighboring countries and that the level of mistrust of Japan following the accidents seems to be unaffected by the distance of these countries from Japan.

Even though we found that responses among Taiwanese citizens were similar to those in other studies, it was unclear whether there was a similar change in attitude among people in other nations, especially South Korea. This country is located very close to Japan and has plans to develop a nuclear power industry. From the reports of the World Energy Council (2012), South Korea ranks high in nuclear energy use and is one of the countries that continues to use and build nuclear power plants after the Fukushima nuclear accident. It is therefore essential to examine how South Korean people felt after the 2011 East Japan disasters in regard to the perception of risks and benefits of nuclear power, and also the influence of the evidence on their personal lives. Due to the proximity of the two countries, the people of South Korea and Japan have interacted for thousands of years. Even now, South Korea is an important economic partner with Japan, with large numbers of visitors and goods imported from Japan (Japan Tourism Agency, 2011). As a continuation of our previous study that reported the change of attitudes toward the Fukushima nuclear accident, visiting Japan and buying products made from Japan 7 months after the disaster, we conducted an interview study in South Korea, one year after the 2011 East Japan events.

The present study involved a group of semi-structured interviews of South Korean women living in Seoul. The reason that we selected women in Seoul as participants was because Seoul is a center of economic activity and education in South Korea. People are capable of and have an interest in accessing information beyond that provided by the government of their own country. Furthermore, compared to men, women tend to have a greater concern about health and nuclear issues. (Newcomb, 1986; Rabow, Hernandez & Newcomb, 1990). Additionally, this type of interview was applicable to the study because it is time-efficient and we could obtain detailed answers from the participants. Participants also had an opportunity to confirm whether they understood the questions and the researchers were able to provide additional questions for obscure responses (Krueger, 2002).

The purpose of the study was to examine perceptions about the following topics: the 2011 Japan disasters, anxiety regarding radiation exposure from the air, necessity and safety of nuclear power in their own country, intention to buy products made in Japan, behavior of Japanese refugees, disaster response of citizens in their own country and preparedness strategies perceived as essential. The results and implications from the present study will be used as a basis for further rigorous research in this area. In particular, our study will provide additional information about the impact of the 2011 East Japan earthquake and subsequent nuclear accident on people in a neighboring country.

Method

Participants

A total of 20 South Korean women who were living in Seoul participated in the study. The age range was from 21 to 38 years old (mean: 24.8 years, SD: 5.0 years). Fourteen participants were students (three were graduate students) and the others had various occupations, such as writer, programmer and religious studies teacher.

Interview agenda

The interview agenda was developed from our previous study, which was conducted in Taiwan (Wiwattanapantuwong et al., 2011). Participants were asked the following questions:

1) Impressions about the 2011 East Japan disaster: "Have you ever heard about the disaster in East Japan, 2011?" and "How do you feel about these events?"
2) Anxiety about radiation exposure: "When you first heard about the nuclear accident, did you worry that radiation would spread to South Korea?" and "What are your recent thoughts about the spread of radiation?"
3) Perception of necessity and safety of nuclear power: "What do you think of nuclear power since the nuclear accident in Japan?"; "How do you think about the safety of nuclear power?"; "Is nuclear power necessary for South Korea?" and "Have your perceptions changed since the nuclear disaster in Japan?"
4) Intention to purchase Japanese products: "Do you often purchase industrial products or fresh food produced in Japan?" and "If yes, did you change your shopping behavior concerning Japanese products since the nuclear accident?"
5) Perceptions of the behavior of Japanese refugees and predictions of citizens' responses to the disaster: "Regarding the 2011 disaster, what do you think about the evacuation of Japanese people?" and "If an emergency occurred in South Korea, how do you think people would respond to it?"
6) Preparedness strategies applied and needed: "After the 2011 disaster, have you made any alternative preparations for a potential disaster?" and "If yes, please specify what you would do"; "What kinds of preparation for disaster do you think are necessary?" and "Please give specific examples."

Procedure

Participants were contacted through a network of personal acquaintances (one researcher recruited people she knew and from whom she could subsequently request further contacts). The interviews were conducted in March 2012. Participants were asked for consent to participate in the 1- to 2-hour interview. Then, they were interviewed in groups of five participants. The second author was the interview leader. She was a native speaker of Korean and was trained in the interview process beforehand. At the time of the interview, the third and fourth authors supervised and provided additional questions to clarify answers. Sessions

took around 1.5 hours. Each participant received 20,000 won for volunteering her time. The study was approved by the local ethics committee of the Graduate School of Arts and Letters at Tohoku University. We obtained permission for recording the conversations and informed consent from each participant.

Analysis

The recorded interview files were transcribed. Then, the keywords that related to the question were extracted and similar keywords were grouped. The number of participants who responded for each keyword was counted and the statements were reported as examples of that category. Also, the participant's code is noted after each statement (e.g., P1, P2).

Results

Impressions of the 2011 East Japan disaster

Initially, 19 participants had heard about the disaster from a secondary source, such as television or the Internet. One participant was in Japan at the time of the disaster. Their emotional responses toward the events included worry (n = 7): "*I heard about it from the news. At first I was shocked. I was worried about all the people in the affected areas*" (P2). "*When I saw the news, I was worried about my friends and relatives who were in Japan. I thought that Japan was going to face a major turning point*" (P4). Five people mentioned shock: *"I couldn't believe it. It didn't seem real. It looked like the world was coming to an end"* (P14). *"At first, I thought, it wasn't unusual because Japan has a lot of earthquakes. But this was extraordinary. I didn't believe that it had happened"* (P6). Three people expressed sadness: *"Since there was an earthquake in China, and now in Japan. I was very sad"* (P18). *"At first, I felt nothing, but when I read about the news [of the disaster], I cried. It was a sad story"* (P17). Another response was guilt: *"It was a frightening event. I cancelled my travel plans afterward because I felt guilty about the disaster victims"* (P10).

Anxiety about radiation exposure

Fifteen responses revealed the participants' anxiety about the radiation plume that came from Fukushima, whereas other participants (n = 5) said they did not worry about it. Of those 15 who worried about the radiation plume, only two changed their attitude to a more positive one after one year had passed. The reasons for anxiety that were mentioned included the long half-life of the radioisotopes (n = 2): *"Because radiation is long lasting, I still believe it is dangerous"* (P7). Another reason is related to the proximity between Japan and South Korea: *"South Korea is close to Japan. So I am still afraid"* (P16). Or they stated their fear of the effects of radiation: *"I am so afraid of the radiation. It was very dangerous. So I am afraid of nuclear power, too"* (P14).

Perception of necessity and safety of nuclear power

Thirteen responses expressed the belief that nuclear power plants were dangerous. The main reason mentioned was serious health effects: *"We need to investigate it [radiation effects on health] more thoroughly. In fact, I was afraid. Time passes and we don't understand what will happen to our body"* (P1). Despite that, three participants felt anxiety but did not object to nuclear power. The reasons were because of governmental decisions: *"Here, people always solve the problem after it has already happened. I don't know what to do. So I have no choice but to believe [our government]"* (P4); cost: *"I do not believe that it is safe in our country. But it may cost a huge amount of money to close all the plants. I think we have no choice but to continue it"* (P7) and the lack of alternative energy: *"I think because our country has no alternative energy we may have no choice"* (P9). One response expressed confidence in the safety of nuclear plants because South Korea has a low risk of earthquake: *"Since we can believe that South Korea is safe from earthquakes, I think there is no need to worry about a nuclear accident here"* (P12).

Intention to purchase Japanese products

Eleven participants answered that they would continue to buy electronic goods and stationery; no one disagreed. However, for products that come in contact with the body, such as cosmetics, food and clothing, responses were divided. There were four responses that indicated an intention to continue buying cosmetics, four responses to continue buying food and one response to continue buying clothing. In contrast, there were five responses indicating an intention to stop purchasing cosmetics, six responses regarding the intention to stop buying food and one response about the intention to stop buying clothing.

Perceptions of the behavior of Japanese refugees and predictions of citizens' responses to the disaster

All participants mentioned that refugee activities in Japan were calm and systematic. However, 16 responses predicted that the South Korean people would not stay calm during a disastrous event. In support, they mentioned the lack of experience with large-scale earthquakes ($n = 5$): *"Because buildings in South Korea weren't designed to endure earthquakes, it could be difficult to get out of a building easily"* (P20); *"I think earthquakes might not occur in the near future. Even so, we lack experience with earthquakes, so I think it could be difficult"* (P4); national characteristics, i.e., impatient and always in rush ($n = 4$): *"I think Korean people would not be systematic. They have no sense of queuing. Not only that, they don't know evacuation routes so there is likely to be confusion"* (P1); *"The South Korean people are always rushing. So, I think it is impossible that people will stay calm"* (P5); and lack of education in disaster management ($n = 2$): *"We don't know how to prepare for an earthquake. It might be because we have not experienced a strong earthquake for a long time. No one has taught us what to do. Thus, I think it would be difficult"* (P16). Other responses expressed suspicions and lack of confidence in the government information on risk and the apparent lack of a person directing the emergency response (one response each).

Preparedness strategies applied and needed

Of the preparedness activities that people used after the 2011 events, there were five who confirmed the location of emergency kits in public places, four located emergency exits, two watched news reports and searched for more information about the disaster on the Internet and one each moved heavy luggage down to a lower position, increased attention to emergency preparedness, prepared nonperishable foods and always carried a passport. Furthermore, three participants mentioned the need for more effective earthquake prevention standards in construction. Only one participant said that she made no changes as a result of the events.

Discussion

This study examined the impact of the 2011 East Japan earthquake and subsequent nuclear accident on a sample of women living in Seoul, South Korea, using a semi-structured interview. Our results showed that more than half the participants reported anxiety about the radiation plume and mistrust about the safety of nuclear power in their own country. The results matched surveys after the Chernobyl nuclear accident (Eiser et al., 1989; McDaniels, 1988; Midden & Verplanken, 1990; Peters et al., 1990; Rankin et al., 1981; Renn, 1990; Sjöberg & Drottz, 1987; Sjöberg & Sjöberg, 1990; Tsunoda, 2001) and the study of the Fukushima accident's effects in European countries (Kessides, 2012; Visschers et al., 2013) and in Taiwan (Wiwattanapantuwong et al., 2011). People discussed how fearful they were of radiation but did not talk much about the possibility of the occurrence of a nuclear accident in their own country. Our study highlights the finding that reminding people of the danger of radiation creates more fear than mentioning the possibility of accidents at nuclear power plants. However, some people considered the accident to be unique and not likely to happen again (Midden & Verplanken, 1990).

Our study did not find a "rebound effect" in attitude (Rosa, & Dunlap, 1994) about risk perception or attitudes about nuclear power. In spite of the fact that South Korea still found food imported from Japan to be contaminated with radiation (Kim, 2012, June 19), the rebound effect of attitude is reflected in the shopping behavior of women living in Seoul. The only products that were affected were those that were applied to the body or ingested. It is possible to explain that the Fukushima nuclear accident was considered as a series of disasters after the strong earthquake and tsunami rather than a single event. As a result, the vivid images of people suffering from the disasters were implanted in people's minds and created a stronger impression than did images from Chernobyl.

The altruism exhibited by Japanese people in refugee centers was compared with that of South Koreans in the present study. Participants had negative opinions about the orderly evacuation of people in their country. Japanese evacuation behavior was praised by people from many countries (Takeda, 2011, April 25). However, according to the "panic myth" (Clarke, 2002; Perry & Lindell, 2003; McEntire, 2006) due to the influence of the media, people naturally focus on hazards when there is an emergency situation. Thus, these thoughts about

hazard might come from the imagination. Also, many studies argued that disaster experience (Norris & Murrell, 1988), disaster education (Tanaka, 2005) and cultural factors (Palm, 1998) are key determinants in creating effective disaster preparedness strategies. Additionally, the Japan disaster improved the awareness of how to deal with emergency situations. This example should help educate others about how to respond in an emergency to garner the confidence of the people.

