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Research Article

Reasons for Adding Different Tastes: An Example of Sprinkling Salt on Watermelon and Its Relation to Subjective Taste Perception, Taste Preference, and Autistic Traits

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Each basic taste can be perceived differently due to stored knowledge and differences in receptor properties. Depending on how these tastes are perceived, eating behavior may change. In this study, we examined the relationships between subjective feelings of taste perception, taste preferences, and autistic traits with the behavior of adding flavor to food using an example of sprinkling salt on watermelon. From an online questionnaire survey among a general Japanese population, we found that salty and sour tastes could be subjectively perceived more quickly than sweet and umami tastes, in line with our expectations. Moreover, the hedonic responses to watermelon with salt were negatively correlated with a preference for bitter taste, i.e., those participants who dislike bitter taste sensations tended to enjoy watermelon with salt more. There was no correlation between the hedonic response to watermelon with salt and the subjective feeling of taste perceptions and autistic traits and no correlation between autistic traits, and the subjective feeling of taste perceptions and taste preferences. These results suggest that adding different tastes could be influenced by taste preferences; thus, the addition of a different taste was thought to be related to an unconscious motivation to reduce bitterness.

1. Introduction

People sometimes add different tastes to foods. For example, some people like to sprinkle salt on watermelon (*Citrullus lanatus*) in Japan, as it is empirically thought that this enhances the feeling of its sweetness. Watermelon is one of the most popular fruits consumed across the world. It is composed of approximately 94% water and contains simple sugars like sucrose, fructose, and glucose, with relatively low amounts of ascorbic acid, resulting in its characteristic mild sweetness [1, 2]. Sparkling salt on watermelon may increase the hedonic experience, while the reasons for adding different tastes are currently poorly understood.

Studies have suggested that salts can selectively filter flavors by suppressing the unpleasant bitterness and enhancing the salience or intensity of the palatable sweetness [3, 4]. Sprinkling salt on watermelon may give rise to benefits from the salt's filtering effect, such as suppressing the bitterness or sourness of an unripe watermelon and increasing the intensity of its sweetness. The contrasting sweetness enhancement of salts on watermelon may also stem from the differences in taste receptor properties. For instance, salty tastes are detected faster than sweet tastes due to the different taste receptors [5]. This subsequently perceived sweetness may contribute to a high hedonic experience of sparkling salt on watermelon. Previous studies suggested that eating behaviors can be shaped by many factors, such as taste perceptions, taste preferences, and developmental traits [6–8]. Sparkling salt on watermelon might result from individual differences in some of those factors.

Taste perceptions vary greatly among individuals, and influence food selection and eating behaviors [9, 10]. Individual differences in taste perceptions may stem from genetic differences in taste receptors, and these differences have been found to contribute to variations in taste-related eating behaviors [10–13]. Specifically, sour and salty tastes are sensed by ionotropic receptors, while sweet, bitter, and umami tastes are sensed by metabotropic receptors, that the transmission time is slower [14]. Moreover, people have a subjective feeling/memory that some tastes are perceived faster, last longer in the mouth, are easier detected, or are easier identified among mixtures than other tastes. That is, the subjective feeling/memory of tastes could differ among these five basic tastes. The feelings of speed, lasting flavor, detection, and identification might influence the hedonic experience of some foods, and are critical for food preferences and eating behaviors [15, 16]. However, there has been little study of those subjective feelings and tastes. Here, we expect a difference in subjective feelings on speed, lasting, detection, and identification for the five basic tastes, and individual differences in those subjective taste perceptions might affect eating behaviors, such as adding different tastes.

Taste preferences are reported to be different for the five basic tastes. Sweet and umami tastes are generally liked more than sour and bitter tastes [17–19]. Several factors influence individual taste preferences, such as genetics and exposure through eating habits [20, 21]. Moreover, taste preferences are reported to influence eating behaviors. A higher sweet taste preference is associated with higher consumption of sweet foods and an increased risk of being overweight [22–24]. A preference for sour tastes has been associated with an increased consumption of more diverse foods and fruits [9, 25–27]. A preference for bitter tastes has been associated with the acceptance and consumption of some vegetables [28]. Thus, individual differences in eating behavior resulting from adding different tastes may result from preferences for some tastes.

