Original Research

SAGE Open
January-March 2021: 1–7

DOI: 10.1177/2158244021989318
journals.sagepub.com/home/sgo
SAGE

Fear Reduces Perceived Sweetness: Changes in the Perception of Taste Due to Emotional State

Naoya Zushi[1], Midori Ogawa[1], and Saho Ayabe-Kanamura[1]

Abstract

The taste of food and beverages can depend on changes in our taste perception. Also, this change may be due to emotional state. This study manipulated the emotional state of participants by having them watch different types of movies: comedy, horror, and documentary. High state anxiety was triggered among the participants who watched a horror movie, and high juice consumption was confirmed among them. The perception of sweetness of the mixed juice was found to be reduced in the horror movie group compared with the other two groups. Also, we also confirmed the negative correlation between perception of sweetness and state anxiety. Furthermore, the relationship between liking the juice and perception of sweetness was found to differ according to emotional state. This study confirms that our emotional state affects our perception of taste, including that feeling fear and anxiety can reduce the perception of sweetness.

Keywords

taste perception, emotional state, emotional state manipulation, sweetness, fear

Introduction

The ability to taste is important for enjoying eating and maintaining health. A study by Goldstein et al. (2005) indicated that taste perception was associated with body mass index (BMI). PROP non-taster women had a higher mean BMI than PROP supertaster women.

However, the tastes we perceive are influenced not only by the characteristics of the food and beverages themselves but also by the various contexts in which they are consumed. In fact, several research studies have reported that sound affects taste sensation. For example, Zampini and Spence (2004) verified that amplifying the loudness of the sound heard when biting potato chips or emphasizing high-frequency sounds increased the perception of freshness and crispness. Wang and Spence (2016) found that the sweetness of mixed fruit juice was enhanced by listening to consonant soundtracks, and its sourness was enhanced by listening to dissonant soundtracks. In addition, many wine marketers are currently using this multisensory perception in their marketing (Spence, 2019). Another study (Reinoso-Carvalho et al., 2017) found that chocolate was perceived as creamier and sweeter when participants were listening to soft or smooth sounds than when they were listening to hard or rough sounds.

Concerning the association between vision and taste, it has been reported that the flavor of strawberry mousse was perceived as sweeter and more intense when served on a white plate than when the same mousse was served on a black plate (Piqueras-Fiszman et al., 2012). A study on beetroots determined they were rated as less sweet when their presentation was angular (i.e., three pieces of beetroot were cut into pyramids and displayed so as to form a triangle) on a square plate, when compared with a rounded presentation (i.e., three pieces of beetroot were cut in half-spheres and displayed in a circle); the same beetroots on a round plate resulted in the perception of sweeter flavor (Fairhurst et al., 2015). Taken together, these findings indicate that the perception of taste can change depending on contextual factors.

One of these factors seems to be the emotional states people experience in their daily lives. Mattar et al. (2019) found that participants who watched a violent movie consumed more fatty and salty foods than did participants who watched a non-violent movie. A recent study (Wang & Spence, 2018) showed that seeing pleasant visual stimuli, such as a child's smile, can increase the perception of sweetness; conversely, seeing unpleasant stimuli, such as a crying face, can increase

[1]University of Tsukuba, Japan

Corresponding Author:
Naoya Zushi, Graduate School of Comprehensive Human Science, University of Tsukuba, 1-1-1, Tennnohdai, Tsukuba, Ibaraki 305-8572, Japan.
Email: picturemaster0718@gmail.com

the perception of sourness. Another study (Reinoso-Carvalho et al., 2019) found that participants perceived beer as being sweeter when they listened to positive music compared with when they listened to negative music. Kantono et al. (2016) also indicated that listening to music one disliked decreased pleasantness ratings of chocolate gelati, increased bitter, and decreased sweet sensation ratings.

Noel and Dando (2015) focused on hockey fans, and examined the correlation between their satisfaction with a hockey game and how they evaluated the taste of ice cream. The study found that fans perceived more sweetness when they felt more satisfaction with the game. Meanwhile, they tasted more sourness when they felt less satisfaction. Mattar et al. (2015) reported that the types of movies that participants watched did not affect their hunger or appetite, but triggered food preferences. Participants who watched a romantic movie showed more of a preference toward eating something sweet than did participants who watched a horror movie. However, Siervo et al. (2013) found that participants who played violent video games reported a tendency toward sweet food consumption.