Several limitations should be considered regarding the present findings. We did not have information about pre-disaster attitudes of the participants.Futhermore, our results were obtained from a limited sample and area in South Korea. Therefore, the influence of gender (Palm & Carroll, 1998), age (Cohen & Poulshock, 1977; Bolin & Klenow, 1982-1983) and other social factors could not be clarified. Even so, using interviews helped us gather open-ended responses, which cannot be statistically evaluated. Ideally, a larger sample containing a demographically representative mix of gender and age groups with participants from both rural and urban areas and high and low socioeconomic groups would be a valuable contribution to the literature, making it possible to make worthwhile generalizations about South Koreans' affective, cognitive and behavioral responses to the 2011 Japanese disaster.

In conclusion, this study indicates that South Korean people's attitudes and behaviors were affected by the 2011 Japan disaster, especially in the perception of the radiation plume, the acceptance of nuclear power and shopping behavior. Importantly, one year after the event the purchase of goods made in Japan returned to normal despite continued fear of the radiation plume and the acceptance of nuclear power. One suggestion to lessen the negative impact from disasters is to replace images that can cause trauma with positive images. For instance, Japanese and other national governments should portray images of recovery in Japan together with efforts by the Japanese government to improve safety in Japan and the safety of Japanese exports.

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Shipley and Kellman (1992) unified these two spatial parameters into one, which was later referred to as *support ratio* by Lesher and Mingolla (1993). Support ratio is defined as the ratio of the diameter of an inducing element to the separation distance between the centers of the two nearest inducing elements. More generally, it is defined as the ratio between the physically specified contour, that is, the contour specified by luminance gradient, to the total length of the contour. Note that support ratio is independent of retinal size of the stimulus.

Kellman and Shipley (1991) and Shipley and Kellman (1992, Experiment 1) found that perceived magnitude of illusory contours for the stimuli of approximately equal support ratio was quite similar to one another even though the stimuli differed from one another in both the separation length between the centers of the two nearest inducing elements and the diameter of an inducing element. They claimed that not the absolute retinal size but support ratio of the stimulus was the main spatial determinant of perceived magnitude of illusory contours. Scale invariance of illusory contours held over the range of support ratio from 0.29 to 0.80.

Shipley and Kellman (1992), however, obtained different results in their Experiments 2 and 3. They presented the observers families of congruent figures with various support ratios as stimuli. They found that perceived magnitude of illusory contours was scale invariant at support ratios of 0.5 and 0.8 and that it was larger for larger retinal size of the stimulus at support ratio of 0.3. This result was, however, inconsistent with the results of two studies using stimuli of lower support ratios. Dumais and Bradley (1976) reported that perceived magnitude of illusory contours was larger for smaller retinal size of the stimulus of support ratio fixed at 0.38. Ringach and Shapley (1996) reported that scale invariance held for illusory contours at support ratio of 0.25.

Depth stratification and brightness enhancement are also the attributes of illusory figures (Kanizsa, 1979; Lesher, 1995). To our knowledge, only Bradley and Dumais (1984) investigated the effect of support ratio on the perceived magnitude of depth stratification using families of congruent figures with various support ratios as stimuli. They reported that at support ratio of 0.38 perceived magnitude of depth stratification was larger for the stimulus of smaller retinal size. No authors investigated the effect of support ratio on perceived magnitude of brightness enhancement using families of congruent figures with various support ratios as stimuli. So further investigation is needed to know whether the perception of illusory figures is scale invariant.

The aim of the present study was to investigate the effects of retinal size of the stimulus of fixed support ratio on perceived magnitude of illusory contours, brightness enhancement, and depth stratification in illusory figures to know whether the perception of illusory figures is scale invariant. In the present study, we measured perceived magnitude of contour clarity, apparent brightness, and apparent depth by the method of magnitude estimation using families of congruent figures at support ratios of 0.20, 0.40, and 0.80 as stimuli.

Method

Observers

Seventy-eight undergraduates (15 male and 63 female) with a mean age of 21.4 (SD = 2.23) years participated in the experiment as observers. They were familiar with illusory figures but were not aware of the purpose of the experiment. All had normal or corrected-to-normal visual acuity. Informed consent was received from each observer after the procedure of the experiment had been explained.

Apparatus and stimuli

The stimuli were presented on a 17-inch CRT monitor (Nanao FlexScan E53F). The observers viewed the stimuli binocularly and freely at a distance of 57.3 cm.

The stimulus was the Kanizsa figure. It consisted of four notched black disks, that is, the inducing elements, which were placed in order for the area cornered by them to form an imaginary square.

For the reference stimulus, the separation length between the centers of the two nearest inducing elements and the diameter of an inducing element were fixed at 2.30 deg and 1.40 deg, respectively.

Figure 1 shows the two sets of the test stimulus used in the present experiment. In the variable separation set, the diameter of an inducing element of the stimulus was fixed at 1.40 deg, and the separation length between the centers of the two nearest inducing elements was set at 1.75, 3.50, and 7.00 deg, at which the support ratios were 0.80, 0.40, and 0.20,

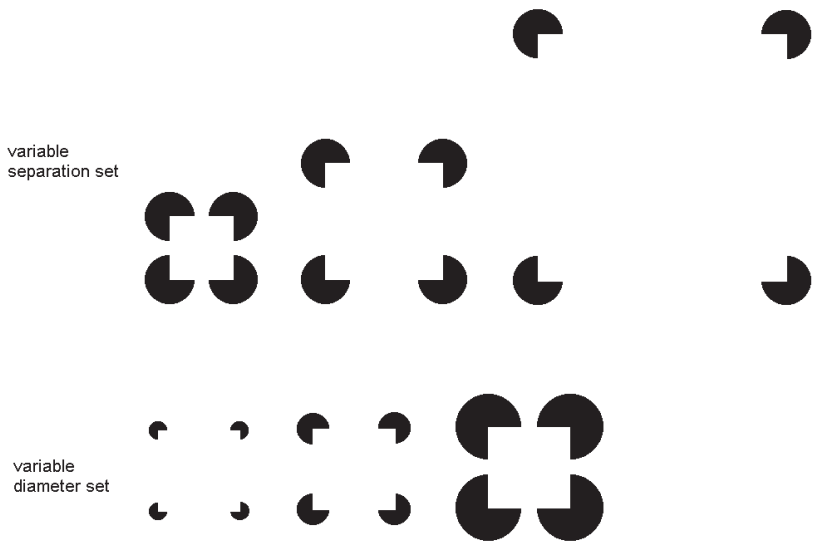

Figure 1. Two sets of the test stimulus in the present experiment. The upper row shows the variable separation set and the lower row shows the variable diameter set.

respectively. In the variable diameter set, the separation length between the centers of the two nearest inducing elements of the stimulus was fixed at 2.30 deg, and the diameter of an inducing element was set at 0.46, 0.92, and 1.84 deg, at which the support ratios were 0.20, 0.40, and 0.80, respectively.

The reference stimulus and the test stimulus were presented 16 deg horizontally apart between the centers of the imaginary square on the gray background of 32 × 20 deg. The test stimulus was presented right to or left to the reference stimulus at random between observers. The luminance of the inducing elements was 18.1 cd/m^2 and that of the background was 81.5 cd/m^2.

Procedure

Twenty-six observers were randomly assigned to one of three groups. In each group, measurements were made with only one attribute of illusory figures.

Perceived magnitude of illusory contours, brightness enhancement, and depth stratification was measured as magnitude of contour clarity, apparent brightness, and apparent depth, respectively. They were measured by the method of magnitude estimation. Perceived magnitude of the attributes of illusory figures for the reference stimulus was called 100. The observer was asked to report perceived magnitude of the attribute by assigning a number to the test stimulus relative to that for the reference stimulus.

Test stimuli in the variable separation set and in the variable diameter set were intermixed, and each test stimulus was presented three times in a random order in a session. The session was repeated twice for each observer. So a total of six ratings were made at each combination of attribute and support ratio in each test stimulus set per observer, the mean of which was used for the data analysis. Practice trials were given to each observer before the measurements.

Results

Figure 2 shows the mean rating of perceived magnitude of the attributes of illusory figures as a function of support ratio. The open symbols and the filled ones show the results for the variable separation set and for the variable diameter set, respectively.

A three-way ANOVA showed that there was a significant two-way interaction between support ratio and test stimulus set, $F(2, 150) = 31.23$, $p < .001$. The analysis of simple main effects and multiple comparisons using Ryan's method showed that the variable separation set was larger than the variable diameter set in mean rating at support ratios of 0.20 and 0.40. At support ratios of 0.20 and 0.40 mean ratings for the variable diameter set were as low as on average 49.2 % of those for the variable separation set.

There was also a significant two-way interaction between attribute and test stimulus set, $F(2, 75) = 7.25$, $p = .001$. The analysis of simple main effects showed that the variable separation set was larger than the variable diameter set in mean rating for all the attributes.

These results show that the scale invariance holds at support ratio of as high as 0.80 and

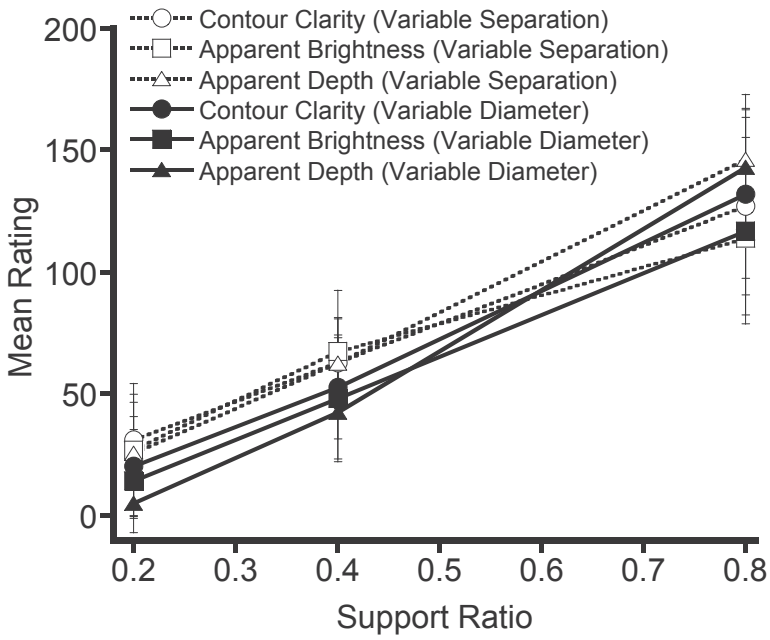

Figure 2. The mean rating of perceived magnitude of the attributes of illusory figures as a function of support ratio.

that it collapses at support ratios of 0.20 and 0.40 for all the attributes.

There was also a significant two-way interaction between support ratio and attribute, $F(4, 150) = 4.65$, $p = .001$. The analysis of simple main effects and multiple comparisons using Ryan's method showed that perceived magnitude of illusory contours, brightness enhancement, and depth stratification was increased by the increase of support ratio, and that depth stratification was larger than illusory contours and brightness enhancement in mean rating at support ratio of 0.80. The result that perceived magnitude of illusory contours was increased by the increase of support ratio is consistent with the results of previous studies (Banton & Levi, 1992; Kellman & Shipley, 1991; Liinasuo et al., 1997; Pillow & Rubin, 2002; Purghé & Russo, 1999; Shipley & Kellman, 1992; Tanaka, 1985; Watanabe & Oyama, 1988).