In addition, autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by impaired social communication, restricted and repetitive behaviors, interests, or activities, and difficulties in sensory processing [29]. Individuals with ASD are reported to exhibit atypical taste perceptions, such as identifying basic tastes less accurately than matched controls [30, 31]. The differences in taste perception and atypical eating behaviors (e.g., limited food preference and rigid food consumption) have been a common symptom identified among individuals with ASD [32–34]. Studies have showed that individuals with ASD exhibit less preference for mixed flavors, which might be caused by atypical sensory processing and overloading from multiple sensory information [35, 36]. Adding different tastes, such as watermelon with salt, involves a mixture of sweet and salty tastes, which may lead to a different hedonic response in autistic perception. Moreover, ASD is generally understood as the extreme end of the quantitative distribution of autistic traits in the general population [37, 38]. Previous studies that measured autistic traits using the Autism-Spectrum Quotient [39] showed that people with high AQ but no diagnosis of ASD showed similar tendencies in perceptual and cognitive tasks to people who were diagnosed with ASD [37, 40, 41]. Consistent with this, testing the relationship between autistic traits (AQ scores) and subjective feelings of tastes, taste preferences, and preference for adding different tastes in a typically developing population may give us a better perspective on selectivity eating problems in individuals with autism.

Based on those previous findings, the current study aimed to explore the reasons for adding different tastes to food by examining relationships between an example of specific eating behavior, watermelon with salt, and subjective taste perceptions, taste preferences, and autistic traits in the general population using an online questionnaire survey. The autistic traits were measured by a Japanese version of the autism spectrum quotient (AQ-10) questionnaire survey [42, 43]. The AQ-10 is a short version of the self-reported AQ-50 questionnaire developed for a brief and sensitive screening for ASD [44, 45], which provides a continuous measure ranging from low to high autistic-like traits in normative samples. We hypothesized that hedonic responses to watermelon with salt could associate with subjective taste perceptions, taste preferences, and autistic traits, such as people with higher autistic traits may less like watermelon with salt.

2. Methods

2.1. Participants. One hundred and twenty-five Japanese (80 females; 69 participants were 15–29 years old, 36 participants were 30–49 years old, and 20 participants were over 50 years of age) volunteered to participate in an online questionnaire survey. A prior power analysis determined that a sample of 82 individuals would be sufficient to detect a correlation coefficient of 0.3 with an alpha of 0.05 and a power of 80% [46]. We collected more data to account for any missing inputs and errors. The participants were mainly from research participant pools at the National Rehabilitation Center for Persons with Disabilities and Waseda University. Twelve of the participants were diagnosed with developmental disorders (5 with autism spectrum disorder (ASD), 1 with learning disorder (LD), 1 with attention deficit hyperactivity disorder (ADHD), and 1 with an intellectual disability), other psychiatric disorders (1 with depression, 1 with panic disorder), or suspicion (2 participants). One ASD participant had additional diagnoses of ADHD and depression; one ASD participant had additional diagnoses of ADHD and bipolar disorder; one LD participant had an additional diagnosis of cyclic vomiting syndrome. Six participants who filled out the questionnaire with missing/duplicate responses were excluded, meaning 119 participants' responses were used for data analysis. All participants were Japanese speakers and agreed to participate in the questionnaire survey. This study was reviewed and approved by the ethics committee of the National Rehabilitation Center for Persons with Disabilities (2020-082).

2.2. Materials and Procedure. This study was conducted using Google Forms (see Supplementary Material: Online questionnaire survey for details). Participants undertook

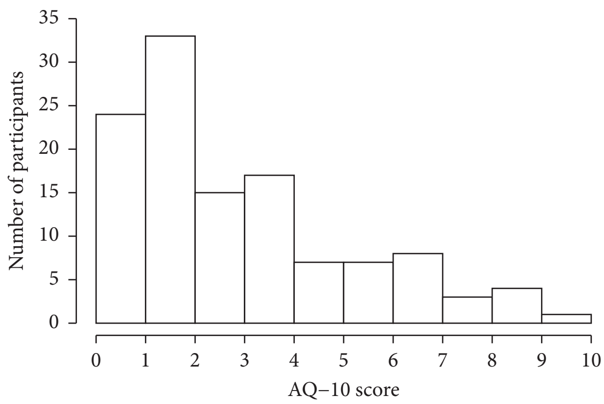

Figure 1: Distribution of participants' AQ-10 scores.