Ileri-Gurel et al. (2012) measured participants' taste perception after eliciting stress using the Stroop color-word interference test and the cold pressor test. The results indicated that the taste thresholds for sweetness and saltiness significantly decreased during stressful conditions. Meanwhile, in another study (Heath et al., 2006), a 5-HT-specific reuptake inhibitor (Selective Serotonin Reuptake Inhibitor [SSRI]), an agonist of serotonin receptors within the central nervous system, was administered to patients to reduce their anxiety levels. In this emotional state, there was a significant reduction in their thresholds for tasting sweetness and bitterness. The findings of these two studies are conflicting in terms of the effect of stress and anxiety on the ability to detect sweetness. The reason for this difference may be that different neurotransmitters are involved depending on the degree of anxiety and stress experienced. However, the fact that both studies reported changes in the perception of sweetness suggests that there is some correlation between emotional states and sweetness perception.

In the current body of research, there is insufficient information regarding how a person's emotional state can affect their perception of taste. As the effects of stress and anxiety on the perception of sweetness differed in previous studies, the present study specifically aimed to explore the perception of taste while experiencing anxiety (fear), and then compared this perceptual experience with taste perception while experiencing positive emotions.

Furthermore, sweetness is generally considered to be a favorable taste. Fox and Davidson (1986) found that even infants have a preference for sweetness. In addition, previous research reported that the relationship between a sweetened taste and a liking of it varied with emotional states (Kuenzel et al., 2011). In the study, either a sweetened or unsweetened taste stimulus was given at the same time every day for 1 week to three groups, who experienced different emotional states evoked by viewing a movie. After 3 days, the liking of the sweetened taste stimulus was reported to be different between the relaxed emotion group and the control group. However, there were no group differences in the results of liking the unsweetened stimulus. Therefore, the relationship between liking a taste stimulus and sweetness perception was also examined in the present study.

A previous study indicated that female participants perceived sweetness, saltiness, sourness, and bitterness more intensely than male participants (Fischer et al., 2013). In addition, Noel and Dando (2015) indicated that the degree of change in the perception of creaminess depending on satisfaction was found to be greater among female participants. Thus, we included gender as a factor of analysis, as gender differences were predicted to correlate with the extent to which emotions would be aroused and affect taste sensitivity. It was further predicted that the degree of change in the perception of taste due to emotional state would be greater in female participants.

Materials and Methods

Participants

We estimated an adequate sample size to be 64, by performing a preliminary test to detect the main effect of group ($\alpha = .05$, $1 - \beta = .80$, $f = .40$). In total, 87 Japanese university and graduate school students (39 males and 48 females; aged 18–26 years) were included in the study. Of them, 29 (13 males, 16 females) were assigned to the comedy movie group, 29 (13 males, 16 females) to the documentary movie group, and 29 (13 males, 16 females) to the horror movie group. Participants were randomly assigned to the three groups by order of participation; however, four female participants who declared their dislike of horror movies were assigned to groups other than the horror movie group. Also, each participant was not to control their hunger or thirst levels.

Prior to conducting this study, approval was obtained from the Human Research Ethics Committee of the University of Tsukuba (Tsuku 30-150). All participants were informed regarding what the task entailed and provided written informed consent to participate.

Taste Stimulus

A juice mixture was used as the taste stimulus. The blend ratio was 1:2:2 (Dole grapefruit juice:Dole peach mix juice:KIRIN salty lychee juice). Each sample consisted of 250 mL of juice and was served at room temperature in a 320-mL transparent plastic cup. The taste stimulus was designed to be sweet, salty, sour, bitter, and not unpleasant, and was specifically designed to provide an unfamiliar stimulus. This was confirmed by three members of the laboratory team.