Discussion

The aim of the present study was to investigate the effects of retinal size of the stimulus of fixed support ratio on perceived magnitude of the three attributes of illusory figures, that is, illusory contours, brightness enhancement, and depth stratification, to know whether the perception of illusory figures is scale invariant. We found that at support ratio of 0.80 perceived magnitude of all the attributes was independent of retinal size of the stimulus, and that at support ratios of 0.20 and 0.40 it was larger for the variable separation set than for

the variable diameter set. This result indicates that the perception of illusory figures is scale invariant only at higher support ratios such as 0.80, and that it is facilitated by larger retinal size of the stimulus at lower support ratios such as 0.2 or 0.4.

This result is consistent with the results of Experiments 2 and 3 of Shipley and Kellman (1992) that when support ratio of the stimulus was held constant perceived magnitude of illusory contours was determined solely by support ratio at and higher than 0.5 and that it was larger for larger retinal size of the stimulus at support ratios lower than 0.5. Ringach and Shapley (1996), however, reported that scale invariance held for illusory contours at support ratio of as low as 0.25. The inconsistency in result at lower support ratios between Shipley and Kellman (1992)'s Experiments 2 and 3 as well as the present study and Ringach and Shapley (1996) seems to be attributed to the difference in observer's task. In order to estimate the magnitude of illusory contours, rating task was used in the present study and Shipley and Kellman (1992), whereas shape-discrimination task in Ringach and Shapley (1996). Illusory contour interpolation reported in Ringach and Shapley (1996) occurred with no reduction in strength over retinal distances of at least 13.2 deg, which is much longer than that predicted from the results of experiments using rating task (Purghé & Russo, 1999; Tanaka, 1985; Watanabe & Oyama, 1998). These two tasks might tap different visual interpolation processes, and so might have given inconsistent results.

Mendola et al. (1999) showed that the activation patterns in the lateral occipital complex in human cortex, which is thought to contain neurons with size-invariant receptive fields (Tootell, Mendola, Hadjikhani, Liu, & Dale, 1998), were remarkably consistent across a wide variation in retinal size of the stimulus inducing illusory figures of fixed support ratio of 0.5. This finding provides a neurophysiological support for scale invariance of illusory figure perception at higher support ratios.

Dumais and Bradley (1976) reported that at support ratio of as low as 0.38 perceived magnitude of illusory contours was larger for smaller retinal size of the stimulus, which is inconsistent with the results of the present study and Shipley and Kellman (1992). Shipley and Kellman (1992) speculated that the result of Dumais and Bradley (1976) might have been an artifact due to textured surface, which interfered with illusory contour formation, on the hand-drawn stimulus display that became more noticeable with the stimuli of larger retinal size.

Bradley and Dumais (1984) reported similar result to those of Dumais and Bradley (1976) for perceived magnitude of depth stratification, which is also inconsistent with the result of the present study. Illusory contour formation seems to be a cause of the emergence of depth stratification (Takiura, 2006; Watanabe & Oyama, 1988) so that one can speculate the result of Bradley and Dumais (1984) was also an artifact due to textured surface on the hand-drawn stimulus display.

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Toward Normative Values of Blink Activities for Differences Across Age Groups[1]

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Two experiments were conducted to establish normative values for various measures of endogenous blink activities in each age and gender group, using relatively large samples and similar tasks. The ages of participants in Experiment 1 ranged from 3 months to 3 years and in Experiment 2 from 5 to 93 years. Video recording was performed during quiet resting for the former three age groups and an identical task of video watching was delivered to the latter 11 age groups. The major results were as follows: 1) the youngest infants blink infrequently, increasing gradually until the age of 9–10 years, with no statistical differences for the older age groups, 2) no differences in blink durations of closing, reopening, and total blink were obtained throughout all age groups in Experiment 2, whereas three age groups of infants aged less than 3 years in Experiment 1 showed some differences, and 3) the distribution patterns of blink frequency in each age group were roughly divided into three types.

Key words: endogenous blink, lifelong development, normative values of blink behaviors

Introduction

It is well known that blinks are affected by many kinds of variables, such as cognitive, emotional, arousal, and state variables (Ponder & Kennedy, 1927; Hall & Cusack, 1972; Stern, Walrath, & Goldstein, 1984; Tecce, 2007). There are, however, many inconsistencies in published results (Doughty, 2001). Hall and Cusack (1972) inferred that these inconsistencies resulted from methodological deficits in blink research, such as too short a period of observation. However, other reasons for these inconsistencies, we think, are that sample sizes were too small and the experimental situation and conditions were different. The relatively large sample for this study is required because of the large between-subject differences in blink rates (for example, Bacher & Allen, 2009). In fact, the most reliable data reported previously were based on a large sample of about 50 samples per group (Ponder & Kennedy, 1927; Yamada, Yamasaki, K., & Miyata, 1979; Yamada, Yamasaki, Nakayama, & Miyata, 1980; a series of studies by C. N. Karson in the 1980s, for example: Karson, 1979; Karson, Berman, & Donnelly, 1981, Karson, Burns, LeWitt, Foster, & Newman, 1984). In particular, in the

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developmental study of blinks, few studies were found that were based on a large sample.

One method for understanding the detailed mechanism of blinks and the possible origins of this wide range of inter-individual differences is to describe the ontogenetic developmental course. However, such studies are also very few in number. Some studies have investigated the lifelong development of blink activities from newborns to the elderly (Knorr, 1929; Zametkin, Stevens, & Pittman, 1979; Bentivoglio, Bressman, Cassetta, Carretta, Tonali, & Albasese, 1997) and other studies are concerned with development up to adolescence (Ködding, 1940; Pivik & Dykman, 2004; Bacher & Smootherman, 2004a, 2004b). These studies again present many contradictory findings. The one consistent observation is that blinks are virtually absent at birth and increase rapidly until preadolescence (Sugiyama & Tada, 2010) and adolescence (Zametkin et al., 1979).

The inconsistencies are as follows: 1) difference in age at highest blink rate, 2) the absolute value of number of blinks, and 3) whether or not the levels are maintained throughout adulthood. The peaks are at 20 years old in some data (Knorr, 1929; Zametkin et al., 1979), whereas in others no age differences were found (Norn, 1969; Bentivoglio et al., 1997). The blink rate level is about 16 bpm (blinks per minute) in Zametkin et al. (1979) but about 20 bpm in Bentivoglio et al. (1997). Zametkin et al. (1979) and Bentivoglio et al. (1979) suggested that this peak level is maintained throughout adulthood but Knorr (1929) reported a decrease after 20 years of age to old age. Thus, no standards for blink rate in each age and gender group have been developed. Therefore, one of the purposes of the present study was to establish a tentative standard value of endogenous blink activity in each age or gender group.

Possible reasons why these findings do not agree with each other are as follows: 1) the number of subjects per age group is too small, 2) the duration of data collection is too short; some authors suggest that 3 min may be adequate (Depue, Arbisi, Krauss, Iacono, Leon, Muir, Allen, 1990; Depue, Iacono, Muir, & Arbisi, 1998), while others recommend 5 min (Zaman & Doughty, 1997), 3) the methods for data collection or blink detection are not uniform, 4) conditions under which blinks are sampled differ, 5) the methods for recording and measuring are different, and 6) the criteria for blink identification might be not unified.

As mentioned above, there are large individual differences in blink rate, thus relatively large samples are required (for example, Bacher & Allen, 2009). If the criterion value of the control group is changed from study to study, it is very difficult to compare the data between the control and experimental groups. The experimental conditions under which blinks are sampled are also important (Doughty, 2001), because blinks may be affected strongly by these situations depending on whether subjects are in a hospital, airport, library, and so on. In fact, the earliest study (Ponder & Kennedy, 1927) already identified the importance of sample size and observed gender differences in eye blink rates depending on the conditions of recording situations, i.e., library and streetcar. They observed a shorter inter-blink period (higher blink rates) in men than women in the streetcar but in the reading rooms in libraries those of women were shorter (more frequent) than men. They collected about 50 samples of each gender group, in total over 200 samples, based on their preliminary observation using small

samples. Therefore, to reduce these problems, we conducted our experiment by using relatively large samples and administered the same task to maintain constancy for the experimental conditions. This was possible for all age groups with the exception of infants less than 3 years old.

In previous reports, many studies have pointed out that female subjects blinked more frequently than male subjects (Peterson & Allison, 1931; Newhall, 1932; Henderson & Prough, 1950; Zametkin et al., 1979; Stern, Boyer, Schroeder, & Stoliarov, 1996; Bentivoglio et al., 1997). Some studies reported no difference between gender (Norn, 1969; Yolton, Yolton, Lopez, Bogner, Stevens, & Rao, 1994; Doughty, 2001) and even the opposite result, i.e., the blink frequency of male subjects was higher than that of female subjects (Pivik & Dykman, 2004). Another kind of gender difference was also pointed out: strength of association, i.e., that higher levels of extraversion were associated with more frequent eye blinking was stronger among female subjects than among male subjects. (Berenbaum & Williams, 1994). The results are chaotic and thus the present study aimed to investigate this difference at each age stage using larger samples.

The reasons why we investigated other parameters of blinking are as follows. Blink duration and blink latency are affected by the sensory modalities of visual and auditory tasks (Stern et al., 1984; Goldstein et al., 1985; Bauer, Goldstein, & Stern, 1987) and hypnosis brings about the lengthening of duration and slowing of speed (Tada, Yamada, & Hariu, 1990). Blink duration is prolonged, blink amplitude is reduced, and asynchrony of both eyelids was markedly found especially in the case of occipital-lobe epilepsy patients (Tada, Takenaka, Minakawa, & Sugiyama, 2004). Blink burst or flurry may increase as a function of fatigue (Stern, Boyer, Schroeder, & Stoliarov, 1996) and be anticipated in some kinds of patients (Tinuper, Montagna, Laudadio, Ripamonti, & Lugaresi, 1989). However, the standard values of these parameters in each group have been not established and thus it is one of the purposes of this study to determine the normative values of these parameters in each group.

Amplitude (relative height of eyelid movement in pixel units), closing and reopening duration in ms (which was calculated by counting the number of frames of eyelid movement in 1/30 accuracy), and other measures, as well as the blink rate (bpm), blink burst or flurry ratio (percent of blinks that arise continuously over three times per second), sole blink rates (percentage of blinks without associated head movements), synchronization of left and right eyelid movements (percentage of synchronized and asynchronized eyelid movements, synchronization was measured by frame), and temporal distribution of accumulated blinks of the group over 3-min video watching.

Two experiments were conducted. Although it would have been ideal to conduct these under the same conditions across all age groups, it was very hard to perform them under completely identical conditions and situations throughout the ages from 3-month-old babies to 93-year-old elderly individuals. We have already published three separate papers related to the present paper in Japanese (Sugiyama & Tada, 2007; Sugiyama & Tada, 2010; Sugiyama & Tada, 2012). The aim of this paper is to report the residual data that have not been described

in these papers, combining two experiments, and reanalyzing data from a lifelong perspective. The other detailed data described in these papers, has been described in Japanese with abstract, figures, and tables in English.

Experiment 1

The purpose of Experiment 1 was to describe eye blink behaviors in the three youngest infant groups using simple recording of eye blink behaviors with relatively large samples.

Methods

Participants

A total of 232 participants (113 female and 112 male subjects and 7 subjects discarded), ranging from 3-month-old infants to 5-year-old children. Participants in these three groups (3 months, 1.5 years, and 3 years) were all recruited from physical examinations.