four sequential sessions (subjective taste preference, subjective taste perception, experience of watermelon with salt, and AQ-J-10 survey). In addition, questionnaires on taste-visual associations (with 85 participants; [47]) and eating behavior studies (with 96 participants; [36]) were simultaneously conducted. At the beginning of the online questionnaire survey, participants provided their consent to participate and their demographic information, including age range, sex, diagnosed developmental disorder, and birthplace. Before each of the sessions, participants were given detailed instructions on the rating tasks.

In the taste preference session, the participants were instructed to rate how much they liked each of the basic taste words (i.e., sweet, sour, salty, umami, bitter) on a five-point Likert scale, arranged horizontally from left to right: (1) do not like it at all, (2) slightly dislike, (3) neutral, (4) slightly like, and (5) like it very much.

In the session of subjective taste perception, the speed, lasting quality, detection, and identification of the five basic tastes were examined. Participants were asked to indicate the extent to which they agreed with the content of each item using a five-point Likert scale, arranged horizontally from "strongly disagree (1)" to "strongly agree (5)." Twenty items were included, with 5 items to examine the speed, lasting power, detection, and identification of the 5 basic tastes. Taking the sweet taste as an example, the subjective feeling of taste speed is described as "I can notice a sweet taste the moment it enters the mouth," the subjective feeling of taste lasting: "I feel the sweet taste lasting a long time in the mouth," the subjective feeling of taste detection. "I can notice the sweet taste even if it is very light," the subjective feeling of taste identification: "I can identify the sweet taste in mixed tastes."

In the session of eating behavior with watermelon, two questions are presented. Participants were first asked to indicate whether they had eaten watermelon with salt, with "yes" and "no" two options. Then, they were asked to rate the hedonic response of watermelon with salt on a five-point Likert scale, from "taste not good (1)" to "taste very good (5)."

Finally, participants completed the Japanese version of the AQ-10 questionnaire. Participants were asked to rate the degree to which the content of each item matches them on a four-point Likert scale ("definitely agree," "slightly agree," "slightly disagree," and "definitely disagree"). For example, the first item states, "I prefer to do things with others rather than on my own." Higher AQ-10 scores indicated a greater magnitude of ASD traits. The distribution of AQ-10 scores for the 119 participants is shown in Figure 1. To further understand the effect of autistic traits, participants were divided into three groups as in a previous study [36]. An AQ score of five was used as the criterion for the high AQ group (AQ ≥ 5; 30 participants), an AQ score of 2 as the criterion for the low AQ group (AQ ≤ 2; 57 participants), and participants with an AQ score between them were grouped into the medium AQ group (3 ≤ AQ ≤ 4; 32 participants). Being in the high AQ group does not mean that the participant is diagnosed with ASD, rather they scored higher on the autistic traits.

2.3. Data Analysis. Since the subjective ratings for taste preferences, taste perceptions, the hedonic response to watermelon with salt, and AQ-10 scores were not normally distributed (all ps < 0.05; Shapiro–Wilk's test), Spearman's rank correlation analysis was applied to examine the relationships between them. The FDR correction for multiple testing was used to adjust the p-values and control for false-positive results [48]. A multivariate analysis of covariance (MANCOVA) with the AQ group (low, medium, and high) as a fixed factor was conducted to reveal the effect of autistic traits on subjective taste preferences and taste perceptions. A repeated measurement analysis of variance (ANOVA) was used to examine taste preferences and perceptions among the five basic tastes. Data analyses were performed using R 4.0.2 software (R Core Team, 2020).

3. Results

3.1. Subjective Taste Perception

3.1.1. Subjective Feeling of Taste Speed. A repeated measures ANOVA on the subjective feeling of speed for the five basic tastes showed a significant main effect (Figure 2), with $F\,(4, 590) = 37.02$, $p < 0.001$, $\eta_p^2 = 0.20$. A sour taste was rated faster than the other four tastes (Tukey's HSD, all ps < 0.01), while an umami taste was rated slower than the other four tastes (Tukey's HSD, all ps < 0.001). A salty taste was faster than a sweet taste (Tukey's HSD, p = 0.004).

