

Subjective Happiness and Emotional Responsiveness to Food Stimuli

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Abstract Through three studies, this study aims to investigate the relationship between subjective happiness and responsiveness to eating and to foods. In Study 1, 299 Japanese undergraduates completed the Japanese subjective happiness scale and self-report questionnaires for attitudes toward eating and food. Study 1 revealed that in daily life, people with higher happiness levels show a stronger tendency to feel pleasure by eating than those with lower happiness levels. In Study 2, 26 Japanese undergraduates performed impression assessments for foods when looking at pictures of them. In Study 3, 22 Japanese undergraduates performed the same assessments when looking at real foods and eating them using a comparison with the data from pictures of non-food items as a control condition. The results of the study indicate that people with higher happiness levels show a stronger emotional response (happy and glad) to food stimuli than those with lower happiness levels. Even images of food were effective. No such group differences were observed for appetitive responses. It was also shown that emotional responses to the pictures of non-food items' condition in the two groups did not differ. The present studies provided empirical evidence that subjective happiness has relevance to daily eating behavior and attitudes. Further studies should investigate the possibility that subjective happiness is related to a wide range of behavior and cognition in our daily life.

Keywords Subjective happiness · Attitude toward food · Food-related stimuli · Palatability · Positive emotion

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1 Introduction

Over the past few decades, many studies have reported the strong relation between our subjective well-being, or subjective happiness, and socially desirable accomplishments in daily life. When compared with less happy people, happy people have a highly satisfying family life and better interpersonal or romantic relationships and tend to express more positive events and emotions in their daily life (Diener and Seligman 2002). Most of the studies have focused on factors that exert a significant impact on subjective happiness. Income is one of those factors that has been studied intensively, and rising income has been shown to not inevitably be accompanied by increased happiness (Diener et al. 2013). As the relation of subjective happiness with personality and self-esteem, extraversion and neuroticism predicted subjective happiness mediating through self-esteem among adolescents (Cheng and Furnham 2003). Subjective happiness has been regarded as not only an outcome of circumstances but also the cause of more desirable circumstances. High subjective happiness can lead to more cooperation and social responsibility (Edmans 2012), greater work productivity (Harter et al. 2010), a higher ratio of recalling positive emotional events in autobiographical memories (Otake 2015), and a positive effect on effective coping, better health, and longevity (Diener and Chan 2011; Lyubomirsky et al. 2005).

Although these studies have revealed that subjective happiness can influence an important dimension of our lives that is captured by comprehensive and macroscopic concepts, such as health and longevity, little attention has been paid to the relation between subjective happiness and a more concrete and particular behavior or cognition in daily life. Given that our health and longevity can be improved through accumulating daily concrete and particular practices, it is worth examining how subjective happiness influences our daily actions and cognitions. Csikszentmihalyi and Wong (1991) reported that subjective happiness increases when we engage in sports, eat meals, or engage in a hobby. If so, it is possible to speculate that subjective happiness influences daily common behavior. In the present study, we shed light on eating behavior and responses to food stimuli that are essential for our everyday lives (Westenhoefer and Pudel 1993) and examine their relation to subjective happiness. Moreover, we derived the answer for the question as follows: Are attitudes toward eating or cognitive and behavioral responses to food for individuals with higher levels of subjective happiness different from those of individuals with lower levels of happiness?

Previous studies investigated the interrelationship between eating behavior and emotion. Gómez-Pinilla (2008) clearly described the neural and molecular mechanisms that are responsible for the effect of diet on brain health and cognitive and emotional function. In contrast, studies using questionnaires have indicated that our emotions have a significant effect on our eating behavior (Macht 2008). In particular, negative emotion has been noted to be a risk factor in eating behavior. For example, negative emotions have been shown to cause overeating in obesity (Van Strien and Ouwens 2003) and to trigger various eating problems such as binge eating (Agras and Telch 1998; Jasinska et al. 2012; Nolan et al. 2010). The mechanisms of these increases in food intake have been explained through the psychosomatic theory (Kaplan and Kaplan 1957), a more developed affect regulation model (Telch 1997), and escape theory (Heatherton and Baumeister 1991). In contrast, recent studies have reported the influence of positive emotions on eating behavior. Some have indicated the active role that positive emotions play in promoting healthy eating (Christensen and Brooks 2006; Macht 1999; Macht

et al. 2005; Macht et al. 2002), whereas others have revealed that positive emotions may lead to risky eating behavior (Bongers et al. 2013; Cyders and Smith 2008; Evers et al. 2013; Patel and Schlundt 2001).

Needless to say, it is important not to confuse a positive emotion, e.g., “happy,” as a concept descriptive of a state, with subjective happiness and optimism as the psychological traits associated with the comprehensive concept. States and traits associated with emotions have been distinguished in psychology, though these concepts (trait and state) are strongly interrelated. In particular, this is well-known in studies on negative emotions, for instance, anxiety and anger, and both trait and state questionnaires have been developed for each emotion. On the other hand, as a state/trait associated with positive emotion, some researchers have distinguished the trait gratitude as individual differences from the state gratitude as what is experienced after receiving aid (Wood et al. 2008). Although there are few studies on the distinction between state and trait on positive emotion, we may consider subjective happiness to be a trait associated with positive emotion; however, we may regard the emotion happy as an emotional state. Through this division of the two concepts, it will be possible to investigate the relationship between emotional experiences as a state and personality trait as a long-term individual character. Moreover, the investigation of the influence of subjective happiness on eating behavior may contribute to the resolution of the intertwined relation between emotion and eating behavior.