Task and Procedures

No tasks were delivered to participants and eye blink behaviors of infants were videotaped during resting in the spine position on the floor or interviewing with a doctor while held in a mother's arms.

Results and Discussion

The results and discussion of Experiment 1 will be described later in combination with the results of Experiment 2, because it is very convenient and easy to describe and discuss combining these two sets of results.

Experiment 2

The purpose of Experiment 2 was to establish the standard values of eye blink activities and to describe the developmental course of eye blink activities in 11 age groups that could be compared with identical task conditions across these age groups with relatively large samples.

Methods

Participants

A total of 1190 participants (547 male and 630 female subjects and 14 subjects discarded), ranging from 5-year-old children to 93-year-old elderly individuals, were evaluated in the present experiment. A total of 14 age groups were obtained: seven groups by 10 years over 20s and seven groups under 20 years for the younger groups. Participants were recruited from two kindergartens, two public schools (an elementary and a junior high), a private high school,

nurses, radiologists, hospital clerks, car dealers, high school teachers, the retired healthy aged, and housewives.

Task

To standardize the experimental task conditions across age groups, all participants performed an identical task. They were asked to watch an edited video stimulus for 3 min. The stimulus video was an anthology composed of street scenes of Germany with Mozart's "*Eine Kleine Nacht Musik*" and other music concurrently presented, which was delivered from a TV set from one to several meters in front of the participants. Experiments were conducted with one to five people at a time depending on the room size and, therefore, the screen sizes of the TV sets were 20–40″ inches depending on these experimental conditions. The face of each subject was videotaped using standard recording equipment (for example, DCR-VX2000 NTSC; Sony Corporation, Tokyo, Japan).

Procedures

First, an experimenter informed study participants about the purpose of the study. Informed consent was obtained either from the participant or, in the case of young children, their parents. Finishing the watching task, they were required to complete a questionnaire on their hand and eye dominance. Similar procedures were administered to all age groups. There were slight differences in the conditions under which data were collected, with some experiments conducted in schools and some at office facilities.

Data Reduction

The blink data of each subject was videotaped one by one. The videotaped data were sent to the PC using software (Premiere of Adobe Co. and DV-Gate; Sony Corporation) and the movements of the eyelids were detected using movie analyzing software (Dipp-Motion 2D; Ditect Co., Tokyo, Japan). Afterwards, using additional software (Blink Detection Program; Mizuno Measurement Co., Sendai, Japan), the data were reduced to obtain the blink wave attributes such as amplitude, closing duration, reopening duration, and other measures, as well as the blink rate, blink burst ratio, association of blinks with head movements, synchronization of left and right eyelid movements, and temporal distribution of blinks over the 3-min video presentation.

Results of Experiment 1 and Experiment 2

We collected data on 1423 participants, as mentioned above. Some of the data were discarded, because of a high-activity level and the wearing of contact lenses. We found, in the course of data reduction, that the wearing of contact lenses caused an increased blink rate. Participants wearing contact lenses were principally young adults. The data from contact lens wearers were eliminated. Earlier work from our laboratory had also demonstrated this effect. (Tada & Iwasaki, 1984).

Eye Blink Rates

Overall results of eye blink rates are shown in Figure 1, which presents the average (± standard deviation [SD]) maximum and minimum blink rates in each age group. The mean blink rate across all 1289 participants was 18.2 ± 14.1 bpm, while that of adults only was 19.9 ± 14.6bpm (Sugiyama & Tada, 2007). As can be seen in Figure 1, this developmental curve is very similar to that of the so-called neural type mode (Scammon, 1930) and the other developmental curves of eyeball mass and eyeball width. Very young infants blink infrequently. Blink frequency gradually increases until elementary school age. Hereafter, no statistically significant differences were obtained among age groups until the elderly groups. A two-way (gender and 14 age groups) analysis of variance (ANOVA) revealed a significant main effect of gender ($F(1,1373) = 7.4$, $P<0.01$) and age group ($F(13, 1373) = 33.1$, $P<0.001$), but the interaction between gender and age group was not significant (ns) ($F(13,1373) = 1.1$, ns). Multiple comparisons revealed significant differences between the three infant groups of 3 months, 1 year, and 3 years old and the residual older groups, respectively, and between the 5-year-old group and the groups from 9 to 20 years, 60s, and 70s. The blink rates of 5-year-old children did not show any significant differences between those of the 30s or 50s age groups.

The other remarkable finding, shown in Figure 1, was that while the maximum blink rates changed in proportion to mean blink rates as a function of age group, minimum blink rates were consistent across all age groups ranging from 3 months to 80 years old. Maximum frequencies were beyond 60 bpm in all age groups more than 5 years old, and especially in the elderly groups their incidences exceeded 80 bpm. To determine the relative extent of individual differences, the coefficient of variation in % (CV%: SD/mean multiplied by 100) was calculated. The mean CV% of all 14 age groups was 77.5 %, ranging from maximum 113.1% in 1.5-year-old infants to minimum 50.1% in the 12-year-old group. Even that of the 3-month-old infants was 83.0%.

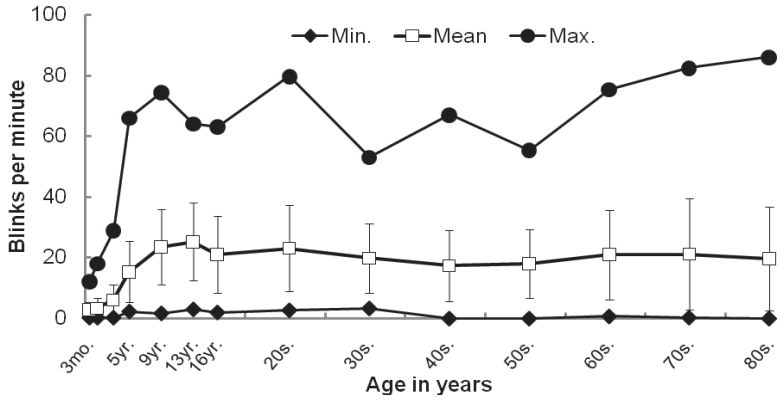

Figure 1. Mean, minimum, and maximum blink frequency as a function of age group, which is produced by combining two data sets from Sugiyama and Tada (2007) and Sugiyama and Tada (2010).

Contrary to this tendency of large variation in maximum frequency, minimum blinkers in each age group maintained uniform blink rates across all age groups. The mean minimum frequency of 14 age groups was 1.2 bpm, ranging from 0.0 bpm in the 40s, 50s, and 80s groups to 3.3 bpm in the 30s group. These findings were also supported by ratio analysis. The percentage of subjects with fewer than 5 bpm was less than 5%, from elementary school children to young adulthood. Thereafter, the frequencies increased gradually, resulting in 17.7% in the 80s group. Conversely, high blinkers, those with more than 60 bpm were 1–4% across all ages but increased in the older groups.

We can also observe the age differences in blink rates in the distribution map and its normal curve illustrated in Figure 2. It is very easy to understand the age difference in distribution pattern in Figure 2. The youngest four age groups showed the so-called J-shaped distribution (Ponder & Kennedy, 1927; Bentivoglio et al., 1997; Doughty, 2001) and the groups from preadolescence (9 years old) to adults demonstrated the more typical normal (symmetrical) distribution, partially indicated by the irregular form, especially in the elderly groups. None of our groups generated the bimodal distribution identified by Ponder and Kennedy (1927).

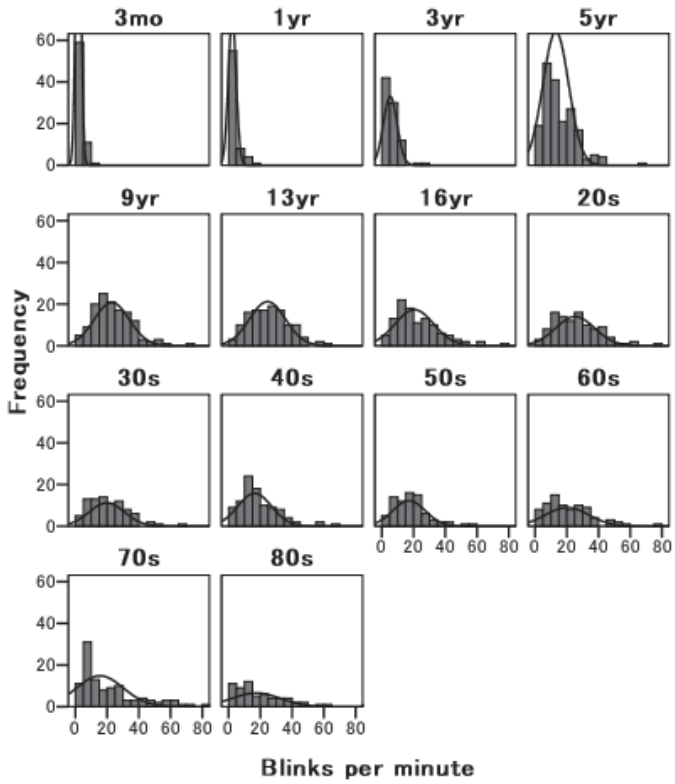

Figure 2. Distribution map and normal curves of eyeblinks in each age group.

Blink Durations

Figure 3 illustrates the closing, reopening, and total blink durations as a function of age group. In this figure, we also find curves similar to the developmental curves (Figure 1), with the exception of results for the 3-month-old group. The durations of all phases in the youngest four groups were shorter than in the remaining age groups and the durations in all groups older than 9 years were almost identical. The averaged durations and their SDs of all 14 age groups in closing, reopening, and total duration were 125 ± 17 ms (CV% = 13.3), 258 ± 59 ms (CV% = 22.9), and 383 ± 65 ms (CV% = 16.9), respectively. It was noted that, compared with blink rates, this range of variation is very small.

A two-way (gender and 14 age groups) ANOVA revealed a significant main effect of age group factor in all phases; closing duration ($F(13,1278) = 24.1$, $P<0.001$), reopening ($F(13,1278) = 104.8$, $P<0.01$), and total duration ($F(13,1278) = 92.0$, $P<0.001$), also in the gender factor in the reopening duration ($F(1,1278) = 10.1$, $P<0.001$) and total duration ($F(1,1278) = 9.3$. $P<0.01$). The only exception was the closing phase ($F(1,1278) = 0.2$, ns) and there were no significant interactions in any phase (for closing $F(13,1278) = 1.2$, ns, for reopening $F(13,1278) = 0.7$, ns, and total duration $F(13,1278) = 1.0$, ns, respectively).

Multiple comparisons of age group factors in three phases showed identical tendencies. That is, in all phases, groups less than 5 years old showed a uniform difference between the age groups older than 9 years old. However, the case in the closing duration was relatively complex: in 3-month-old infants, significant differences were obtained when compared with all age groups except 5 years, 9 years, and 13 years; in the 1-year group except 3 years, 30s, 40s, and 50s; in the 3-year group except 20s to 50s; in the 5-year group except 9 years, 13 years, 16 years, 70s, and 80s; in the 9-year group except 13 years, 16 years, and 80s; in the 13-year group except 16 years, 70s, and 80s; in the 16-year group except 60s and 80s; for the remaining groups no differences were found between them.