3.1.2. Subjective Feeling of Taste Lasting. The lasting of the five basic tastes was rated significantly different, $F\,(4, 590) = 28.22$, $p < 001$, $\eta_p^2 = 0.16$. A bitter taste was rated as lasting longer in the mouth than the other four tastes (Tukey's HSD, all ps < 0.0001). A salty taste lasted for shorter time than sour and sweet tastes (Tukey's HSD, all ps < 0.01).

3.1.3. Subjective Feeling of Taste-Detection. There was significant difference in detection ratings for the five tastes, $F\,(4, 590) = 13.92$, $p < 0.001$, $\eta_p^2 = 0.09$. An umami taste was rated as being detected less easily than salty, bitter, and sour tastes (Tukey's HSD, ps <0.05). A bitter taste was rated as being

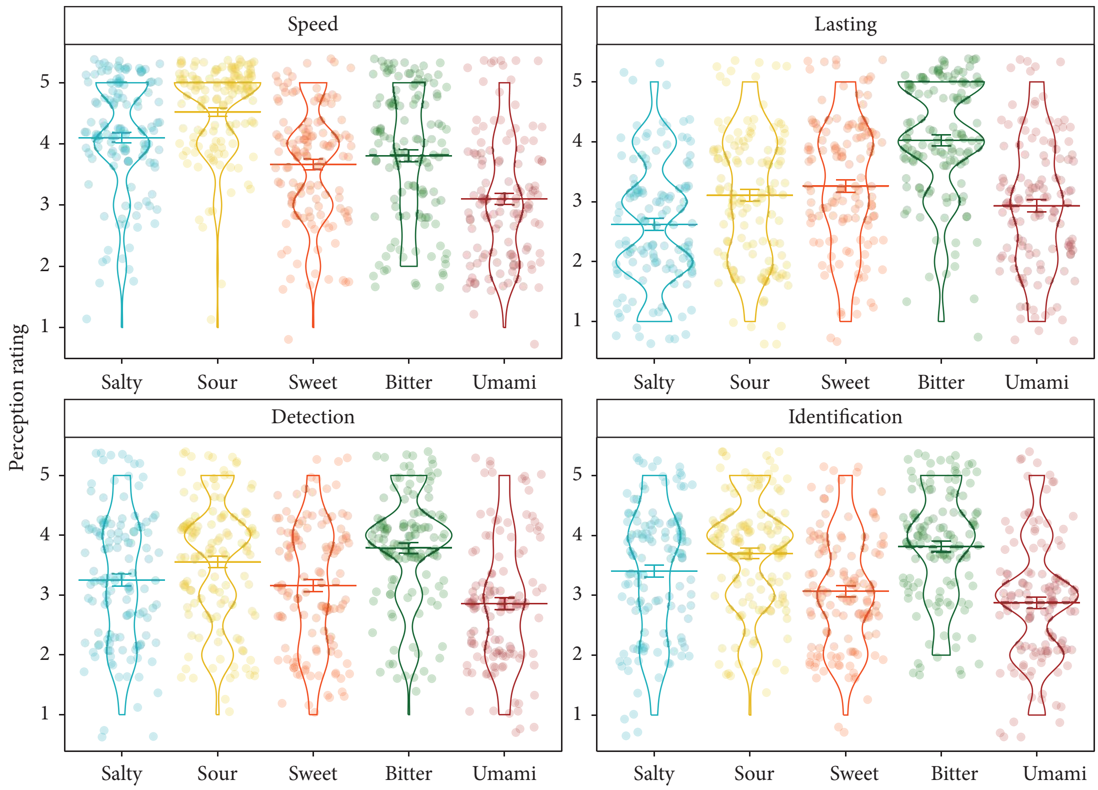

FIGURE 2: A violin plot of subjective feelings of speed, lasting, detection, and identification for the five basic tastes. Each dot represents the mean rating in each condition for an individual participant. Note that $N = 119$, the lines represent the mean ratings, and error bars represent the standard error on the mean; the salty, sour, sweet, bitter, and umami taste terms are represented by the colors blue, yellow, red, green, and brown, respectively.

detected easier than salty, umami, and sweet (Tukey's HSD, $ps < 0.001$), while a sour taste was rated as being detected easier than sweet and umami tastes (Tukey's HSD, $ps < 0.05$).