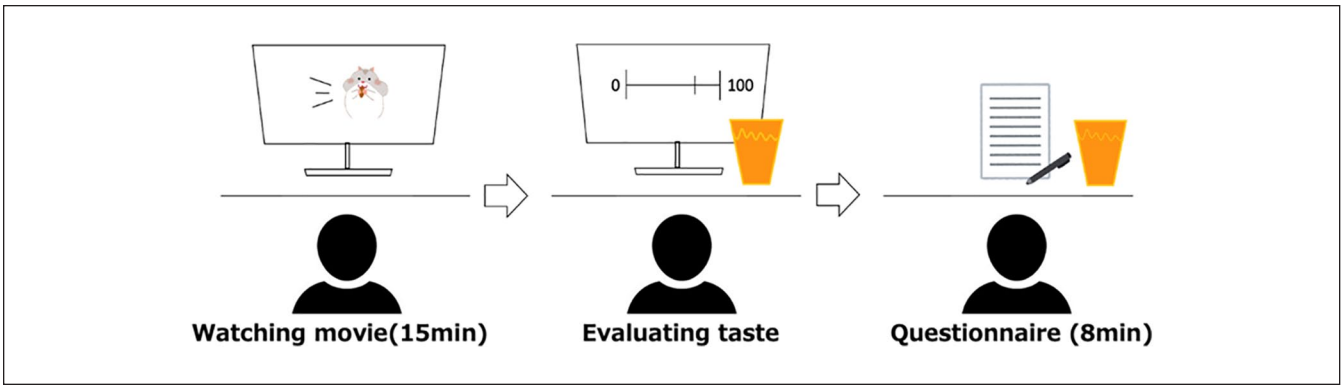

Figure 1. The timeline of this experiment.
Note. Each participant watched one type of movie.

Movie Stimuli

Three movies were used: Delinquent Hamsters (Piso Studio) for the comedy movie group, See the World by Train (Asahi Simbun Publications, Inc.) for the documentary movie group, and Honogurai Mizu No Soko Kara (KADOKAWA) for the horror movie group. Fifteen-minute excerpts were taken from each movie (comedy: ~0:15:18, documentary: ~0:14:45, horror: 1:07:33~1:22:38). These movies were chosen by three researchers to evoke three types of emotions, avoid extremely harsh content, and be unfamiliar to participants (i.e., students in their 20s).

Procedure

Each participant sat in front of a computer screen with headphones and watched the movie that he or she had been assigned to watch. After doing so, participants were asked to drink the juice and evaluate the intensity of its sweetness, saltiness, sourness, bitterness, and umami using a visual analog scale (VAS), ranging from 0 (*no taste*) to 100 (*strong taste*). The VAS is a commonly used psychophysical measure of taste intensity perceptions (e.g., Noel & Dando, 2015; Wang & Spence, 2016). Each VAS for the five tastes was arranged on a single screen, allowing participants flexibility in adjusting their evaluations. Next, participants also evaluated their liking of the juice using a VAS ranging from 0 (*do not like*) to 100 (*like*).

After evaluating the juice, each participant answered the STAI-JYZ (Hidano et al., 2000), the Japanese version of the State–Trait Anxiety Inventory (STAI; Spielberger et al., 1983) used to investigate the state anxiety caused by watching the movies. There are two subscales in STAI. The state anxiety score indicates the degree of respondents' anxiety at that time, while the trait anxiety score shows respondents' ordinary degree of anxiety. Participants could consume the juice freely while evaluating its taste and answering the STAI. The remaining juice was weighed at the end of the experiment. While the participants were watching the movie (15 min) and answering the STAI (8 min), the experimenter waited in another room (Figure 1). Participants were not informed of the aim of the experiment and were told to watch a movie and taste a juice.

Statistical Analysis

Each subscale score of the STAI, consumption and liking of the juice, and intensity of the juice's sweetness, saltiness, sourness, bitterness, and umami were compared for each group using a two-way factorial analysis of variance (ANOVA) with gender (male and female) and group (comedy, documentary, and horror movies) as factors. We also confirmed the group differences using the Bonferroni correction. A p value less than .05 was considered statistically significant. For any tastes that showed a significant difference between groups, the correlation between taste scores and state anxiety was confirmed using Pearson's correlation analysis. Pearson's correlation analysis was also conducted with the liking rates and sweetness scores in each group.

Results

Emotional State

STAI. Regarding the mean trait anxiety score, we found no main effects of group, $F(2, 81) = 1.49$, $p = .2307$, $\eta_p^2 = .04$, or gender, $F(1, 81) = 2.69$, $p = .1047$, $\eta_p^2 = .03$; comedy: male $M = 52.69$, $SD = 9.58$, female $M = 47.94$, $SD = 9.16$; documentary: male $M = 50.08$, $SD = 9.80$, female $M = 45.62$, $SD = 13.07$; horror: male $M = 46.54$, $SD = 11.01$, female $M = 43.94$, $SD = 11.00$. No interaction was found, $F(2, 81) = 0.08$, $p = .9243$, $\eta_p^2 = .00$.