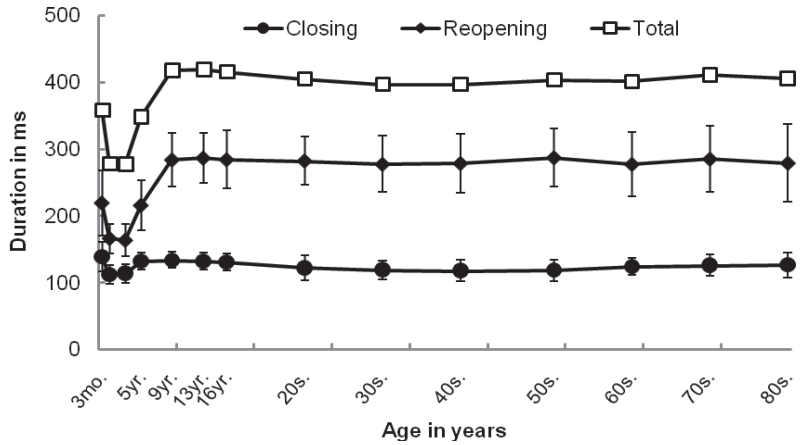

Figure 3. Closing, reopening, and total durations of eyeblinks as a function of age group, which is produced by combining two sets of data from Sugiyama and Tada (2007) and Sugiyama and Tada (2010).

Discussion

Earlier research has suggested that blinking is virtually absent at birth, increases steadily until adolescence at about 20 years, and that this blink level is maintained throughout adult life (Ponder & Kennedy, 1927; Knorr, 1929; Ködding, 1940; Zametkin et al., 1979). The present study adds some new findings to these results. The average baseline of blink rate appears to be somewhat higher in Japanese adults compared with the earlier studies. The age at which a stable level of blinking is achieved is considerably different from the results of Zametkin et al. (1979), the most systematic of the previous studies. They suggested that asymptote is reached at about 20 years of age while our results indicate a much earlier time, namely approximately 10 years of age.

We will explore possible reasons for the difference below:

1. Sample size. The number of subjects per group is considerably larger in our study than in any of the previous studies. It is well known that there are large inter-individual differences in blink rate, therefore relatively large samples are required to determine the standard values for each age group. In this regard, it is essential to use between-subject design studies. A series of studies by Karson, C. N., the representative researcher in this field, usually collected samples of between 19 and 82 subjects. Results for his control groups are generally stable across the studies (Tada & Sugiyama, 2006; Tables 5 and 6).

2. Requiring performance of a homogeneous task during the sampling of blinks is necessary for comparison between groups. Many studies have demonstrated that a large variety of psychological and physiological factors influences blink rate. A small difference in task and observation conditions may subtly influence blink rate (Doughty, 2001). Therefore, it is essential to maintain strict homogeneity across participants.

3. The relationship of obtained results to Scammon's developmental model. We find that the shape of the developmental curve obtained in this work closely mirrors that of Scammon's neural mode type (1930) and those of eyeball width and mass, and furthermore, to some kinds of intellectual developments suggested by J. Piaget. This suggests that our results might more reliably reflect developmental changes. That is, the developmental course of blink behaviors may parallel or depend on the neural development of the visual system. Findings that young infants blink frequently after the appearance (Bacher & Smootherman, 2004b) and disappearance (Murai, Nihei, & Adachi, 1989) of a visual stimulus suggests that endogenous blinks reflect a developmental course of central nervous system activity. These reports and many others, i.e., a series of studies by J. A. Stern, suggest the importance of cognitive function in blink activity. Recently, the report that the development of cognitive function in terms of blink activity in preadolescents around 10 years old was very similar to that of adults (Pivik & Dykman, 2004) may be considered further evidence that the blink function has already matured at the preadolescent stage of development. Sutton (1958) also observed that there were some differences between winking ability in children above and below 10 years of age. These reports also suggested that the age of about 10 years might be a critical period for

the development of adult blink activities.

A second finding concerning the blink rate was the demonstration that large individual differences across ages were already observed in very early stages in life, as shown in Figures 1 and 2. The most striking finding was that the minimum blink frequency in all age groups was quite constant. How might one interpret the finding that minimum blink rates are constant across the age span while both average and maximum blink rates demonstrate a developmental course? We hypothesized that there are two kinds of blinks, i.e., essential and extra blinks. The former may be physiologically essential, for example, maintaining a film of fluid across the cornea, preventing the desiccation of the eyeball including spontaneous (periodical) activities like general movements in the fetus and newborns (Prechtl & Nijhuis, 1983). Newborn infants already blink several times per minute. A recent report suggested that fetuses also blink every 10 min (Petrikovsky, Kaplan, & Holsten, 2003). People who need not blink more frequently keep at this level throughout the life and may need not extra blinks. However, most people learn to blink as a tool for a variety of psychological, physiological, and biological adaptations, for instance, some kinds of information processing, reflection of some inner state, tension release, and some kinds of communication styles. What kinds of blinking people learn allows a wide range of alternatives, resulting in huge individual differences. Thus, the large individual differences in blink rate are attributable to differences in how people process information and the affective state associated with such processing.

Some prior reports have referred to distribution maps of blink rate and they classified blink rate into three types: J-shaped, normal (symmetry), and irregular (Ponder & Kennedy, 1927; Bentivoglio et al., 1997; Doughty, 2001), but we have not observed the bimodal type reported by Ponder and Kennedy (1927). Generally speaking, concerning our data, we can say that a J-shaped distribution is typical for the youngest age groups, normal distributions are common to adults, and the elderly groups were more likely to demonstrate the irregular type. One reason for such patterns may be the differences in blink frequency between groups.

The results concerning blink duration depicted in Figure 3 suggest: 1) closing duration was approximately half of the reopening phase, 2) the variability of duration among participants was very small comparing with blink frequency, probably about one-third of blink rates, and 3) the developmental curve was close to that of blink rates with the exception of the 3-month-old group. This exception in 3-month-old infants might be derived from a neural immaturity.

Conclusions

The present study showed the developmental course of endogenous blinking and some tentative standard values for each age and gender group. The study was conducted using relatively large samples and utilized the same experimental condition for all but the youngest participants. However, these results might yet be tentative, because blinks might be affected by other unexpected and unknown factors such as cultural differences. Further studies will be required to establish the normative values for each group, which might be essential for

a between-group study on blinks. These standards might be useful in the evaluation of the validity of acquired eyeblink data as control group data.

The other related data such as isolated (sole) blink rate (blinks not associated with head movements), side superiority of eyelids, blink burst (flurry), and the temporal distribution of eye blinks during 180-s video watching can be found in our previous articles (Sugiyama & Tada, 2007; Sugiyama & Tada, 2010; Sugiyama & Tada, 2012).

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Brand Categorization and Hedonic Transfer: Negative Evaluations of a Beverage Transfer to a Novel Beverage from the Same Brand

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Many studies have shown that brand cues affect not only qualitative product evaluation, but also hedonic evaluation of food and beverage products. Although most research has focused on familiar brands associated with cultural or affective values (e.g., Coke, McDonalds, and Starbucks), only a few studies have examined the categorical aspects of brands that lead consumers to associate one product with other products from the same brand. In the present study, we hypothesized that if palatability evaluations of a beverage transfer to those of a novel beverage from the same brand, *hedonic transfer* will occur. We designed two experiments to test this hypothesis. In Experiment 1, each participant tasted and evaluated two beverages sequentially. The first was a context (hedonically negative) beverage and the second was a target (hedonically neutral) beverage, with or without information indicating these two beverages were from the same brand. In Experiment 2, each participant tasted and evaluated a context (hedonically neutral) beverage and target (hedonically negative) beverage, with or without the information. The results from Experiment 1 showed that participants who were informed that the two beverages were the same brand evaluated the target beverage as less palatable than did those without brand information; in other words, negative hedonic transfer occurred. In contrast, Experiment 2 did not show any indication of positive hedonic transfer. The results indicate that even if the brand does not have cultural value or familiarity, brand cues affect the palatability of a beverage, based on brand categorization and hedonic transfer.

Key words: hedonic transfer, palatability, brand, brand-categorization

Introduction

Consumers often prefer products of a specific brand to products of other brands, even if the quality between the two does not differ; for example, people often prefer Coke products to Pepsi products (McClure, Li, Tomlin, Cypert, Montague, & Montague; 2004). A better way for marketers to appeal to the rationality and sensitivity of consumers is to improve the quality of their products and then promote the products by emphasizing their high quality. However, as the example indicates, consumers appear to be less sensitive to the quality of products itself. This begs the questions: How do consumers make product evaluations? What factors affect such evaluative processes? The current study sought to examine the processes underlying

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palatability evaluations of beverages and how brand cues affect such evaluative processes.

When we talk about a certain food, we are often talking about the palatability as the objective attributes of that food (e.g., "McDonald's is very palatable"). Thus, marketers often focus on the quality which defined as chemical structure of food and beverage products. However, several psychological experiments have shown that perceived palatability of foods and beverages depends not only on their quality but also on contextual factors such as physiological state (Cabanac, 1979), order of tasting (Kamenetzky, 1959; Sakai, Kataoka, & Imada, 2001), cultural beliefs (Zellner, Stewart, Rozin, & Brown, 1988), expectations of the products' qualities (Cardello & Sawyer, 1992; Deliza & MacFie, 1996; Lee, Frederick, & Ariely, 2006), prices (Plassmann, O'Doherty, Shiv, & Rangel, 2008), and brands (Allison & Uhl, 1964; McClure et al., 2004). These findings consistently indicate the importance in defining perceived palatability to include these contextual factors. In other words, perceived palatability refers to the subjective hedonic experience rather than referring solely to the objective attributes of food and beverages (Sakai et al., 2001; McClure et al., 2004; Plassmann et al., 2008).

In this context, many researchers have indicated that brand cues affect hedonic evaluation of food and beverages (McClure et al., 2004; Robinson, Borzekowski, Matheson, & Kraemer, 2007). For example, McClure et al. (2004) demonstrated that knowledge of a familiar brand such as Coke affected preferences and brain activity as measured with fMRI. More specifically, the authors found an increase in activity in participants' hippocampus, the dorsolateral prefrontal cortex, and the thalamus after viewing the Coke brands. They interpreted this activity as evidence of retrieval of brand information during the tasting and suggested that culturally familiar brands can actually affect the hedonic experience of food and beverages. In addition, Robinson et al. (2007) demonstrated that brand cues might affect the food preference of preschool children: children preferred food and beverages when they thought the food and beverages were from McDonalds. These studies suggest that brand cues affect consumers' evaluation of products, especially when the brands are very familiar and associated with cultural values. However, if the brand is not associated with cultural values or is unfamiliar, do brand cues affect palatability evaluations?

The present study sought to determine whether brand cues affect perception of branded products, even when the brand is unfamiliar. Because categorical information (e.g., race, group association, generation, sex) is very informative and is the basis of our perception and cognition of the external world (Allport, 1954), we often utilize this type of information not only in social cognition but also in product evaluation (Gilbert & Hixon, 1991; Friese, Wanke, & Plessner, 2006; Shook, Fazio, & Eiser, 2007; Ranganath & Nosek, 2008; Ratiliff & Nosek, 2011; Ratliff, Swinkels, Klerx, & Nosek, 2012). Thus, this study used brand categorization as the schema by which consumers evaluate a novel product according to memories or evaluations of other products from the same brand.

Ratliff et al. (2012) showed that implicit attitude towards one product automatically transfers to other novel products from the same brand. The authors described the phenomenon as *implicit attitude transfer*. Their results also influenced brand studies because they presented

fictional brands to the participants. Participants in their study evaluated products using brand categorization. The current study defines *hedonic transfer* as the transfer of hedonic value from one food product to other food products of the same brand, a definition similar to attitude transfer described in other studies (Ranganath & Nosek, 2008; Ratliff et al., 2012)

Participants in Ratliff's study did not actually use or taste the products, only evaluated them by questionnaires; thus, it remains unclear whether brand categorization actually leads to generalization of the hedonic experience of food and beverage tastings. Therefore, our participants were asked to actually taste and evaluate unfamiliar beverages. The first hypothesis was that people with brand knowledge about an unpalatable beverage would also evaluate other beverages from the same brand as unpalatable; in other words, negative hedonic transfer will occur. The second hypothesis was that people with brand knowledge about a palatable beverage would also evaluate other beverages from the same brand as palatable; in other words, positive hedonic transfer will occur.