3.1.4. Subjective Feeling of Taste Identification. There was a significant effect on the subjective feeling of taste identification for the five basic tastes, $F\ (4, 590) = 18.96$, $p < .001$, $\eta_p^2 = 0.11$. A bitter taste was rated as easier to be identified among mixed tastes than salty, sweet, and umami tastes (Tukey 's HSD, $ps < .05$). A sour taste was rated to be easier identified than sweet and umami tastes (Tukey's HSD, p $s < .001$). Salty tastes were rated to be easier identified than umami tastes (Tukey's HSD, $p < 0.01$).

3.2. Correlation between Subjective Taste Perceptions and AQ Scores. Among the 119 participants, Spearman's correlation analysis showed no significant correlation between subjective feelings of taste perceptions (i.e., speed, lasting, detection, and identification perceptions) and AQ-10 scores (all $ps > 0.05$, FDR corrected; see Table 1).

MANCOVA analysis showed no significant effect of the AQ group on subjective taste perceptions, with $F\ (40, 196) = 1.11$, Pillai's Trace = 0.37, $p = 0.31$, and $\eta_p^2 = 0.18$. Univariate ANCOVA showed that there was no significant effect of the AQ group on each of the subjective feelings of speed, lasting, detection, and identification perception (all $ps > 0.05$, FDR corrected; Supplementary Table S1). Thus, autistic traits had little effect on the subjective feeling of speed, lastingness, detection, and identification.

TABLE 1: Correlation coefficients between subjective feelings of taste perceptions and AQ-10 scores.

	Salty	Sour	Sweet	Bitter	Umami
Speed					
Rho	0.13	−0.04	0.1	−0.06	0.09
p	0.15	0.66	0.29	0.53	0.33
Lasting					
Rho	0.04	0.13	0.04	0.02	−0.03
p	0.69	0.17	0.66	0.79	0.73
Detection					
Rho	0.02	0	0.16	−0.09	0.05
p	0.81	0.97	0.08	0.33	0.58
Identification					
Rho	0.19	0.05	0.06	−0.07	−0.1
p	0.03	0.57	0.54	0.43	0.27

Note. $N = 119$, p value before FDR correction for multiple testing.

3.3. Subjective Taste Preference. A repeated measurement ANOVA revealed a significant difference in preference for the five basic tastes, with $F\ (4, 590) = 35.95$, $p < 0.001$, $\eta_p^2 = 0.20$. Participants liked bitter taste less than the other four tastes (Tukey's HSD, $ps < 0.001$), liked sour less than sweet

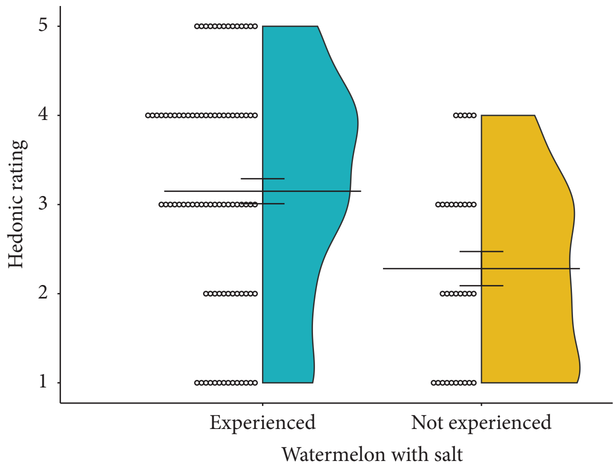

Figure 3: A violin plot of the hedonic rating of watermelon with salt in participants who had either experienced it or not. Each empty circle represents the mean rating for an individual participant. The lines represent the means and the error bars represent the standard error of the means.

and umami tastes (Tukey's HSD, ps < 0.001), and liked salty taste less than umami taste (Tukey's HSD, $p = 0.0001$), as we reported separately [36].