Recently, the effects of perceiving food images have attracted the attention of researchers who focus on eating behavior. Given that today’s environment presents us with a vast volume of visual food cues all the time (Burger and Stice 2011) and that the information provided by those cues affects our eating behavior (Rousseta et al. 2008), understanding how we respond to a visual image of food is important. Soussignan et al. (2009) revealed that women with anorexia nervosa do not feel positive emotions and happiness from seeing pictures of palatable food, compared to normal individuals. Pictures of high-calorie foods elicited greater motivation in women with binge eating disorder (Svaldi et al. 2010). McNamara et al. (2008) assessed the levels of emotional responses to food images across a wide range of ages, from primary school to university students, and reported that emotional reactions increased with age and that a fearful response was higher in adult females with eating disorder features and body dissatisfaction. Thus, to date, many studies have focused on the types of the responses of people who have abnormal dietary behavior.

In the present study, we attempted to distinguish the state from the trait associated with particular positive emotions, and focused on the influence of individual differences among normal individuals, i.e., individual differences in the level of subjective happiness. We prepared different types of visual food cues, a picture of food and a visual presentation of the real food, and analyzed the variance in the participants’ responses to those cues.

Through three studies, we investigated the relation between subjective happiness and daily eating behavior and responsiveness to food. In Study 1, we confirmed the existence of individual differences in daily eating behavior associated with the difference in subjective happiness. In Study 2, we examined whether the difference in subjective happiness was reflected in the actual responses to food-related stimuli, i.e., pictures of foods. Finally, in Study 3, we replicated the results of Study 2 using different stimuli and attempted a closer examination of differences in responses to food by providing new conditions in which food was displayed as a picture, as a visual presentation of the real food, and as a real food to be eaten, in addition to the comparison with the data from non-food pictures as a control condition.

2 Study 1

The purpose of this study is to confirm the existence of individual differences in eating behavior associated with the difference in subjective happiness. Using questionnaires, we examined whether the participants' level of subjective happiness is relevant to their attitude toward eating and food in their daily lives. When compared with less happy people, we hypothesized that happy people derive more pleasure from eating and meals.

2.1 Method

2.1.1 Participants

Participants were 299 (93 males and 206 females) Japanese undergraduates (mean age = 19.6 years and SD = 2.28, age range 18–53 years), enrolled in psychology classes, who completed the questionnaire for course credit.

2.1.2 Measures

2.1.2.1 Japanese Subjective Happiness Scale A Japanese version of Lyubomirsky and Lepper's (1999) subjective happiness scale, called the Japanese subjective happiness scale (JSHS), was developed and has been confirmed for internal consistency, test–retest reliability, factorial validity, convergent validity, and discrimination validity (Shimai et al. 2004). The JSHS has satisfactory internal reliability ($\alpha = .84$) in this study. The scale contains four items. The first item asks the participants to characterize themselves using absolute ratings from 1 (=not a very happy person) to 7 (=a very happy person). The second item asks the participants to characterize themselves relative to their peers from 1 (=less happy) to 7 (=more happy). The third item provides a general description of happy people ("Some people are generally very happy, and they enjoy life regardless of what is going on, getting the most out of everything") and asks the participants to rate from 1 (=not at all) to 7 (=a great deal) on how well this characterization describes them. Finally, the fourth item is reverse worded and similarly asks the participants to what extent an unhappy characterization ("some people are generally not very happy, and although they are not depressed, they never seem as happy as they might be") fits them, ranging from 1 (=not at all) to 7 (=a great deal). Answers to all four items were combined and averaged into a single JSHS composite score, with higher scores reflecting greater subjective happiness. Based on their JSHS scores and the standard deviation, we divided them into a high happiness group (scores >20) and a low happiness group (scores <16) in this study. Following this classification, the total scores were averaged into a single JSHS composite score.

2.1.2.2 Questionnaire on Attitudes Toward Eating An originally designed questionnaire on attitudes toward eating composed of three items. As a preliminary investigation, we asked ten people what they had eaten for and extracted three categories from the qualitative data obtained in the interviews. The first item asked the participants "what does eating mean to you?" Responses were recorded as a percentage for each choice (to satisfy hunger, to acquire power, to feel pleasure, and other), with responses equaling 100 % in total. The second and third items addressed a positive attitude toward eating by asking "do you like eating?" and "do you find happiness by eating?" The participants

responded to each question by assigning a numerical value ranging from 0 (=not at all) to 4 (=perfectly).

2.1.2.3 Pleasantness Estimation in Positive and Negative Situations The pleasantness estimation questionnaire asked the participants to evaluate the level of pleasantness they would feel if they ate something in positive and negative meal situations. This was an originally designed questionnaire, and we developed the four items that comprise the pairs (positive vs negative) through interviews. For positive situations, the participants were asked to rate the pleasantness: “When I ate my favorite foods,” “when I ate something with an intimate friend,” “when I ate the choicest foods,” and “when I was very hungry.” Similarly, there were four negative scenarios: “When I ate foods I found disgusting,” “when I ate with a person I hated,” “when I ate the cheapest foods,” and “when I was very full.” The reliability of this questionnaire in each situation was established using Cronbach’s alpha test, while maintaining the internal consistency of positive situations ($\alpha = .70$) and negative situations ($\alpha = .72$). Responses for each situation were given as a numerical value ranging from 0 (=not at all) to 4 (=very pleasant).