However, for state anxiety scores, a main effect of group was found, $F(2, 81) = 57.87$, $p < .0001$, $\eta_p^2 = .59$ (Figure 2). The mean state anxiety score for the horror movie group was higher than those of the other two groups (comedy: male $M = 35.07$, $SD = 4.30$, female $M = 32.12$, $SD = 6.15$; documentary: male $M = 36.46$, $SD = 7.57$, female $M = 36.5$, SD

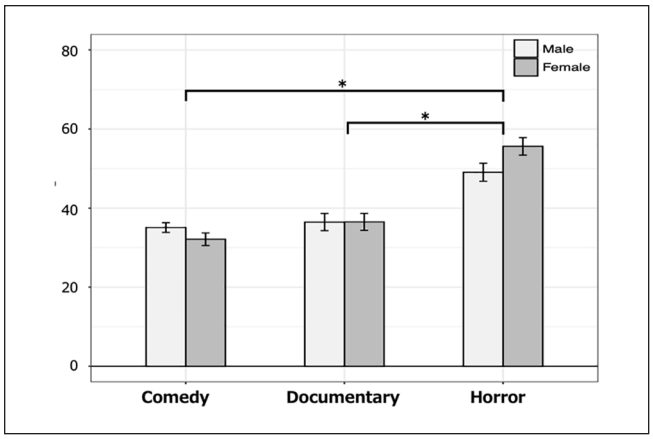

Figure 2. Mean state anxiety scores for each group.
Note. Error bars represent standard error of the mean.
*$p < .05$.

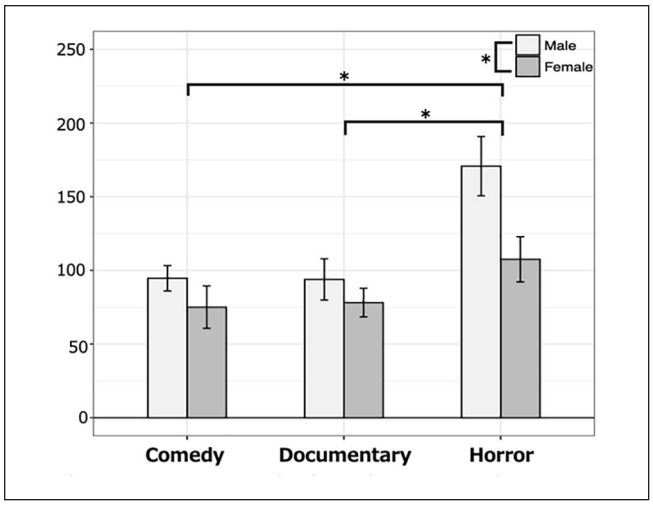

Figure 3. Mean consumption for each group.
Note. Error bars represent standard error of the mean.
*$p < .05$.

= 8.32; horror: male $M = 50.07$, $SD = 7.06$, female $M = 55.5$, $SD = 7.8$). No main effect of gender, $F(1, 81) = 0.29$, $p = .5958$, $\eta_p^2 = .00$, and no interaction, $F(2, 81) = 0.43$, $p = .0941$, $\eta_p^2 = .05$, were found.

Consumption

Regarding consumption, there were main effects by group, $F(2, 81) = 7.78$, $p = .0008$, $\eta_p^2 = .16$, and gender, $F(1, 81) = 6.18$, $p = .0149$, $\eta_p^2 = .07$. The horror movie group exhibited significantly higher consumption than did the other two groups, and male participants showed higher consumption than did female participants (comedy: male $M = 94.62$, $SD = 27.77$, female $M = 78.75$, $SD = 68.18$; documentary: male $M = 93.85$, $SD = 48.44$, female $M = 78.13$, $SD = 37.79$; horror: male $M = 173.85$, $SD = 68.56$, female $M = 105.00$, $SD = 57.66$; Figure 3). No interaction was found, $F(2, 81) = 2.36$, $p = .1010$, $\eta_p^2 = .06$.

