The Association of Taste with Change in Adiposity-Related Health Measures

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ABSTRACT

The relationship between taste-intensity patterns and 5-year change in adiposity-related health measures was determined. Participants were members of the Beaver Dam Offspring Study, a study of the adult children of participants in the population-based Epidemiology of Hearing Loss Study. There were 1,918 participants (mean baseline age=48.8 years; range=22 to 84 years) with baseline taste (2005 to 2008) and follow-up (2010 to 2013) data. Outcomes included 5-year change in body mass index, waist circumference, blood pressure, non−high-density lipoprotein cholesterol, and glycosylated hemoglobin A1c, and hedonic ratings of specific foods. Cluster analysis with Ward's minimum variance method identified the following 5 patterns of the suprathreshold taste intensities of salt, sweet, sour, and bitter: salt and sweet intensities slightly above population averages, average sour and bitter intensities; salt, sour, and bitter intensities above population average, average sweet intensity; salt, sour, and bitter intensities above population average, sweet intensity substantially above average; all intensities below population averages; and all intensities close to population average. The General Linear Model procedure was used for testing cluster differences in the outcomes. With covariate adjustment, the group with all intensities close to population averages had a significantly lower average increase in body mass index compared with the group with above-average intensities for salt, sour, and bitter (+0.4 vs +0.9), and in glycosylated hemoglobin A1c compared with the group with above-average intensities for all tastes (+0.20% vs +0.34%). Clusters differed in the hedonics of foods representing sweetness and saltiness. The study's findings provide evidence that perceived taste intensity might be related to changes in adiposity-related health.
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FOOD CHOICE PLAYS A ROLE IN TOTAL CALORIC intake and in the maintenance of health. The relationship between dietary choices and adiposity has been of particular interest because of the association of obesity and central adiposity with chronic diseases, such as diabetes, cardiovascular disease, and cancer.[1-3] Previous cross-sectional studies have reported associations between specific dietary patterns and body mass index (BMI) and body fat distribution.[4-6] Prospectively, a link between food-choice patterns and change in BMI and waist circumference was observed in the Baltimore Longitudinal Study of Aging[7] and in the Framingham Offspring Cohort, subjects with higher Mediterranean-style dietary pattern scores were found to have significantly smaller waist circumferences after approximately 7 years of follow-up.[8]

Many factors are involved in food choice and consumption, including taste, food preference, familiarity with food items, level of education, cultural habits, cooking habits, health attitudes, weight concerns and dietary restraint, genetics, cost, availability, and advertising.[9-13] The relative importance of each of these factors in influencing food choice can vary between individuals. However, taste has been found to be one of the strongest general influences,[9,14] and research has suggested that taste perception plays a role in the reinforcing value of food.[15]

In the studies of factors related to food choice or consumption, food preferences, and the broad concept of flavor, a combination of taste, olfaction, and somatosensation were evaluated,[16,17] and response to any of the specific basic tastes, namely salt, sweet, sour, and bitter, was generally not measured. Work has been done, primarily in small, select study populations, investigating the relationship of food preferences and consumption with perception of 6-*n*-propylthiouracil (PROP), a bitter thiourea compound,[18-27] and

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with the *TAS2R38* taste receptor gene, which plays a role in PROP taster status.[27-33] Studies have also evaluated the relationship of adiposity with PROP phenotype or genotype with inconsistent results.[23,25,30,34-36]

Because taste has been implicated as an important influence on dietary choices,[9,14] and dietary patterns have been found to be related to BMI and body fat distribution,[4-8] it is possible that taste is associated with changes in adiposity over time. The purpose of the present study was to evaluate the association between perceived intensity of the basic tastes of salt, sweet, sour, and bitter presented at suprathreshold concentrations and longitudinal change in adiposity-related health measures. Patterns of taste intensities were identified and the relationship between these patterns and changes in the health measures was assessed. In addition, differences in hedonic ratings for various food items across the taste-intensity patterns were evaluated.

METHODS

Study Population

The study population was comprised of participants in the Beaver Dam Offspring Study, a longitudinal cohort study of the adult children of participants in the population-based Epidemiology of Hearing Loss Study (1993 to present).[37-39] The baseline examination took place from 2005 through 2008 and there were 3,285 participants (ages 21 to 84 years, predominately non-Hispanic white).[40] Of these, 2,374 participants completed the taste test.[41] Taste testing was performed in the baseline examination in response to a request from the National Institute on Deafness and Other Communication Disorders to develop and test methods for assessing taste function in observational investigations.

The 5-year follow-up examination was conducted in 2010 through 2013. There were 1,918 participants with baseline taste-intensity measures and follow-up health information. Approval for this research was obtained from the Health Sciences Institutional Review Board of the University of Wisconsin and informed consent was obtained from all participants before each examination. Standardized protocols were followed by trained and certified examiners at each study phase.