2.1.3 Procedure

The participants answered three questionnaires as part of a booklet in their classes. Before completing the questionnaires, it was ensured that the participants were entirely informed about the purpose of this study and that they confirmed their full consent. In our studies, in order to investigate the influence that the strong tendency of the trait of subjective happiness had on our responses to eating behavior, we focused on two specific groups whose happiness trait was more definite. We divided the participants into two groups (high- and low-happiness groups) based on the JSHS mean scores and the standard deviation.

2.2 Results and Discussion

The total mean score of all four items on the JSHS was 17.7 ($SD = 3.92$). The mean JSHS item score for the high happiness group ($n = 81$, 24 males and 57 females) was 5.59 ($SD = 0.58$) and for the low happiness group ($n = 112$, 38 males and 74 females) was 3.48 ($SD = 0.64$). The *t* test revealed a significant difference in the mean score between groups ($t(191) = 23.38$, $p = .001$). In the JSHS scores, there was no sex difference between the groups.

The mean percentages of each choice (to satisfy hunger, to acquire power, for pleasure, and other) in the questionnaire for each group are shown in Table 1. The percentage

Table 1 Mean percentages of each choice by high and low happiness groups in answer to the question “What does eating mean to you?”

Alternatives	High happiness group	Low happiness group
To satisfy hunger	44.3	51.8
To acquire power	20.5	16.4
For pleasure	33.2**	27.2**
Others	2.0	4.6

** $p < .01$

selecting the “for pleasure” option was significantly higher in the high happiness group ($t(191) = 2.76, p = .006$). The mean scores for the question “do you like eating?” were not significantly different between the high and low happiness groups. However, the high happiness group scored higher on the question “do you find happiness by eating?” ($t(191) = 2.71, p = .007$). Scores did not differ between males and females.

The total scores from the pleasantness estimation for each positive and negative meal situation in the high happiness group were higher than those in the low happiness group ($t(191) = 2.19, p = .038$). A more detailed analysis of each negative scenario showed that the high happiness group experienced a significantly greater level of pleasantness in three of the negative scenarios (Table 2).

These results support the hypothesis. First, the participants’ level of subjective happiness was relevant to their attitude toward eating and food in their daily lives. Second, when compared to people with lower happiness levels, people with higher happiness levels showed a stronger tendency to find pleasure in eating and to feel pleasure by eating. Thus, the question whether this tendency is observed in the actual responses to food-related stimuli is raised.

3 Study 2

Study 2 was designed to investigate the differences in hedonic responses to food-related stimuli between people with high and low happiness levels. Given the findings in Study 1 that indicate the tendency of happy people easily to find pleasure in eating, we postulated that people who score high on subjective happiness would be more likely to anticipate a feeling of pleasantness or to feel positive emotion than people with a low score, when they look at pictures of foods and dishes.

3.1 Method

3.1.1 Participants

Participants were 26 (9 males and 17 females) Japanese undergraduates (mean age = 19.7 years and $SD = 0.51$, age range 18–20 years) who participated in the experiment in exchange for course credit. The JSHS survey was administered in their psychology class in advance, and the participants were classified into the high or low happiness group in the same manner as that done in Study 1. There were 14 high happiness (6 males and 8 females) and 12 low happiness participants (3 males and 9 females) who provided consent for the study.

Table 2 Mean scores for each negative meal situation for high and low happiness groups

Situation	High happiness group	Low happiness group	<i>t</i> value
When I ate food I found it disgusting	0.41 ± 0.54	0.26 ± 0.46	2.12*
When I ate with a person I hated	1.40 ± 0.91	1.13 ± 0.85	2.16*
When I ate the cheapest foods	2.07 ± 0.74	1.96 ± 0.57	1.22
When I was very full	1.70 ± 0.76	1.48 ± 0.73	2.10*

* $p < .05$

3.1.2 Materials

3.1.2.1 Pictures of Food Based on a preliminary experiment with 8 additional undergraduates, 15 colored pictures of foods and meals, all of which were highly regarded as stimuli that would increase the students' appetites, were selected from a large set of JPEG files free from copyright on CDs. They included pictures such as curry and rice, sushi, sukiyaki, an omelet with rice, boiled and seasoned noodles, grilled fish, cakes, Japanese sweets, and fruits. All the pictures were pasted randomly one by one into slides in a PowerPoint file.

3.1.2.2 Impression Assessment for Pictures Impression was assessed by asking the participants to evaluate a picture of each food. As a preliminary experiment, we developed the 17 items on the scale of impression assessment for foods through interviews. We investigated the scores of the 17 items after exhibiting the 10 pictures of foods to 76 female undergraduate students (mean age = 19.42 years and SD = 0.85, age range 19–24 years), and finally 7 items were selected by item analysis. Factor analysis revealed two components and the cumulative contribution ratio was 80.67 %. The first factor was identified as "emotional aspects," comprising 3 items: "felt happy," "became glad," and "was excited." The second factor was concerned with motivational or physiological aspects, and named "appetitive aspects," which consisted of 4 items: "looked delicious," "stimulated appetite," "desired to eat it," and "salivated." The reliability of each factor was established using Cronbach's alpha test, where the internal consistency of "emotional aspects" was $\alpha = .92$ and that of "appetitive aspects" was $\alpha = .87$. We used this 7-item scale, including two factors, to assess the impression of food pictures. The reliability of the two aspects in this study established the total scores of all food pictures, and it was shown that the internal consistency of "emotional aspects" was $\alpha = .97$ and that of "appetitive aspects" was $\alpha = .84$. The participants responded on a five-point scale (from 0 "not at all" to 4 "perfectly") for each assessment. Following each assessment, using absolute ratings from 0 (=hate) to 4 (=love), the participants answered a question about their preference for food presented on a screen.