Taste Perception

Intensity and liking. Regarding intensity and liking (six evaluations), the p values were adjusted using a Bonferroni correction to 6 times to avoid Type 1 errors. In doing so, we found a main effect of group, $F(2, 81) = 8.10$, $p = .0036$, $\eta_p^2 = .17$ (Figure 4), in the intensity of sweetness. The horror movie group's score was significantly lower than those of the other two groups. In addition, a significant negative correlation ($r = –.38$, $p = .0002$) was found between state anxiety and sweetness intensity. There was no significant effect with regard to gender, $F(1, 81) = 0.92$, $p = 1.0000$, $\eta_p^2 = .01$, and no interaction, $F(2, 81) = 0.44$, $p = 1.0000$, $\eta_p^2 = .01$.

Regarding the other taste evaluations, there were no significant differences by group—saltiness: $F(2, 81) = 0.94$, $p = 1.0000$, $\eta_p^2 = .02$; sourness: $F(2, 81) = 0.29$, $p = 1.0000$, $\eta_p^2 = .01$; bitterness: $F(2, 81) = 3.76$, $p = .1650$, $\eta_p^2 = .08$; umami: $F(2, 81) = 0.01$, $p = 1.0000$, $\eta_p^2 = .00$; liking: $F(2, 81) = 1.69$, $p = 1.0000$, $\eta_p^2 = .04$—or gender—saltiness: $F(1, 81) = 0.09$, $p = 1.0000$, $\eta_p^2 = .00$; sourness: $F(1, 81) = 1.04$, $p = 1.0000$, $\eta_p^2 = .01$; bitterness: $F(1, 81) = 6.90$, $p = .0618$, $\eta_p^2 = .08$; umami: $F(1, 81) = 0.94$, $p = 1.0000$, $\eta_p^2 = .01$; liking: $F(1, 81) = 2.41$, $p = .7500$, $\eta_p^2 = .03$. There were also no interactions—saltiness: $F(2, 81) = 0.51$, $p = 1.0000$, $\eta_p^2 = .01$; sourness: $F(2, 81) = 0.01$, $p = 1.0000$, $\eta_p^2 = .00$; bitterness: $F(2, 81) = 1.10$, $p = 1.0000$, $\eta_p^2 = .03$; umami: $F(2, 81) = 2.23$, $p = .6840$, $\eta_p^2 = .05$; liking: $F(2, 81) = 0.23$, $p = 1.0000$, $\eta_p^2 = .01$.

The relationship between liking and sweetness. The results of examining the correlation between taste intensity and liking using Pearson's correlation analysis revealed that sweetness intensity was positively correlated with the pleasantness of the juice for the documentary movie group ($r = .60$, $p = .0006$). However, there were no significant correlations for the comedy ($r = .14$, $p = .4406$) or horror ($r = .36$, $p = .0529$) movie groups. The scores for sweetness and liking are shown in Figure 5.

Discussion

The aim of this study was to examine the differences in taste perception depending on emotional state. The emotional states of the study's participants were manipulated by the type of movie they were assigned to watch. The state anxiety score of the STAI confirmed that watching a horror movie aroused state anxiety among the participants. Meanwhile, no main effect of movie group was observed in trait anxiety scores; thus, there was no overall difference between the groups in terms of a tendency toward anxiety as a personal characteristic. We also observed that juice consumption in the horror movie group was significantly higher than that in