3.4. Correlation between Subjective Taste Preference and AQ Scores. Spearman's correlation analysis showed no correlation between the preference ratings for the five basic tastes and AQ-10 scores (all ps > 0.05, FDR corrected). MANCOVA analysis showed no significant effect of the AQ group on taste preferences; F (10, 226) = 0.74, Pillai's Trace = 0.06, $p = 0.69$, $\eta_p^2 = 0.04$. Univariate ANCOVA showed no significant effect of the AQ group on the preference ratings for each of the five tastes (all ps > 0.05, FDR corrected; Supplementary Table S2). Thus, autistic traits showed little effect on subjective taste preferences.

3.5. Hedonic Response to Watermelon with Salt. 73.11% of the participants (87 out of 119) had experienced of eating watermelon with salt (Figure 3). The participants who had experienced watermelon with salt (mean = 3.15, SD = 1.31) tended to judge watermelon with salt more tasty than those who had not experienced (mean = 2.28, SD = 1.08), F (1, 117) = 11.24, $p = 0.001$, $\eta_p^2 = 0.09$.

3.6. Correlation between Hedonic Response to Watermelon with Salt and AQ Score. Among the participants who experienced watermelon with salt ($N = 87$), there was no significant correlation between the hedonic rating of watermelon with salt and AQ-10 scores (rho = −0.13, $p = 0.23$). ANOVA analysis showed no significant difference between the three AQ groups on the hedonic responses to watermelon with salt among experienced participants, F (2, 84) = 0.09, $p = 0.91$, $\eta_p^2 = 0.00$. Thus, autistic traits played little effect on hedonic responses to watermelon with salt.

3.7. Correlation between Hedonic Response to Watermelon with Salt and Taste Preference. Among participants who had the experience of eating watermelon with salt ($N = 87$), there was a significant correlation between the hedonic rating of watermelon with salt and a preference for bitter taste (rho = −0.35, $p = 0.0009$; FDR corrected; Table 2). No significant correlation was observed with preferences for the other four tastes and the hedonic response to watermelon with salt (all ps > 0.05, FDR corrected; Table 2). Thus, participants who liked fewer bitter tastes tended to enjoy watermelon with salt more.

3.8. Correlation between Hedonic Response to Watermelon with Salt and Subjective Taste Perception. Among participants who had experienced watermelon with salt ($N = 87$), no significant correlation was observed between the hedonic responses to watermelon with salt and subjective taste perceptions (i.e., taste speed, lasting, detection, and identification perceptions; all ps > 0.05, FDR corrected; see Table 3).

In summary, the current study showed that there were some relationships between hedonic responses to watermelon with salt and taste preference for bitter that people who rated higher for hedonic experience of watermelon with salt tended to less like bitter taste. There was no significant correlation between hedonic ratings for watermelon with salt, subjective taste perception, and autistic traits. Moreover, there was no significant correlation between autistic traits and subjective taste perception or subjective taste preference (Figure 4).

4. Discussion

In this study, we explored the reasons for adding different tastes, using an example of sprinkling salt on watermelon, and examined its relations to subjective feeling of taste perceptions, taste preferences, and autistic traits from an individual difference approach. Results showed that the hedonic response to watermelon with salt was significantly correlated with preference for bitter taste, in that, participants who less like bitter taste tended to enjoy watermelon with salt more. In contrast, there was little correlation between the hedonic response to watermelon with salt and subjective feeling of taste perceptions, autistic traits. Furthermore, autistic traits had little effect on subjective taste perceptions and preferences.

Previous studies suggested that eating behaviors, such as adding different tastes to foods, could be shaped by many factors, such as taste perceptions and taste preferences [8, 36]. It is well known that some tastes can be perceived differently in terms of speed. For instance, an evoked potential measurement during magnetoencephalography suggests that salty taste can be perceived faster than sweet taste [5]. Our participants subjectively thought salty taste could be faster than sweet taste, providing further evidence. Moreover, salty taste could be felt as lasting shorter in the mouth than sweet taste. Although the present study could not show clear results, the differences in speed and lasting for

Table 2: Correlation between hedonic responses to watermelon and salt and taste preferences.

		Preference				
		Salty	Sour	Sweet	Bitter	Umami
Hedonic responses to watermelon with salt	Rho	0.12	0.03	0.03	**−0.35****	0.09
	p	0.28	0.77	0.78	**0.0009**	0.39

Note. $N = 87$, $^{**}p < 0.01$, p value before FDR correction for multiple testing.