3.1.3 Procedure

The participants who agreed in advance that they would eat nothing after breakfast took part in the experiment before lunch in a small group. They received instructions for the experiment and were informed of their option to terminate the experiment at any time.

The pictures in the PowerPoint file were presented on a screen (1.5 m \times 2.0 m) using a projector with a time of 20 s per item. The participant's task was to assess his or her impression of each food picture on the basis of several different aspects.

3.2 Results and Discussion

First, the participants' responses to the question about the preference for each food were checked because it would be reasonable to assume that people assess the impression of the food they hate as very low irrespective of any other aspect. Responses rated as "0" (=hate) were observed in only 9 out of 390 responses, and those responses were excluded from the subsequent analysis. Further, there was no significant difference in mean values to the question for any food picture between the groups with high and low subjective happiness

levels. These results supported the notion that personal preferences for food would not seriously influence the results in the experiment described below.

Scores for each impression assessment in each participant were calculated by averaging the ratings for all 15 pictures. The mean scores for each impression assessment for the high and the low happiness groups are shown in Fig. 1. The high happiness group scored significantly higher than the low happiness group in three assessments that were concerned with emotional aspects: “felt happy” ($t(24) = 2.67, p = .013$), “became glad” ($t(24) = 2.29, p = .031$), “was excited” ($t(24) = 2.42, p = .024$). Next, in the appetitive aspect, it was shown that the scores for “looked delicious” ($t(24) = 2.72, p = .012$) was significantly higher in the high happiness group than those in the low happiness group. Mean scores in the other three assessments that dealt with appetitive aspects showed no significant difference between the two groups.

These results indicate that people with a high subjective happiness score have a tendency to anticipate pleasantness and to feel positive emotion more sensitively than people with a low subjective happiness score, when they look at food pictures. The participants’ level of subjective happiness is relevant not only to their attitude toward eating and food in their daily lives, as shown in Study 1, but also to their actual responses to the visual stimuli of food. Furthermore, the results revealed that the sensitivity in people with a high level of happiness emerges in three (happy, glad, and excited) positive emotional aspects and one (looked delicious) appetitive aspect. It may be interesting to correlate this result to the distinction between “liking/pleasure” and “wanting/desire” in research on the mechanism of human eating behavior (Finlayson and Dalton 2012).

4 Study 3

The aims of this study were to replicate the results of Study 2 with different stimuli and to make a closer examination of the differences in the participants’ responses to food stimuli by providing new conditions in which food was displayed as a picture, as a visual



Fig. 1 Mean scores for each impression assessment for the high and the low happiness groups. $*p < .05$

presentation of the real food, and as a real food to be eaten, in addition to the comparison with the data from non-food pictures as a control condition.

4.1 Method

4.1.1 Participants

Participants were 33 (8 males and 25 females) healthy Japanese undergraduates (mean age = 20.1 years and SD = 0.53, age range 19–21 years) who took part in the study in exchange for course credit. None of them had participated in Study 1 or 2. We administered the JSHS survey in advance and classified the participants into a high or low happiness group in the same manner as that done in previous studies. There were 12 high happiness (2 males and 10 females) and 21 low happiness participants (7 males and 14 females) who provided consent for the study.

4.1.2 Materials

4.1.2.1 Food and Pictures Four types of foods (a cookie, chocolate, a potato chip, and gummy candy) were selected as target foods because they were very popular among young Japanese people. Each food was arranged on a white dish and photographed by a research staff with a digital camera (Cannon IXY digital 2000IS), and the food was actually presented after the presentation of the pictures.

Fifteen other pictures of foods were selected from a large set of JPEG files that was not copyrighted on the basis of the fact that they had promoted appetite in a preliminary experiment with 14 additional undergraduates. They included pictures of foods such as sushi, pizza, rice balls, a hamburger, a steak, pasta, cake, Japanese sweets, and fruits. Six pictures of non-food items, used as a control condition, were of a key, a desk, a pen, stationery, a binder, and a trash can; these pictures were also selected from a set of JPEG files that was not copyrighted. Thus, the stimulus set consisted of 25 pictures: Four pictures of food that had been photographed, 15 food pictures, and 6 non-food pictures. All of them were pasted randomly one by one into slides in a PowerPoint file.

4.1.2.2 Impression Assessment for Pictures and Real Foods Items of impression assessment were the same as those in Study 2. Three emotional aspects, “felt happy,” “became glad,” and “was excited,” and four appetitive aspects, “looked delicious,” “stimulated appetite,” “desire to eat it,” and “salivated,” were performed for each picture and for each actual presentation of food.