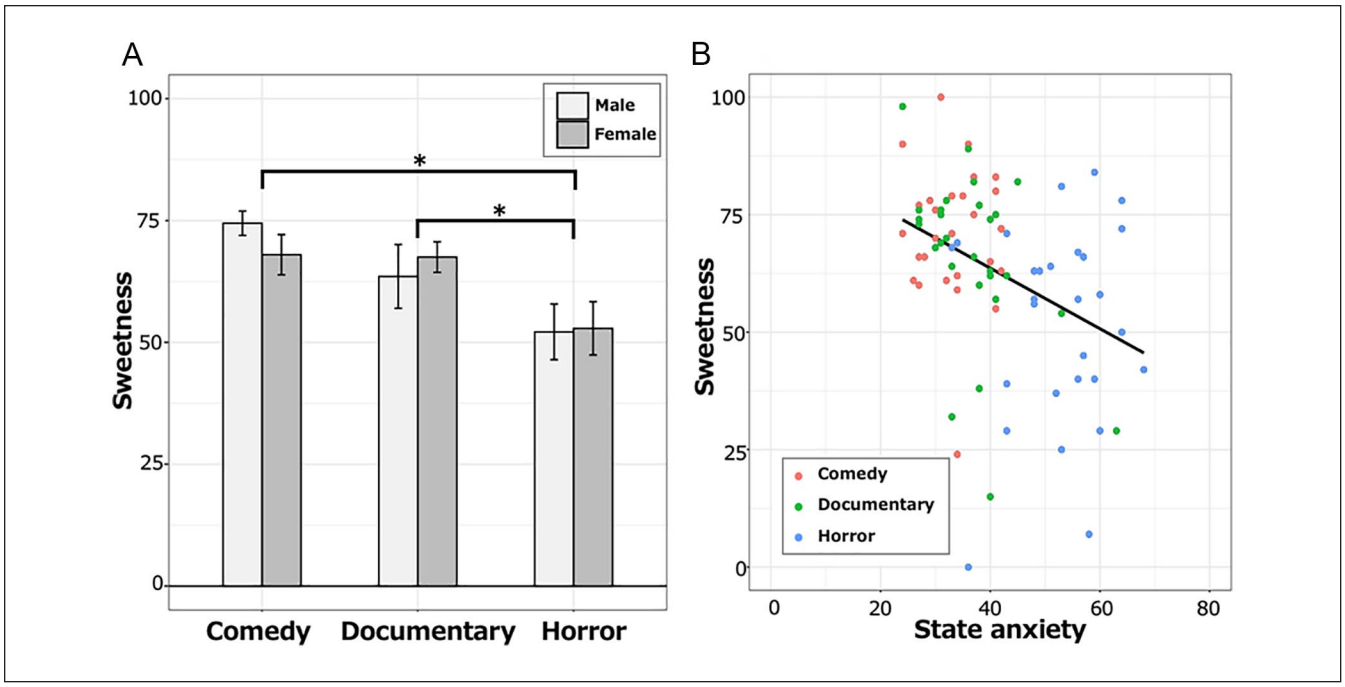

Figure 4. (A) Mean sweetness scores for each group and (B) correlation between state anxiety and sweetness scores.
Note. Error bars represent standard error of the mean.
*$p < .05$.

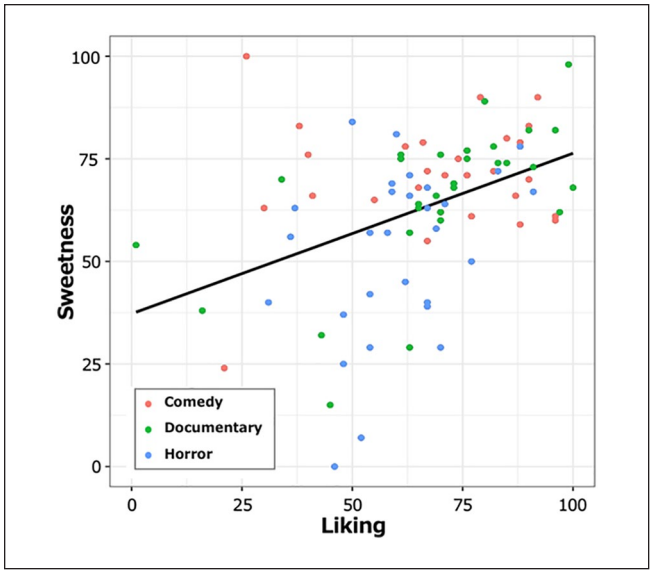

Figure 5. Correlation between degree of liking the juice and sweetness scores.

the other two groups. This could be attributed to the participants' bodies being in a state of tension, causing their parasympathetic nervous systems to function weakly, which, in turn, caused them to be thirsty.

Mattar et al. (2019) found that participants who watched a violent movie consumed a lot of fatty and salty foods. These results might indicate that fear encourages people to consume more, or we could attribute the high level of consumption to the cognitive load of participants who experienced fear. It is possible that participants needed to consume more to verify the taste because the horror movie evoked some kind of cognitive load in participants.

In terms of juice consumption, female participants consumed less juice than did male participants, which was attributed to the different perceptions of men and women surrounding the consumption of large quantities of food and drink in front of others. This suggests that social desirability effects caused female participants to suppress their intake to only a low consumption level. As no correlation was observed between consumption and liking the juice for any group, it is also unlikely that the liking of the juice variable affected consumption.