An assimilation-contrast effect may also be involved in the hedonic evaluation process (e.g., Cardello & Sawyer, 1992; Kamenetzky, 1959; Sakai et al., 2001). It is often reported that a "good" food preceded by a "poor" food might be evaluated as more palatable (i.e., contrast effect) or as less palatable (i.e., assimilation effect) than if there was no preceding food. Thus, hypotheses may stem not only from the hedonic transfer effect but also from the assimilation-contrast effect. To control for this effect, we introduced three experimental conditions: same brand (SB), different brand (DB), and non-brand (NB). In the SB condition, participants evaluated the beverages knowing that they were from the same brand, and in the DB condition, participants knew the beverages were from different brands. In the NB condition, participants evaluated the beverages without any brand information. According to assimilation-contrast theory, evaluative generalization (i.e., the assimilation effect) would occur regardless of experimental condition because only the hedonics of the beverages is important. However, we expected such generalization only in the SB condition because those participants knew they were tasting the same brand; therefore, their evaluation would generalize from the context beverage to the target beverage via brand categorization. If there were no differences between the conditions, that is, evaluative generalization occurred in every condition, assimilation-contrast theory might explain the results. In contrast, if evaluative generalization occurred only in the SB condition, hedonic transfer may be the explanation.

Experiment 1

We hypothesized that if prior knowledge about an unpalatable beverage causes people to evaluate other beverages from the same brand as unpalatable, then negative hedonic transfer occurs. To test this hypothesis, participants in this experiment were asked to sequentially taste and evaluate two beverages; the first one was a context (hedonically negative) beverage and the second a target (hedonically neutral) beverage. Participants were assigned to the SB, DB, or NB condition (Figure 1A). Under this design, only participants in the SB condition could

generalize negative evaluations from context (negative) beverage to target (neutral) beverage. Therefore, we expected participants in the SB condition to evaluate the target beverage as less palatable than would those in DB and NB conditions.

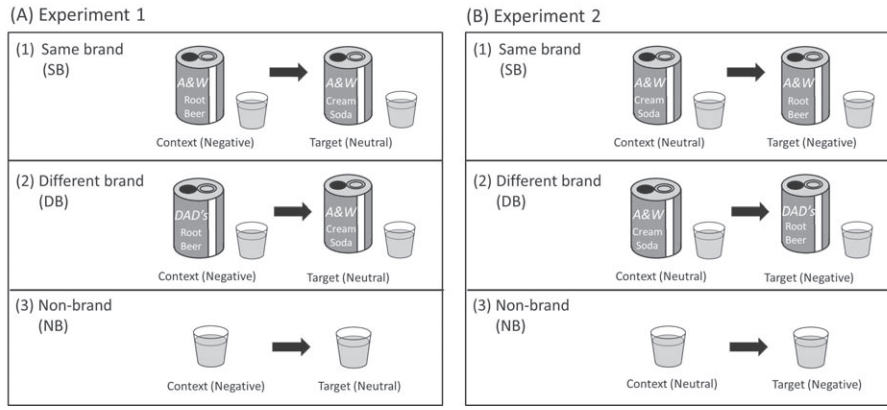

Figure 1. Experimental designs of (A) Experiment 1 and (B) Experiment 2. (A) In the SB condition, participants were presented with real cans of *A&W Root Beer* (context) and *A&W Cream Soda* (target) as visual stimuli of the same brand. In the DB condition, participants were presented with the real cans of *DAD's Root Beer* (context) and *A&W Cream Soda* (target) as visual stimuli of different brands. In the NB condition, participants were not provided with any information about the beverages. Brand information provided before tasting differed between conditions, but the order of evaluation (context to target) and the variety of beverages (*A&W Root Beer* and *A&W Cream Soda*) were the same across all conditions. (B) In Experiment 2, the order of stimuli was reversed, thus participants sequentially tasted *A&W Cream Soda* as the context beverage and *A&W Root Beer* as the target beverage.

Method

Participants

Eighty-one students at Tohoku University (36 women, M_{age} = 20.9 years, *SD* = 1.2 years) participated in the experiment. All participants were uninformed as to the true purpose of the study. Participants were randomly assigned to one of three conditions: SB, DB, or NB. After the experiment, participants were informed the true purpose of the study, and gave informed consent by themselves.

Materials

A&W Root Beer was used as the context (negative) beverage and *A&W Cream Soda* was used as the target (neutral) beverage. These beverages were selected from the results of a pre-test. The palatability score on a 100-mm visual analog scale (VAS) indicated that participants in pre-test evaluated *A&W Cream Soda* as neutral (*M* = 56.3, *SD* = 24.0) and *A&W Root Beer*

as less palatable (M = 26.8, SD = 27.0). There was a significant difference in the palatability score for these two stimuli ($t(12) = 2.894$, $p < .01$). Furthermore, only one from 12 participants in the pre-test knew the *A&W* brand. Thus, *A&W Root Beer* was selected as the context (negative) beverage and *A&W Cream Soda* was selected as the target (neutral) beverage. The stimuli were stored in a refrigerator and prepared just before tasting. At the time of tasting, the stimuli were poured into clear plastic cups (which can contain up to 90 ml) and immediately presented to the participants. Each cup contained 60 ml of the stimuli.

Cans of *A&W Root Beer*, *A&W Cream Soda*, and *DAD's Root Beer* were used as visual stimuli. These visual stimuli served as brand information in the SB and DB conditions. More specifically, cans of *A&W Root Beer* and *A&W Cream Soda* were introduced to the participants in the SB condition and cans of *DAD's Root Beer* and *A&W Cream Soda* were introduced to the participants in the DB condition. These visual stimuli were not introduced to the participants in the NB condition.

Procedure

Figure 2 presents a flow chart of the procedure. In this experiment, the order of evaluation (context to target) and the variety of beverages (*A&W Root Beer* and *A&W Cream Soda*) were identical between the conditions, while the brand information provided before tasting differed between conditions.

In the SB condition, participants were presented with real cans of *A&W Root Beer* (context) and *A&W Cream Soda* (target) as visual stimuli of the same brand. Participants were then asked whether they were familiar with the brand. If participants had indicated prior knowledge about the brand or about its cultural values, they would have been excluded from the analysis, because such knowledge could have affected their evaluations (McClure et al., 2004). However, none of the participants was excluded. After the familiarity check, the visual target stimulus (*A&W Cream Soda*) was temporarily removed and only the visual context stimulus (*A&W Root Beer*) remained on the table. Participants were told to expect the palatability (negative or positive) of the beverage and to evaluate its "expected" palatability. After the evaluations, participants were presented with a cup of the context (negative) beverage (i.e., *A&W Root Beer*), which was prepared behind a partition during the expectative evaluation phase. Then, participants were asked to taste the beverage at their own pace and evaluate the "experienced palatability" of the beverage, as well as how much they liked it ("liking"). After the evaluations, participants were asked to rinse their mouths thoroughly with mineral water, and then the visual context stimulus was replaced with the visual target stimulus (*A&W Cream Soda*). Participants were again asked to expect the palatability of the beverage and evaluate its "expected palatability" in the same way as the context beverage. After the evaluations, participants were presented with a cup of the target (neutral) beverage (i.e., *A&W Cream Soda*), again prepared behind a partition during the expectative evaluation phase. Then, participants were asked to taste the beverage and evaluate the experienced palatability of the beverage and how much they liked it, in the same way as for the context beverage.

In the DB condition, participants were presented with real cans of *DAD's Root Beer* (context) and *A&W Cream Soda* (target) as visual stimuli of different brands. However, the visual context stimulus (*DAD's Root Beer*) was ostensible, thus participants in the DB condition also tasted *A&W Root Beer* as a context beverage along with those in SB condition. Except for this point, the other experimental procedures were identical to those in the SB condition.

In the NB condition, participants were not provided with any information about the beverages. Thus, participants tasted and evaluated the beverages sequentially without any visual stimuli. As in the SB and DB conditions, *A&W Root Beer* was the context beverage and *A&W Cream Soda* was the target beverage. Participants in the NB condition were unable to expect the palatability of the beverages before tasting, so they were asked only to taste and evaluate experienced palatability and how much they liked it.

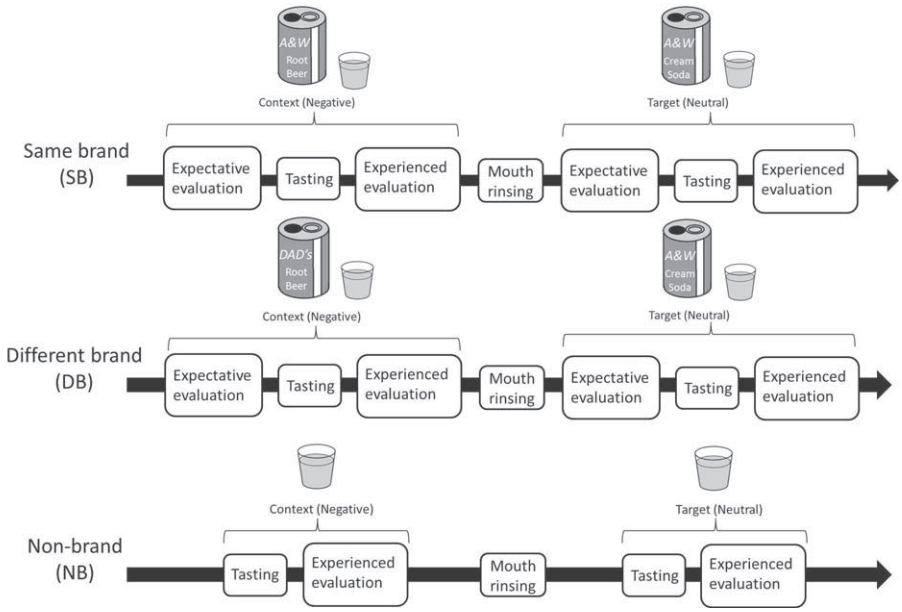

Figure 2. Flow chart of the experimental procedures in Experiment 1. In this study, visual stimuli (real cans of the beverages) were provided before each tasting in both the SB and DB conditions, but not in the NB condition. Participants in the SB and DB conditions were asked to evaluate expected palatability before tasting and experienced palatability and liking after tasting. Participants in the NB condition were not able to expect the palatability of the beverages before tasting, so they were asked only to taste and evaluate experienced palatability and liking.

Participants made their evaluations on a 100-mm visual analog scale (VAS) for each dimension: expected palatability, experienced palatability, and liking. For the expected palatability evaluations (before tasting in the SB and DB conditions), the scale ranged from

"The beverage may be absolutely unpalatable for me" to "The beverage may be extremely palatable for me," without any anchors. For the experienced palatability evaluations (during the tasting in all conditions), the scale ranged from "The beverage is absolutely unpalatable for me" to "The beverage is extremely palatable for me." For the liking evaluations (during the tasting in all conditions), the scale ranged from "I do absolutely not like the beverage" to "I like the beverage very much." All instructions were described in Japanese.

Palatability and liking were separated because these two indices may reflect different aspects of evaluation. According to Sakai et al. (2001), "palatability" reflects the participants' evaluation of the hedonics on the sensory aspects of a food or beverage, while the "liking" reflects the participants' cognitive judgments (e.g., "The taste of chocolate is palatable for me, but it makes me fat so I do not like it so much"). Therefore, we defined palatability as the hedonic evaluation for the stimuli and liking as the cognitive evaluation. We hypothesized that these two indices would be independent of each other.