4.1.3 Procedure

The participants who had been directed in advance to eat nothing after breakfast completed the experiment between 10:00 a.m. and 1:00 p.m. In a small group. After having a seat, they received instructions for the tasks and were informed of their option to terminate the experiment at any time.

First, 25 pictures were shown on a screen (1.5 m × 2.0 m) using a projector with a presentation time of 20 s per picture. The participants performed seven impression

assessments for each picture. Next, the four target foods were presented randomly to each participant by placing the food on the table, and the participants assessed their impression in the same manner as the assessments for the pictures. Finally, the participants performed impression assessments after tasting each of the four foods. Thus, each of the four target foods was presented in each of three different forms (looking at a food picture, looking at real food, and eating the food). In addition, it was noted that the same food was not exhibited in succession in three different conditions.

4.2 Results and Discussion

Prior to the analyses of the assessment scores, the participants' personal preferences for each food were checked. No participants gave the "0" (hate) response to any food picture in this study, and there were no significant differences between the high and low happiness groups in the mean values of preference scores for the food pictures. Therefore, it would be safe to say that personal preferences for food presented in the experiment did not seriously influence the results described below.

The mean scores for each impression assessment for the high and low happiness groups are shown in Fig. 2. The scores for "felt happy" ($t(31) = 2.16, p = .040$) and "became glad" ($t(31) = 2.09, p = .045$) were significantly higher in the high happiness group than those in the low happiness group. Although the scores for "was excited" ($t(31) = 1.79, p = .083$) and "looked delicious" ($t(31) = 1.87, p = .071$) were marginally higher in the high happiness group than those in the low happiness group, there were not significant. In other assessments, no significant difference was observed between the two groups. These results approximately replicate those of Study 2. When they look at a food picture, people who rank high in subjective happiness tend to feel positive emotion more sensitively than people with a low subjective happiness score. Additionally, the sensitivity of high happiness people emerges only in such positive emotional responses as "happy" and "glad."

Next, responses to the four target foods were examined. Assessment scores in each presentation condition of each participant were averaged across the target foods and underwent two-way repeated-measure analyses of variance (ANOVAs) for each

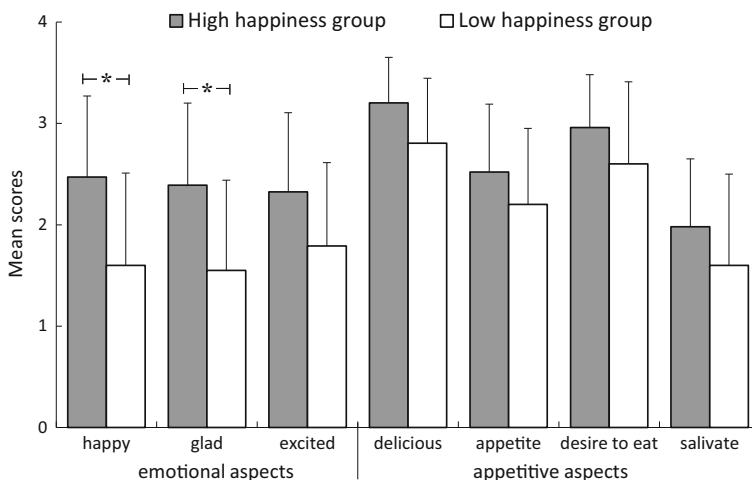


Fig. 2 Mean scores for each impression assessment for the high and the low happiness groups. * $p < .05$

impression assessment with the presentation condition (“looking at a food picture,” “looking at real food,” and “eating the food”) as a within-subject factor and the group (high vs. low happiness group) as a between-subject factor (see Fig. 3, 4). For the assessment “felt happy,” the ANOVA revealed significant main effects of the presentation condition ($F(2, 62) = 15.26, p = .001$) and the group ($F(1, 31) = 5.66, p = .024$) and a significant presentation condition by group interaction ($F(2, 62) = 5.13, p = .009$). Further analysis of the interaction revealed that there was a significant simple main effect only in the low happiness group, and that the “looking at real food” condition was significantly