A relationship was found between state anxiety and the perception of sweetness, as the sweetness evaluation score in the horror movie group was significantly lower than those in the other two groups. In addition, a negative correlation between state anxiety scores and sweetness evaluation scores was identified. This finding complements a previous study (Heath et al., 2006) that found that reducing anxiety increases sensitivity to sweetness. Herman and Polivy (1975) found that people who lacked self-control (those who were unrestrained) consumed larger quantities of ice cream when in a state of high rather than low anxiety. This may imply that high anxiety reduces the perceived intensity of ice cream's sweetness, leading the participants in the aforementioned study to consume large quantities of ice cream in pursuit of

satisfaction in terms of sweetness. Siervo et al. (2013) found that participants who played violent video games reported a tendency toward consuming sweet foods. In this study, participants who watched the horror movie tasted less sweetness. Therefore, it is possible that they consumed more juice because they wanted to taste more sweetness.

No main effects of group or gender were observed for the intensity of saltiness, sourness, bitterness, or umami. However, previous studies (Ileri-Gurel et al., 2012) have shown that stress can cause the threshold for saltiness to decline, and the taste of sourness can increase after being exposed to dissatisfying or unpleasant stimuli (Noel & Dando, 2015; Wang & Spence, 2016, 2018).

No difference was observed between groups in terms of liking the juice. This indicates that emotional state affects the perception of each flavor without changing the level of liking the taste stimuli themselves. Furthermore, a positive correlation ($r = .60, p = .0006$) was observed between sweetness and liking the juice only in the documentary movie group, and no significant correlation was found in the other two groups. Because sweetness releases narcotic-like substances, such as β-endorphin, in the brain, it is considered a desirable taste. According to direct reports in this study, 90% and 69% of the participants who had watched the comedy and documentary movies, respectively, reported that the movie was interesting. Therefore, participants who watched the comedy movie were considered to have been in a relatively positive emotional state. Furthermore, state anxiety scores indicated that participants who watched horror movie experienced a more negative emotional state than the documentary movie group. These findings suggest the possibility that the relationship between sweetness and liking may be weakened when emotions are in a positive or negative state. The previous study (Kuenzel et al., 2011) reported that sweetened stimulus was more preferred in the control group compared with the group that evoked relaxed emotion, but not the unsweetened stimulus, which is consistent with the results of the present study.

This study had limitations in terms of the number of participants, age group, and dietary habits. Consequently, it will be necessary for future studies to examine whether the findings of this study can be generalized to other populations. In addition, only one type of juice was used in this study. However, using other taste stimuli in future studies may also show different changes in taste perception for the same emotional changes.

Conclusion

The intensity of felt anxiety was found to be related to the suppression of sweetness. Some wine marketers are now using music in their marketing (Spence, 2019). If marketers and chefs do not want to lower the intensity of sweetness consumers perceive, then reducing anxiety may be effective. Furthermore, the correlation between taste perception and liking the stimuli was found to vary depending on emotional state. Future studies should investigate what kinds of psychological and physical changes serve as mechanisms by which emotional states affect taste perception. Similarly, we need to consider the possibility that how taste is perceived differs according to the specific type of stress or anxiety endured. Furthermore, our findings are only applicable to the specific taste stimuli used in this study; thus, the changes observed in this experiment cannot be generalized to other taste stimuli. Even when restricted to the characteristics of food and beverages themselves, our perception of the taste of food and beverages is formed by various elements that were not measured in this study, including sharpness, astringency, texture, and temperature. In future research, we need to consider the effects of emotional states using a more realistic tasting experience that includes these various elements.

Acknowledgments

We would like to thank Editage (www.editage.jp) for English language editing.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Naoya Zushi https://orcid.org/0000-0002-5005-6673

References

Fairhurst, M. T., Pritchard, D., Ospina, D., & Deroy, O. (2015). Bouba-Kiki in the plate: Combining crossmodal correspondences to change flavour experience. *Flavour*, *4*, Article 22. https://doi.org/10.1186/s13411-015-0032-2

Fischer, M. E., Cruickshanks, K. J., Schubert, C. R., Pinto, A., Klein, B. E., Klein, R., . . . Snyder, D. J. (2013). Taste intensity in the beaver dam offspring study. *The Laryngoscope*, *123*(6), 1399–1404.