Table 3: Correlations between hedonic responses to watermelon with salt and subjective taste perception.

	Salty	Sour	Sweet	Bitter	Umami
Speed					
Rho	−0.22	−0.13	−0.12	0.1	−0.04
p	0.04	0.22	0.28	0.33	0.71
Lasting					
Rho	0.04	−0.07	0.16	0.14	0.03
p	0.71	0.54	0.15	0.21	0.75
Detection					
Rho	0.01	0.09	−0.14	0.13	0.03
p	0.89	0.41	0.19	0.24	0.78
Identification					
Rho	0.01	0.2	−0.01	0.17	−0.06
p	0.9	0.07	0.92	0.12	0.6

Note. $N = 87$, p value before FDR correction for multiple testing.

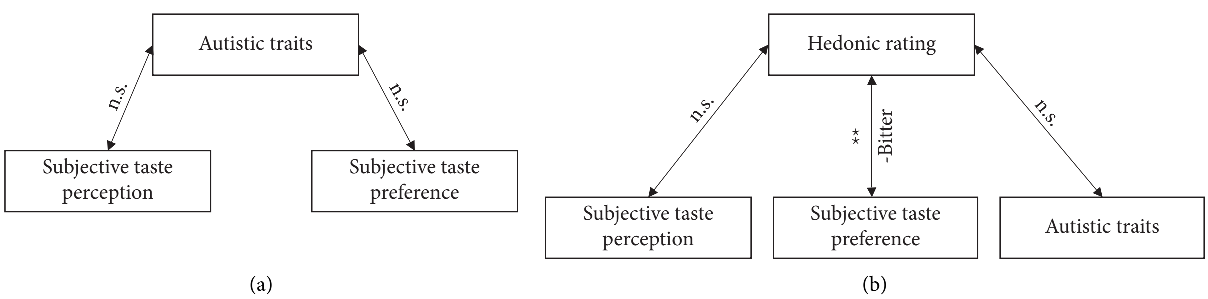

Figure 4: The results of relationships between dimensions in the current study. (a) There is no correlation between autistic traits and subjective taste perception, subjective taste preference; (b) Correlations among hedonic rating of watermelon with subjective taste preference, subjective taste perception, and autistic traits ($^{**}p < 0.01$). (a) All of the participants ($N = 119$); (b) people's experiences with watermelon and salt ($N = 87$).

subjective feeling between salty and sweet may contribute to a high hedonic response for adding salt to some sweet foods. The salty taste can be perceived earlier, which may induce the contrasting taste perceptions and enhance the aftertaste of sweetness, and the lasting feeling of sweet tastes in the mouth is also longer than salty tastes, as revealed in the present results, leading to an enhanced sweetness and hedonic experience.

Watermelon is composed of a high amount of water, simple sugars, and a low amount of ascorbic acid, which makes it refreshing and can be used to relieve the heat in summer [1]. More than 70% of our participants have experienced watermelon with salt, and the participants who had the experience showed higher hedonic responses to watermelon with salt than participants who had no experience. This may reflect an unexpected hedonic experience of watermelon with salt. Moreover, the filtering effect of salts may suggest that sprinkling salt on watermelon results in the bitterness/sourness being suppressed while the sweetness is enhanced [3]. Here, our participants who liked less bitter tastes tended to enjoy watermelon with salt more, providing further evidence for the salt's effect of filtering tastes by suppressing the bitterness. The possibility of a sweet taste enhancement arising from a salty taste, which is empirically known, has not been ruled out. Several psychological experiments do, in fact, suggest that the perception of sweetness is enhanced by the presence of a salty taste [4].