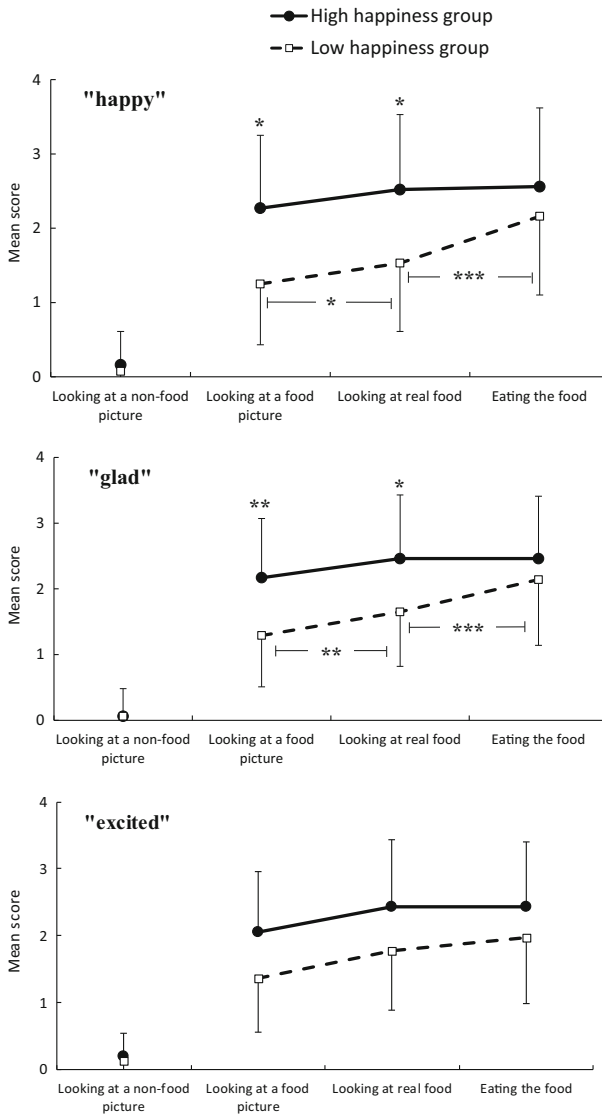


Fig. 3 Mean scores on each impression assessment of emotional aspects by conditions and groups. * $p < .05$; ** $p < .01$; *** $p < .001$

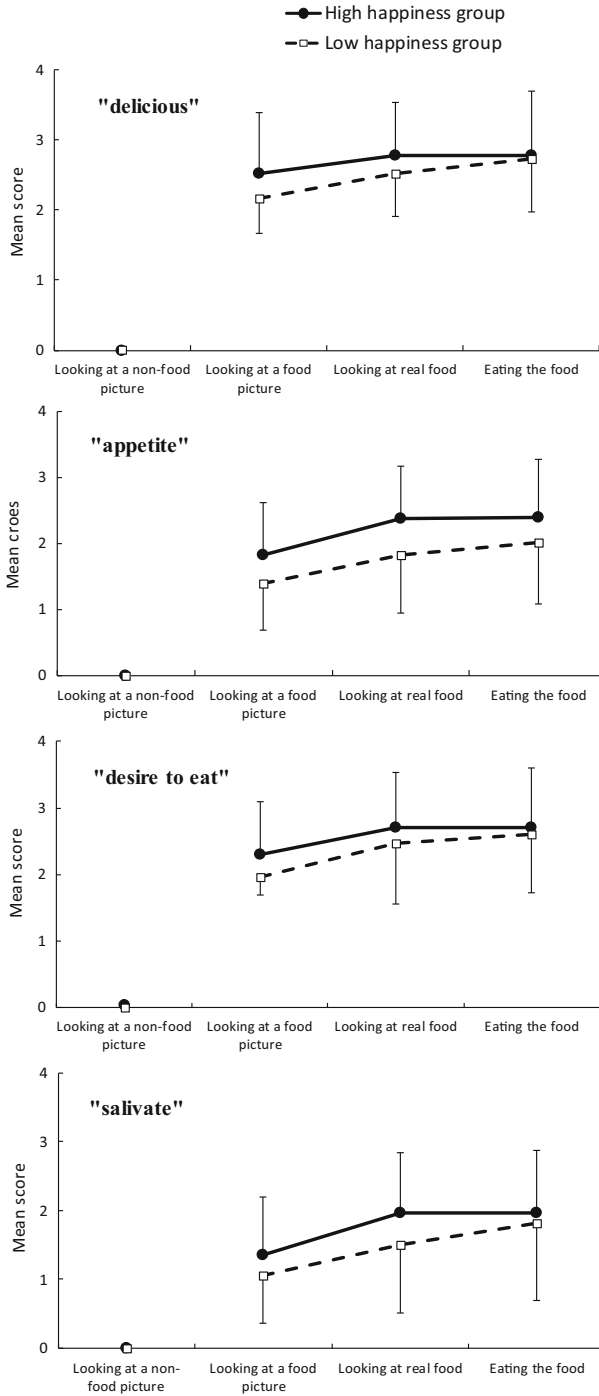


Fig. 4 Mean scores on each impression assessment of appetitive aspects by conditions and groups

higher than the “looking at a food picture” condition ($p = .016$), and the “eating the food” condition was higher than the “looking at real food” condition ($p = .001$). Such an effect was not observed in the high happiness group. The difference in the mean scores between the high and low happiness groups was significant in the “looking at a food picture” condition ($F(1, 31) = 4.86, p = .035$) and in the “looking at real food” condition ($F(1, 31) = 3.99, p = .050$) and was not significant in the “eating the food” condition. Similarly, for the assessment “became glad,” the main effects of the condition ($F(2, 62) = 12.44, p = .001$) and the group ($F(1, 31) = 4.60, p = .040$) and a condition by group interaction ($F(2, 62) = 3.50, p = .036$) were significant. Further analysis of the interaction revealed that there was a significant simple main effect only in the low happiness group, and that the “looking at real food” condition was significantly higher than the “looking at a food picture” condition ($p = .002$), and that the “eating the food” condition was higher than the “looking at real food” condition ($p = .001$). Such an effect was not observed in the high happiness group. The difference in the mean scores between the high and low happiness groups was significant in the “looking at a food picture” condition ($F(1, 31) = 8.22, p = .007$) and the “looking at real food” condition ($F(1, 31) = 6.29, p = .018$) and was not significant in the “eating the food” condition. For each of the other impression assessments, only a significant main effect of the presentation condition was observed: “was excited” ($F(2, 62) = 8.80, p = .001$), “looked delicious” ($F(2, 62) = 7.85, p = .001$), “stimulated appetite” ($F(2, 62) = 17.88, p = .001$), “desire to eat it” ($F(2, 62) = 10.68, p = .001$), and “salivated” ($F(2, 62) = 25.13, p = .001$).