Fox, N. A., & Davidson, R. J. (1986). Taste-elicited changes in facial signs of emotion and the asymmetry of brain electrical activity in human newborns. *Neuropsychologia*, *24*(3), 417–422.

Goldstein, G. L., Daun, H., & Tepper, B. J. (2005). Adiposity in middle-aged women is associated with genetic taste blindness to 6-n-propylthiouracil. *Obesity Research*, *13*(6), 1017–1023.

Heath, T. P., Melichar, J. K., Nutt, D. J., & Donaldson, L. F. (2006). Human taste thresholds are modulated by serotonin and noradrenaline. *Journal of Neuroscience*, *26*, 12664–12671. https://doi.org/10.1523/JNEUROSCI.3459-06.2006

Herman, C. P., & Polivy, J. (1975). Anxiety, restraint, and eating behavior. *Journal of Abnormal Psychology*, *84*, 666–672. https://doi.org/10.1037/0021-843X.84.6.666

Hidano, N., Hukuhara, M., Iwawaki, M., Soga, S., & Spielberger, C. D. (2000). *STAI manual*. Zitsumu kyoiku-syuppan.

Ileri-Gurel, E., Pehlivanoglu, B., & Dogan, M. (2012). Effect of acute stress on taste perception: In relation with baseline anxiety level and body weight. *Chemical Senses*, *38*, 27–34. https://doi.org/10.1093/chemse/bjs075

Kantono, K., Hamid, N., Shepherd, D., Yoo, M. J., Grazioli, G., & Carr, B. T. (2016). Listening to music can influence hedonic and sensory perceptions of gelati. *Appetite*, *100*, 244–255.

Kuenzel, J., Blanchette, I., Lion, R., Zandstra, E. H., Thomas, A., & El-Deredy, W. (2011). Conditioning specific positive states to unfamiliar flavours influences flavour liking. *Food Quality and Preference*, *22*(5), 397–403.

Mattar, L., Farran, N., Kharma, J. A., & Zeeni, N. (2019). Movie violence acutely affects food choices in young adults. *Eating Behaviors*, *33*, 7–12.

Mattar, L., Zeeni, N., & Bassil, M. (2015). Effect of movie violence on mood, stress, appetite perception and food preferences in a random population. *European Journal of Clinical Nutrition*, *69*(8), 972–973.

Noel, C., & Dando, R. (2015). The effect of emotional state on taste perception. *Appetite*, *95*, 89–95. https://doi.org/10.1016/j.appet.2015.06.003

Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. *Food Quality and Preference*, *24*, 205–208. https://doi.org/10.1016/j.foodqual.2011.08.011

Reinoso-Carvalho, F., Dakduk, S., Wagemans, J., & Spence, C. (2019). Not just another pint! The role of emotion induced by music on the consumer's tasting experience. *Multisensory Research*, *32*(4–5), 367–400.

Reinoso-Carvalho, F., Wang, Q. J., van Ee, R., Persoone, D., & Spence, C. (2017). "Smooth operator": Music modulates the perceived creaminess, sweetness, and bitterness of chocolate. *Appetite*, *108*, 383–390. https://doi.org/10.1016/j.appet.2016.10.026

Siervo, M., Sabatini, S., Fewtrell, M. S., & Wells, J. C. (2013). Acute effects of violent video-game playing on blood pressure and appetite perception in normal-weight young men: A randomized controlled trial. *European Journal of Clinical Nutrition*, *67*(12), 1322–1324.

Spence, C. (2019). Multisensory experiential wine marketing. *Food Quality and Preference*, *71*, 106–116.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory (Form Y)*. Consulting Psychologists Press.

Wang, Q. J., & Spence, C. (2016). "Striking a sour note": Assessing the influence of consonant and dissonant music on taste perception. *Multisensory Research*, *29*, 195–208. https://doi.org/10.1163/22134808-00002505

Wang, Q. J., & Spence, C. (2018). "A sweet smile": The modulatory role of emotion in how extrinsic factors influence taste evaluation. *Cognition and Emotion*, *32*, 1052–1061. https://doi.org/10.1080/02699931.2017.1386623

Zampini, M., & Spence, C. (2004). The role of auditory cues in modulating the perceived crispness and staleness of potato chips. *Journal of Sensory Studies*, *19*, 347–363. https://doi.org/10.1111/j.1745-459x.2004.080403.x