Analysis

The length from the left edge of the scale to the mark participants had made was measured for each evaluation and used as ratings. The ratings had a theoretical range from 0 to 100, 0 means "seemed to be absolutely unpalatable" / "absolutely unpalatable" / "absolutely do not like," and 100 means "seemed to be extremely palatable" / "extremely palatable" / "like very much." These ratings were averaged separately in each condition (i.e., SB, DB, and NB). A one-way analysis of variance (ANOVA) was used to analyze the data, using Ryan's method as a post-hoc analysis.

Results and discussion

Palatability evaluations

None of the participants in this experiment was familiar with *A&W* and *DAD's* brands. If participants evaluated the context (negative) beverage as not so bad, this meant that the negative context manipulation did not work for those participants. Therefore, when the ratings of experienced palatability or liking for the context beverage were over 50 (halfway on the VAS lines), the data were excluded from the analysis (n = 11, 14% of the data). Participants who originally had strong preferences for the target beverage (e.g., "I like this kind of beverage very much" or "I dislike this kind of beverage") could have had outlier ratings. Therefore, participants whose experienced palatability or liking ratings for the target beverage deviated from the mean by more than 2 *SD* in each condition were also excluded from the analysis (5% of the data in the palatability analysis and 1% of the data in the liking analysis).

Figure 3 shows the palatability ratings of the target beverage. A one-way ANOVA for the participants' expected palatability ratings failed to reveal a significant main effect for condition ($F(1, 42) = 1.797$, $p = .188$). However, for the participants' experienced palatability ratings, there was a significant main effect of condition ($F(2, 63) = 4.235$, $p < .05$). Post-

hoc analysis using Ryan's method showed that participants in the SB condition evaluated the target beverage as less palatable (M = 49.0, SD = 18.8) than participants in the DB (M = 62.8, SD = 15.0) and in the NB conditions (M = 60.6, SD = 15.8; ps < .05). This result supported our hypothesis: Prior knowledge about a brand of one unpalatable beverage caused participants to evaluate another beverage from the same brand as unpalatable. This indicates that negative hedonic transfer occurred.

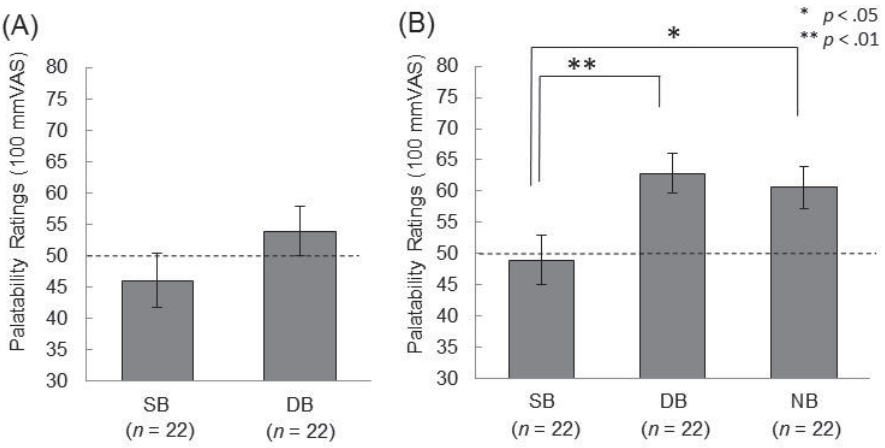

Figure 3. Averaged palatability ratings (mean ± standard error) of the target (neutral) beverage in Experiment 1. (A) Expected palatability before tasting. (B) Experienced palatability during tasting.

Liking evaluations

Figure 4 shows the liking ratings of the target beverage. A one-way ANOVA for the participants' liking ratings revealed no significant main effect of condition (F (2, 66) = 2.316, p = .107). This result did not support our hypothesis: Prior knowledge about a brand of one disliked beverage did not cause participants to dislike another beverage from the same brand.

In this experiment, the effect of prior knowledge of the brand on evaluation ratings was found only in experienced palatability evaluation, but not in liking evaluation. According to Sakai et al. (2001), as mentioned before, palatability and liking have similar meanings but qualitatively different aspects of evaluation for foods in some points. Thus, the results in this experiment supported Sakai and colleagues' notion.

Experiment 2

For Experiment 2, we hypothesized that prior knowledge with a palatable beverage causes people to evaluate other beverages from the same brand more palatable—in other words, positive hedonic transfer occurs. To test this hypothesis, participants in this experiment

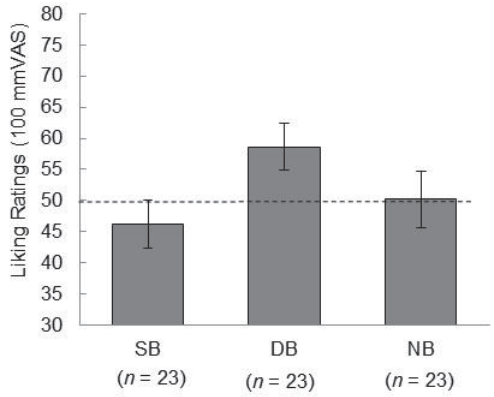

Figure 4. Averaged liking ratings (mean ± standard error) of the target (neutral) beverage during the tasting in Experiment 1.

were asked to sequentially taste and evaluate a context beverage first and then a target (negative) beverage sequentially. Participants were grouped into one of three conditions, as in Experiment 1: SB, DB, and NB condition (Figure 1B). In this experiment, only participants in the SB condition were expected to generalize relatively positive evaluations for context beverage to the target (negative) beverage; in other words, participants in the SB condition would evaluate the target beverage as more palatable than would participants in the DB and NB conditions.

Method

Participants

Fifty-nine students at Tohoku University (30 women, M_{age} = 20.9 years, SD = 1.4 years) participated in this study. All participants were uninformed as to the real purpose of the study. Participants were randomly assigned to one of three conditions. After the experiment, participants were briefed on the true purpose of the study and signed informed consent forms.

Materials

Beverage stimuli were identical to those in Experiment 1, although the order of presentation differed. In this experiment, *A&W Cream Soda* was used as the context beverage and *A&W Root Beer* was the target (negative) beverage. The stimuli were stored in a refrigerator and prepared just before tasting. At the time of tasting, the stimuli were presented in clear plastic cups. Each cup contained 60ml of the stimuli.

Cans of *A&W Cream Soda*, *A&W Root Beer*, and *DAD's Root Beer* were used as visual stimuli. These stimuli served as brand information in the SB and the DB conditions. More specifically, cans of *A&W Cream Soda* and *A&W Root Beer* were introduced to the participants

in the SB condition and cans of *A&W Cream Soda* and *DAD's Root Beer* were introduced to participants in the DB condition. These visual stimuli were not used in the NB condition.

Procedure

In this experiment, although the order of evaluation (context to target) and the variety of beverages (*A&W Cream Soda* and *A&W Root Beer*) were identical between conditions, brand information provided before tasting differed.

In the SB condition, participants were presented with real cans of *A&W Cream Soda* (context) and *A&W Root Beer* (target) as visual stimuli of the same brand. In the DB condition, participants were presented with real cans of *A&W Cream Soda* (context) and *DAD's Root Beer* (target) as visual stimuli of different brands. Moreover, in the NB condition, participants were not provided with any visual stimuli.

All participants in this experiment tasted and evaluated *A&W Cream Soda* as the context beverage and *A&W Root Beer* as the target beverage. All other experimental procedures were identical to those in Experiment 1. Participants made their evaluations, in the same way as Experiment 1, on a 100-mm visual analog scale (VAS) for each dimension: expected palatability, experienced palatability, and liking.

Analysis

The scores were measured and calculated in the same way as in Experiment 1. These scores were averaged separately for each condition (i.e., SB, DB, and NB). A one-way ANOVA with *post hoc* analysis using Ryan's method was used to analyze the data.

Results and discussion

Palatability evaluation

One participant was familiar with the *A&W* brands, so this participant's data was excluded from the analysis. In addition, the data of participants whose ratings of experienced palatability or liking for the target beverage deviated from the mean by more than 2 *SD* in each condition were also excluded from each analysis (5% of the data in the palatability analysis and 3% of the data in the liking analysis).

Figure 5 shows the palatability ratings of the target beverage. A one-way ANOVA for the participants' expected palatability ratings revealed no significant main effect of condition ($F(1, 34) = 2.008$, $p = .166$). A one-way ANOVA for experienced palatability also revealed no significant main effect of condition ($F(2, 53) = .599$, $p = .553$). Thus, the results of this experiment did not support our hypothesis that prior knowledge about a brand of one palatable beverage will make people evaluate other beverages from the same brand as palatable; in other words, positive hedonic transfer did not occur.

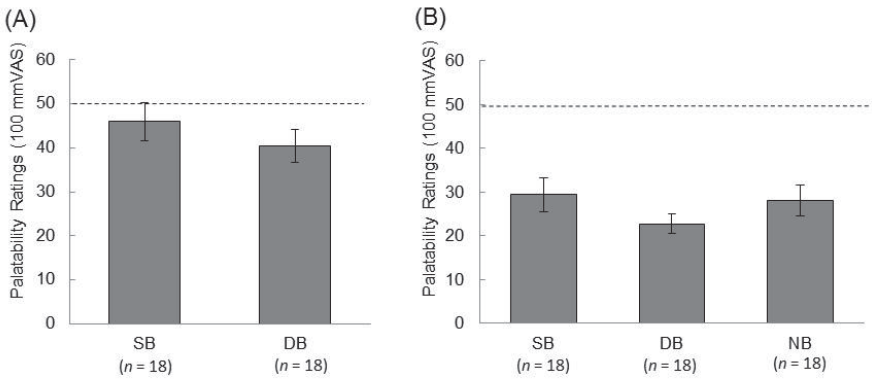

Figure 5. Averaged palatability ratings (mean ± standard error) of the target (negative) beverage in Experiment 2. (A) Expected palatability before tasting. (B) Experienced palatability during tasting.

Liking evaluation

Figure 6 shows the liking ratings of the target beverage. A one-way ANOVA for the participants' liking ratings revealed no significant main effect of condition ($F(2, 53) = .537$, $p = .588$). This result did not support our hypothesis that prior knowledge about a brand of one liked beverage will make people like other beverages from the same brand. Thus, both in the palatability ratings and in the liking ratings, we could not show the effect of prior knowledge of the brands on the evaluation in positive direction.

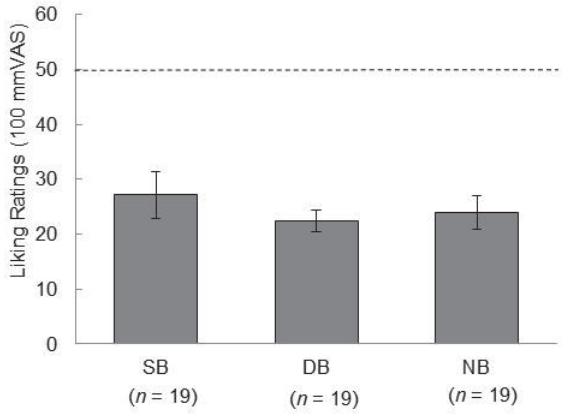

Figure 6. Averaged liking ratings (mean ± standard error) of the target (negative) beverage during tasting in Experiment 2.

General Discussion

The results of the current study showed that negative hedonic transfer of the brand. The presence of negative hedonic transfer is further supported by the fact that the brands held no cultural value or familiarity for the evaluators, suggesting that brand categorization did in fact affect the palatability evaluation of the beverage.