Although the difference between the groups that was found in the condition “looking at a food picture” could be interpreted as the difference in sensitivity to food pictures between the groups that was also observed in fifteen pictures assessments of this study and in Study 2, some of the new findings were provided by comparing scores from the three different presentation conditions of the target foods. First, the scores in people with higher happiness levels were always high irrespective of the condition, whereas the scores in people with lower happiness levels were low in the “looking at a food picture” condition and high in the “eating the food” condition. Considering that positive emotion felt by people with lower happiness levels was at almost the same level as that felt by people with higher happiness levels when they actually ate the food, the responses of people with higher happiness levels to food pictures can be said to reflect the anticipatory positive emotion they would feel if they actually ate the food. The possibility that people with higher happiness levels may be too ready to respond with positive emotions to any stimuli can be rejected because there was no difference between the two groups in responses to the non-food pictures. Another finding is that differences between groups were observed in assessments of such emotional aspects as “happy” and “glad” but not in assessments of appetitive aspects. Similar to results in Study 2, this phenomenon also implies relevance to the difference between “liking” versus “wanting” aspects of human eating behavior. Additionally, the significant difference between groups was not observed in an assessment of the emotional aspect “excited.” Because the statement “was excited” is stronger than the other two emotional statements “felt happy” and “become glad,” it might not have aligned with participants’ perception of how it affected the mood.

5 General Discussion

The results of these studies revealed that the participants’ level of subjective happiness is relevant to their attitude toward eating in their daily lives and to their actual responses to food-related stimuli. Moreover, it became clear that people with higher happiness levels

show a stronger tendency to find pleasure in eating and to feel pleasure by eating than people with lower happiness levels, and that positive emotion is easily aroused in people with higher happiness levels in response to a picture of food as if they were actually eating the food. This may be the first empirical evidence that indicates a relation between subjective happiness and daily eating behavior and attitude. The implications of the results for understanding subjective happiness and eating behavior are discussed below.

The psychological traits associated with positive emotions in people with higher happiness levels can be summed up as a strong tendency to sensitively anticipate positive emotions, especially the emotions happy and glad, when they perceive food-related stimuli or when they think about eating and food. As noted above, it is important not to confuse a positive emotion, e.g., “happy” as a state descriptive concept with “subjective happiness” as a trait associated with a more comprehensive concept. A higher correlation will be observed between the psychological state and positive emotion traits. Therefore, at a glance, the result that happy people can increase their happy emotion as compared with less happy people by only looking at food may be unsurprising. However, in the results of Study 3, it was shown that emotional responses to the pictures of non-food items’ condition did not differ between happy people and less happy people. Therefore, daily stimuli do not always relate high subjective happiness as a psychological trait to higher positive emotion as a state. This result seems to be extremely interesting, and it shows evidence of a distinction between state and trait in positive emotion.

However, it is not clear why only individuals with higher happiness levels show such a tendency. By focusing on its anticipatory nature, when compared with individuals with lower happiness levels, we can interpret the behavior of individuals with higher happiness levels as being the result of a more sensitive and “broadened” functioning. The psychological trait of subjective well-being relates to a global bias consistent with a broadened attentional focus (Basso et al. 1996). Positive emotions have become widely recognized to affect our cognitive functioning, e.g., memory retrieval and creativity, in the direction of the broadened functioning of the behavior of individuals (Fredrickson 1998, 2001). Fredrickson’s “broaden-and-build theory” states that experiences of positive emotions broaden people’s thought–action repertoires, serves to build their enduring personal resources, and finally increases psychological well-being as the psychological trait in our individual differences. Hence, higher subjective happiness as a positive emotional trait promotes more positive emotional experiences as a state, and these relations circulate. For instance, it was shown that people who have a higher trait of gratitude made more positive beneficial appraisals, and benefit appraisals were shown to have a causal effect on the state of gratitude (Wood et al. 2008). The reason may be because people with higher happiness levels are prone to have positive emotional states, and those states may have a supposed effect, or it may be because of another property that individuals with higher happiness levels possess. Further examination is required.

A previous study reported that subjective happiness increases when a person eats daily meals (Csikszentmihalyi and Wong 1991). The present study implies that there may be individual differences in sensitivity to the happiness-increasing effect of the daily eating experience, even if the eating experience has such an effect. There will be a reciprocal process in which the individual difference in sensitivity to the happiness-increasing effect influences the size of the effect from the daily eating experience, and now the difference in the size of the effect develops differentially individual’s level of subjective happiness or the sensitivity to the effect. Needless to say, the present study only showed a relationship between subjective happiness and responses of eating behavior and did not examine directly the causality between them. So we should be careful when considering the

implication of the result. Even so, a closer examination of such reciprocity is desirable to understand the development of subjective happiness, and to that end, obtaining a detailed recording of the daily eating behavior and correlating this with the levels of subjective happiness will be necessary (Veenhoven 2008).