As shown in the results, participants had different subjective feelings for the five basic tastes of speed, lasting, detection, and identification. The differences in subjective feeling of tastes might be related to learn and memory with eating behaviors with different tastes of foods [49]. For instance, the sour taste from a lemon must be felt faster than other tastes, and the accumulated eating experiences might lead to an impression and/or memory about the feelings of the taste. Moreover, specific receptors on the tongue for each taste category may also contribute to the subjective feelings for each taste [50]. For instance, sour and salty tastes are sensed by ionotropic receptors, while sweet, bitter, and umami tastes are sensed by metabotropic receptors, which are slower in transmission [14]. Thus, our participants thought sour was faster than the other four tastes, and umami was slower than the other four tastes. Previous studies using taste-detection experiments with perceptual tastes also showed that sour and salty tastes could be detected faster than the other tastes [51]. Moreover, an umami taste is the last identified taste [52], which may be less familiar and difficult to detect when compared with other tastes. For the subjective lasting of taste in the mouth, our participants rated bitter lasting longer than the other four tastes. Guinard et al. [53] also reported that bitter as tastes arise later and are longer lasting than other taste qualities. The current findings on subjective feelings of tastes were consistent with previous results using psychophysical experimental methods and behavioral responses elicited by perceptual tastants for each taste category [5, 10, 51, 54]. Moreover, some tastes are preferred more than other tastes. For instance, a bitter taste was liked less than others, which was consistent with previous findings [55–57]. This might be related to the fact that bitter tastes are evolutionarily characteristic of poisonous substances, which inhabit pleasure and hedonic experiences [58].

Furthermore, there was little effect of autistic traits on the hedonic responses of watermelon with salt, subjective feelings of tastes, and taste preferences. Previous studies showed that a mix of flavors are preferred less and are avoided in individuals with ASD [35, 36]. Salt on watermelon causes a mixed flavor experience of both salty and sweet, which may lead to sensory overload and, consequently, a less hedonistic response to watermelon with salt. However, we observed no effect of autistic traits on the hedonic rating of watermelon with salt. Studies have shown no difference in sweet taste sensitivity or hedonic response to sweet tastes between the ASD and control groups [59]. It might be possible that the hedonic responses to some tastes were intact in individuals with higher autistic traits. Some studies have suggested that taste identifications are different in individuals with ASD and matched controls. For example, Bennetto et al. [30] found that adolescents with ASD less accurately identified sour and bitter tastes but showed similar identification for sweet and salty tastes. In addition, electrogustometry showed intact taste thresholds in adolescents with ASD [30]. Tavassoli and Baron-Cohen [31] observed that adults with ASD less accurately identified tastes overall. These present results showed no significant correlation between subjective feelings of tastes and autistic traits. It might be related to the limitations of the subjective questionnaire method since the effects of autistic traits on taste preferences and perceptions might be subtle to detect. Future studies may use psychological and psychophysical experimental methods to further examine the effects of autistic traits on taste perceptions using perceptual tastants, and compare participants from a general population to individuals with ASD.

One limitation of this study is that the diagnoses in the sample were self-reported and were not confirmed by a diagnostic review. Future studies should therefore conduct perceptual experiments to overcome these limitations. Moreover, the instrument based on subjective feelings of taste has not been validated. The questions of subjective feelings for speed, lasting, detection, and identification of tastes were developed based on previous studies on taste perceptions by tasters [5]. Future studies may use validated questionnaires, such as the hedonic scale (9-points; [60]) to capture liking for food and the check-all-that-apply (CATA) or just-about-right (JAR) scales on a full range of subjective taste perceptions [61, 62].

The present study complements the existing literature by revealing relationships between a popular eating behavior with different tastes and subjective taste perceptions, taste preferences, and autistic traits in the general population. Hedonic responses to watermelon with salt were negatively correlated with preferences for bitter tastes. Thus, taste preferences contribute to specific eating behaviors when adding different tastes to foods. Meanwhile, autistic traits have little influence on subjective taste perceptions and preferences. Future studies may use a direct perceptual taste experiment, to explore the effect of autistic traits on taste perceptions/preferences/eating behaviors in a general population as well as in individuals with ASD. It would help to reveal the relationships and interactions between atypical eating behaviors and taste perceptions and preferences in individuals with ASD, and finally, future work would aim to indicate possible ways to solve some eating problems in both autistic and general populations.

Data Availability

The data and R code used to support the findings of this study have been deposited in the OSF repository (https://osf.io/hn93d/).

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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Supplementary Materials

The supplementary materials (Table S1, Table S2, and details of online questionnaire survey) for this article are available at https://osf.io/hn93d/. (*Supplementary Materials*)

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