The results from Experiment 1 might be explained by other phenomena, such as the mood congruency effect (e.g., Schwarz & Clore, 1983), rather than by brand categorization and hedonic transfer. The mood congruency effect suggests that people pay more attention to information that is congruent with their affective state. In applying this theory to the current study, the context (negative) beverage could have made participants feel bad, and thus they would have evaluated the target beverage as relatively unpalatable. However, this theory could not explain why participants in the DB and the NB conditions did not evaluate the target beverage as unpalatable. All participants in the experiment tasted the context (negative) beverage before tasting the target beverage, and thus, according to mood congruency effect, all participants should have evaluated the target as relatively unpalatable. In fact, this congruency effect was found only in the SB condition. Therefore, our results support a negative hedonic transfer.

Assimilation-contrast theory suggests that hedonic evaluations of foods and beverages are affected by those of preceding foods and beverages (Kamenetzky, 1959; Sakai et al., 2001) or by participants' expectations (Cardello & Sawyer, 1992). More specifically, this theory suggests that a "good" food preceded by a "poor" food might be evaluated as either more palatable (i.e., contrast effect) or as less palatable (i.e., assimilation effect) than when there is no preceding food. According to assimilation-contrast theory, the finding that participants in the SB condition evaluated the target beverage as less palatable than did participants in other conditions seems to be due to a negative assimilation effect between the context (negative) beverage and the target (neutral) beverage. Simultaneously, the finding also seems to be due to a positive contrast effect in the DB condition and NB condition. In the present study, unfortunately we cannot be sure that assimilation-contrast effect actually occurred because we did not include an experimental condition where only the target beverage was evaluated. To speculate whether assimilation-contrast effect has occurred or not, we compared palatability ratings for the target beverage in Experiment 1 and those for the context beverage in Experiment 2 (see Figure 7). More specifically, experienced palatability ratings for the target beverage in the SB condition and those in the DB condition in Experiment 1 (i.e., target *A&W Cream Soda* labeled *A&W*) were compared with averaged ratings of ratings for the context beverage in the SB condition and those in the DB condition in Experiment 2 (i.e., context *A&W Cream Soda* labeled *A&W*). A one-way ANOVA revealed a significant main effect of condition ($F(2, 77) = 3.479$, $p < .05$). Post-hoc analysis using Ryan's method showed that participants in the SB condition evaluated the beverage as less palatable ($M = 49.0$, $SD = 18.8$) than in the DB condition ($M = 62.8$, $SD = 15.0$) and in Experiment 2 (M

= 60.8, *SD* = 21.4) (*ps* < .05). There was no significant difference between ratings in the DB condition and the averaged ratings in Experiment 2 (p = .705). Also we compared experienced palatability ratings for the target beverage in NB condition in Experiment 1 (i.e., target *A&W Cream Soda* labeled nothing) with those in NB condition in Experiment 2 (i.e., context *A&W Cream Soda* labeled nothing). The result indicated that there was no difference in palatability ratings between the NB condition in Experiment 1 (*M* = 60.6, *SD* = 15.8) and in Experiment 2 (*M* = 57.5, *SD* = 24.9) ($t(39)$ = -.489, p = .628). These results indicated that the context beverage affected palatability evaluation for the subsequent-presented target beverage only in SB condition. In our study, because all participants tasted the context (negative) beverage and then the target (neutral) beverage, assimilation-contrast theory predicts that the negative assimilation effect should have been found in all conditions. However, this effect was found only in the SB condition in our results. Therefore, assimilation-contrast theory cannot be used to explain our results. Nonetheless, to elucidate this concern, further research should examine not only SB, DB, and NB conditions but also the target-only condition in parallel.

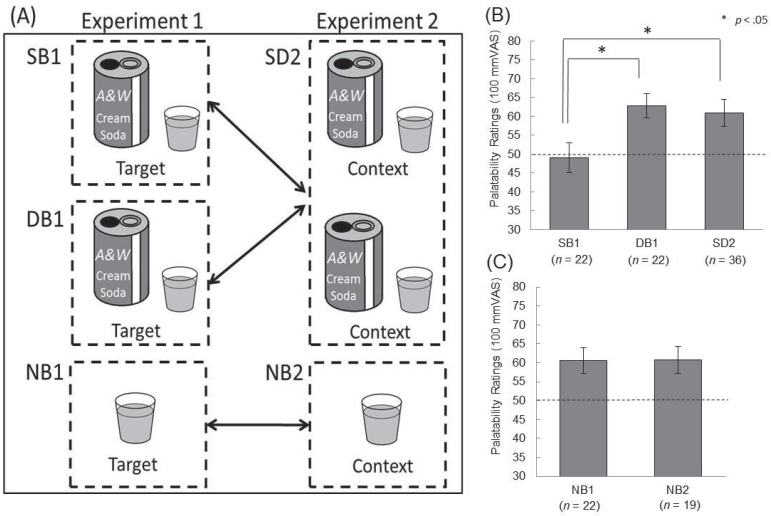

Figure 7. (A) Design of the inter-experiment comparison. Experienced palatability ratings for the target beverage in the SB and the DB condition of Experiment 1 (i.e., SB1 and DB1) were compared with averaged ratings of ratings for the context beverage in the SB condition and those in the DB condition of Experiment 2 (i.e., SD2). Also experienced palatability ratings for the target beverage in the NB condition of Experiment 1 (i.e., NB1) were compared with those for the context beverage in the NB condition of Experiment 2 (i.e., NB2). (B) Averaged experienced palatability ratings (mean ± standard error) for the target beverage in the SB1 and DB1 conditions and those for the context beverage in the SD2 condition. (C) Averaged experienced palatability ratings (mean ± standard error) for the target beverage in the NB1 condition and those for the context beverage in the NB2 condition.

There are some other procedural problems about the brand label used in this study. As mentioned before, there is a fairly large literature on the effect of label itself on evaluation of foods (e.g., McClure et al. 2004). In Experiment 1, we used the labels of *A&W* in the SB and *DAD's* in the DB conditions, respectively. This labeling could result in different effects on the subsequently-presented target beverage. And also in Experiment 2, we used the labels of *A&W* in the SB and *DAD's* in the DB conditions, respectively. The target beverage not only varies on whether participants think it is the same brand as the context, but it also varies on what it is labeled (i.e., *A&W*, *DAD's*, or non-labeled). Since labeling itself is suggested to affect hedonic evaluation of foods, these effects of labeling are considerable problems. To speculate whether the label itself affects participants' evaluation, we conducted additional comparison with the data in Experiment 1. We compared participants' palatability ratings for the context beverage in the SB condition (i.e., labeled *A&W*) and those in the DB condition (i.e., labeled *DAD's*) (Figure 8). The result indicated that experienced palatability ratings for the context beverage labeled *A&W* (M = 25.9, SD = 12.9) and those for labeled *DAD's* (M = 23.4, SD = 11.3) were not significantly different ($t(42) = 0.853$, $p = .400$). This result indicated that, at least in the present study, the labeling itself did not strongly affect on our findings. However, further research should clear these problems.

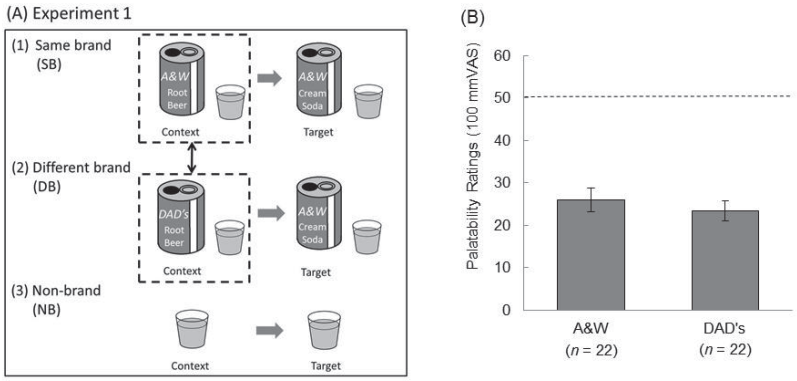

Figure 8. (A) Design of comparison between two labeled context beverages in Experiment 1. (B) Averaged experienced palatability ratings (mean ± standard error) for the context beverage labeled *A&W* (i.e., in the SB condition) and *DAD's* (i.e., in the DB condition) in Experiment 1.

Aaker and Keller (1990) suggested that the negative evaluations of a given brand could be neutralized by elaborating on the attributes of a brand extension (i.e., a new product). If this prediction was the case in Experiment 1, participants in both the SB and DB conditions would have evaluated the target beverage equally. However, contrary to Aaker and Keller's prediction, participants in the SB condition evaluated the target beverage as less palatable

than did those in the DB condition. Thus, the current findings support Ratliff and colleagues' research, which suggested that once a negative attitude is made for a product of one brand, other products from the same brand are also negatively evaluated because of brand categorization.

Intriguingly, the experienced palatability evaluation and the liking evaluation differed; the effect of prior knowledge about the brand of the context beverage was found only in the experienced palatability, but not the liking. This difference between palatability and liking supported the notion of the previous study (Sakai et al. 2001). According to Sakai and colleagues, palatability reflects participants' hedonic evaluations for the sensory aspects of a food or beverage, whereas liking reflects their cognitive judgments on it. In other words, whereas palatability ratings reflect individuals' intuitive evaluation for their hedonic experiences, liking ratings reflect individuals' deliberative evaluation for the foods. Ratliff et al. (2012) showed that attitude to a product implicitly transfers to other novel products of the same brand, but not explicitly. Ratliff and colleagues interpreted that participants explicitly (and deliberatively) evaluate the products based on the product's quality itself, but implicitly (and of course intuitively) evaluate the products based on prior knowledge about the brand. Taken together, in the present study, it is speculated that when participants evaluated their liking, participants deliberatively made their evaluation based on the beverage's quality itself ("This soda seems to affect my weight, because of its sweetness, so I don't like it.") without using the prior knowledge about the brand (i.e., brand categorization). On the other hand, it is also speculated that when participants evaluated palatability, participants intuitively made their evaluation based on some other context factors, such as brand categorization. Therefore, the effect of brand categorization might be found only in the experienced palatability ratings. This difference between palatability and liking evaluation should be addressed more thoroughly in further studies.

In the present study, negative hedonic transfer was found (Experiment 1), but positive hedonic transfer was not (Experiment 2). Ratliff et al. (2012) found implicit attitude transfer not only in the negative direction but also in the positive direction. If this is true, once marketers successfully make their brand positive to consumers, the brand extension may also become desirable. On the other hand, especially in the domain of food consumption, there is considerable evidence of the negativity bias where the negative information is more influential in evaluation than positive information (e.g., Rozin & Royzman, 2001). This may explain the asymmetric results in this study: prior knowledge of context beverage (Experiment 1) was more influential than context beverage (Experiment 2) because the former was negative and the latter was positive (or neutral). However, there are some methodological problems in the design of Experiment 2. In Experiment 2, participants tasted two beverages sequentially in a relatively positive direction (i.e., from the positive (or neutral) context stimuli to the negative target stimuli), but this was perhaps an insufficient positive; in other words, participants had not tasted a context *positive* beverage followed by a target *neutral* beverage. Further research is needed to determine whether positive hedonic transfer can occur as well as the negative

hedonic transfer demonstrated in the present study.

In conclusion, our findings support the existence of hedonic transfer in palatability evaluations of a context beverage (hedonically negative) to those of a novel beverage (hedonically neutral) of the same brand. The results indicate that brand cues actually affect the palatability of food or beverage products, even if the brand has no cultural value or familiarity. This phenomenon likely reflects consumers' evaluative processes based on brand categorization during hedonic evaluation.

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