In our studies, the significant differences between the high and low happiness groups when they looked at a food picture were observed in the impression assessments of the two emotional aspects, “felt happy,” and “became glad,” and not in the assessments of the appetitive aspects. Many researchers who study human eating behavior and appetite discuss the distinction between “liking” and “wanting” components (Berridge 2009; Finlayson and Dalton 2012; Havermans 2012), although the two often occur together (Berridge 2009). There is a significant crossover between the content of the impressions assessed in the present study and popular questions used to measure “liking” and “wanting” food. Therefore, it would be fair to translate the sentences about the results mentioned above as follows: The level of subjective happiness is relevant to the “liking” aspect but not the “wanting” aspect of eating behavior. Burger et al. (2011) investigated the subjective ratings for food appeal (liking) and the desire to eat (wanting) when people were exposed to food pictures and found that the results supported the distinction between the two. If “pleasure” (liking) must be translated into motivation or “wanting” for a food reward to influence the actual eating behavior (Berridge 2009), the current finding that the level of subjective happiness affects “liking” but not “wanting” must shed light on the subtle requirements for such a translation.

In addition, recent fMRI studies have indicated that restrained eaters find palatable food more appealing (liking) than others when eating the food but not when looking at the pictures (Burger and Stice 2011; Stice et al. 2013). On the other hand, individuals with higher happiness levels in the present study find palatable food more pleasurable (liking) than others when looking at the pictures but not when eating the food. This contrast could be found only by comparing the results of the experiments in which the participants’ responses to images of food, anticipated food, and actual intake of food were all examined. Investigating the reason for these differences between restrained eaters and normally happier people will also provide clues to clarify the translation process mentioned above.

Furthermore, individuals with higher happiness levels in the present study had a tendency to find pleasure in eating and to feel pleasure by eating in their daily lives. Recent studies have pointed out that positive emotions may lead to a risky eating behavior (Bongers et al. 2013; Cyders and Smith 2008; Evers et al. 2013) and the dangers of eating for pleasure or hedonic eating (Burger and Stice 2011; Lutter and Nestler 2009; Mela 2006). Burger et al. (2011) reported that the body mass index of the participants was positively related to the desire to eat but not to the appeal ratings, interpreting this as a suggestion that the desire to eat may play a larger role in the dysregulation of weight status relative to the food preference. Some previous studies also suggest that obesity may be related to a greater motivation for food (Mela 2001). Nevertheless, in the present study, the participants in the high happiness group were not out of the normal weight range and did not have any food-related problems. This somewhat complicated the relation between happiness and positive emotion, and the risks of eating will require a more careful examination of the factors and contents dealt in each experiment and questionnaire. As Berridge (2009) suggested, the distinction between the conscious and unconscious components of the psychological process related to eating behavior must be considered.

The present study has several limitations. Initially, we only provided evidence for a correlation between subjective happiness and responses of eating behavior; however, we did not directly examine the causality between them. For example, the impression assessments’

phrasing in Study 3 allows the possibility that participants responded according to their state irrespective of the item presented. If that is the case, then participants in the high happiness group scoring higher than those in the low happiness group might not be surprising. However, we can counter this argument by indicating the overall difference between assessing food stimuli and non-food stimuli (see Fig. 3). Thus, studying in detail mechanisms connecting them through an experiment that manipulates these factors more directly is necessary to achieve better understanding of the relationship between these factors (for example, investigating whether emotional responses to food stimuli first change through increased happiness among low-happiness groups). Next, as an experimental limitation, stimuli used in the present study still leave room for improvement. For example, although we selected emotionally neutral non-food pictures as control stimuli in Study 3, pleasurable non-food pictures (e.g., beautiful flowers, cute children) might be more desirable if we focused on people's responses that were characteristically observed to food pictures. The quantity and quality of food stimuli used in the present experiments were also limited. A wider range of food stimuli, including food that is likely to induce negative emotions, should be presented to the participants to minutely examine the characteristics of participants' responses to food-related stimuli. Further, the range and the number of participants should be larger, although gathering attendees who match a predefined range on the subjective happiness score is difficult. This limitation leads us to be concerned about the cultural differences in subjective happiness and emotional responsiveness to various stimuli, including food pictures. Finally, not only a subjective rating but also behavioral measurements, such as the amount of food eaten, should be used to measure the aspects of "liking" and "wanting" to obtain a more comprehensive understanding of the properties in the eating behavior of individuals with higher happiness levels.

As our studies focused on the relationship between subjective happiness and food-related cognition and behavior, we could not examine the relations between subjective happiness and other types of daily cognition and behavior. There is a possibility that the characteristics of the responses of happy people to food-related stimuli observed in the present study may be obtained by examining their responses to a wide variety of non-food, daily stimuli. Kringelbach and Berridge (2009) discussed the relationship between pleasure or positive emotion and happiness from the perspective of neuroscience and suggested that happiness might be gained by improving the pleasure and positive emotion in our daily life. In their discussion, pleasure (liking) through eating was not differentiated from pleasure that had other origins. Future studies should be conducted that aim to clarify the relationship between subjective happiness and people's daily cognition and behavior by examining emotional and cognitive responses to various daily stimuli of people at high and low subjective happiness levels.

In conclusion, the present studies provided empirical evidence that subjective happiness has relevance to eating behavior, and that individuals with higher happiness levels show unique characteristics in "liking" and "wanting" responses to food-related stimuli. Future research is necessary to overcome the limitations of the present studies described above and to expand the possibility of a positive relationship between subjective happiness and the responsiveness to stimuli, from a limited (food-related) to a wide range (various daily common) of stimuli.

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