Measurements

Taste Intensity. Filter-paper disks, 3 cm in diameter, impregnated with suprathreshold concentrations of 1.0 mol/L sodium chloride (salt), 1.8 mol/L sucrose (sweet), 0.1 mol/L citric acid (sour), and 0.001 mol/L quinine (bitter), along with disks containing 1.2 to 1.6 mg PROP were used for the whole-mouth taste testing during the baseline examination. An outside laboratory provided the disks (L. M. Bartoshuk, University of Florida). To minimize context effects, the tastes were presented in the standard order of salt, sweet, sour, bitter, and PROP. Each participant was asked to place each disk in his or her mouth and to move the disk around to moisten it with saliva. After approximately 10 seconds, the participant removed the taste disk and identified the tastant and estimated the intensity of the taste. Water was sipped between each tastant.

A general labeled magnitude scale was used for rating the perceived taste intensity.[42] The general labeled magnitude scale was anchored at one end with 0 labeled as "No sensation" and at the other end with 100 labeled as "Strongest imaginable sensation of any kind." Training was conducted in the use of the scale and only those participants who successfully completed the training by rating a standard set of sensations in the proper order took part in the taste testing. Additional details of the taste testing have been published.[43]

Health Measures. A number of health-related measures were obtained at baseline and at follow-up. Height and weight were measured using a Detecto 758C digital scale and height bar with the participants wearing clothing with pockets emptied and no shoes. BMI was calculated as weight in kilograms/(height in meters)^2. Waist circumference, at the umbilicus with the participant standing, was obtained using a tape measure (Gullick II, Country Technology, Inc) with a tensioning device ensuring constant tension across participants. Three sets of seated systolic and diastolic blood pressures were obtained with an automated blood pressure machine (Dinamap, GE Healthcare) after the participant had been sitting for 5 minutes; the third measurement was used in analyses. Blood samples were drawn and measurements of glycosylated hemoglobin A1c (HbA1c) using affinity chromatography (Isolab) and serum total and high-density lipoprotein (HDL) cholesterol using reflectance spectrophotometry were performed at the Collaborative Studies Clinical Laboratory, Fairview-University Medical Center, Minneapolis, MN. Non-HDL cholesterol was calculated as the difference between the total and the HDL cholesterol levels. The health measures from the baseline examination were subtracted from the follow-up measures to calculate the 5-year change. For a sensitivity analysis, the subset of participants with a history of diabetes, defined as a report of having been diagnosed by a doctor or a measured HbA1c $\geq$6.5% were excluded.

Hedonic Ratings. A hedonic general labeled magnitude scale[44] was used for rating the intensity of liking or disliking 10 food/drink items. The scale had a range of -100 (strongest imaginable disliking of any kind) to $+100$ (strongest imaginable liking of any kind). The items rated included mayonnaise, whole milk, black coffee, dark chocolate, salted pretzels, grapefruit juice, sweets, strawberries, sausage, and milk chocolate.[43] The data were analyzed as continuous.

Covariates. Baseline factors found to be related to taste intensity[41] were considered as possible covariates in the modeling of the association between taste-intensity cluster and change in health. The demographic variables included age, sex, and education (college graduate [16+ years of education] yes or no). The lifestyle factors evaluated were current smoking, any alcohol consumption in the past year, and frequency of dieting (never, rarely, sometimes, often, or always). Olfactory impairment was determined using the San Diego Odor Identification Test[45-47] and was considered present if less than six of the eight odorants were correctly identified. Participants also completed questions asking for the number of servings of vegetables and fruit consumed in a normal week. Response choices ranged from $<$1 per week to 4+ per day.

For participants aged 45 years and older, DNA was extracted from whole blood and genotyping was performed using the Illumina IBC chip.[48] The PLINK tool set, which makes haplotype predictions using a standard E-M algorithm,[49,50] was used to construct *TAS2R38* haplotypes. There are three common nonsynonymous single nucleotide polymorphisms within *TAS2R38* (rs713598, rs1726866, and rs10246939) and the common amino acid substitutions at these sites are alanine for proline, valine for alanine, and isoleucine for valine. The analyses of the *TAS2R38* haplotype only included participants with the common haplotypes of PAV and AVI.

Statistical Analyses

All analyses were performed using the Statistical Analysis Software (version 9.2, 2008, SAS Institute, Inc). To identify groups of participants with similar patterns of taste intensities, the data for participants with complete information (intensity ratings for salt, sweet, sour, and bitter; n=2,146) were standardized to mean zero and variance one to achieve equal weighting of the four tastes in the clustering. A clustering procedure (PROC FASTCLUS) that utilizes Euclidean distances was used to explore solutions ranging from 4 to 20 clusters. PROC TREE produced results of hierarchical clustering as a tree structure to further elucidate patterns of intensities. A grouping structure of five clusters best matched the data and participants were grouped into the clusters using the Ward's minimum variance method.

To test for differences in baseline characteristics between clusters, the χ^2 test was used when the characteristic was categorical and PROC GLM was used when the characteristic was continuous. PROC GLM was also used to estimate least-square mean baseline adiposity-related health measures, 5-year changes in the measures, and hedonic ratings for each cluster after adjustment for significant covariates. The ObsMargins adjustment was applied to allow for estimates proportional to the margins observed in our population. For pairwise comparisons, no adjustment was made for multiple comparisons.

RESULTS AND DISCUSSION

Five distinct clusters of taste-intensity ratings were identified and explained 67.4% of the total variation in the intensity data (Figure). Cluster 1 was characterized as having mean intensities slightly above average for salt and sweet and close to average for sour and bitter. Clusters 2 and 3 demonstrated

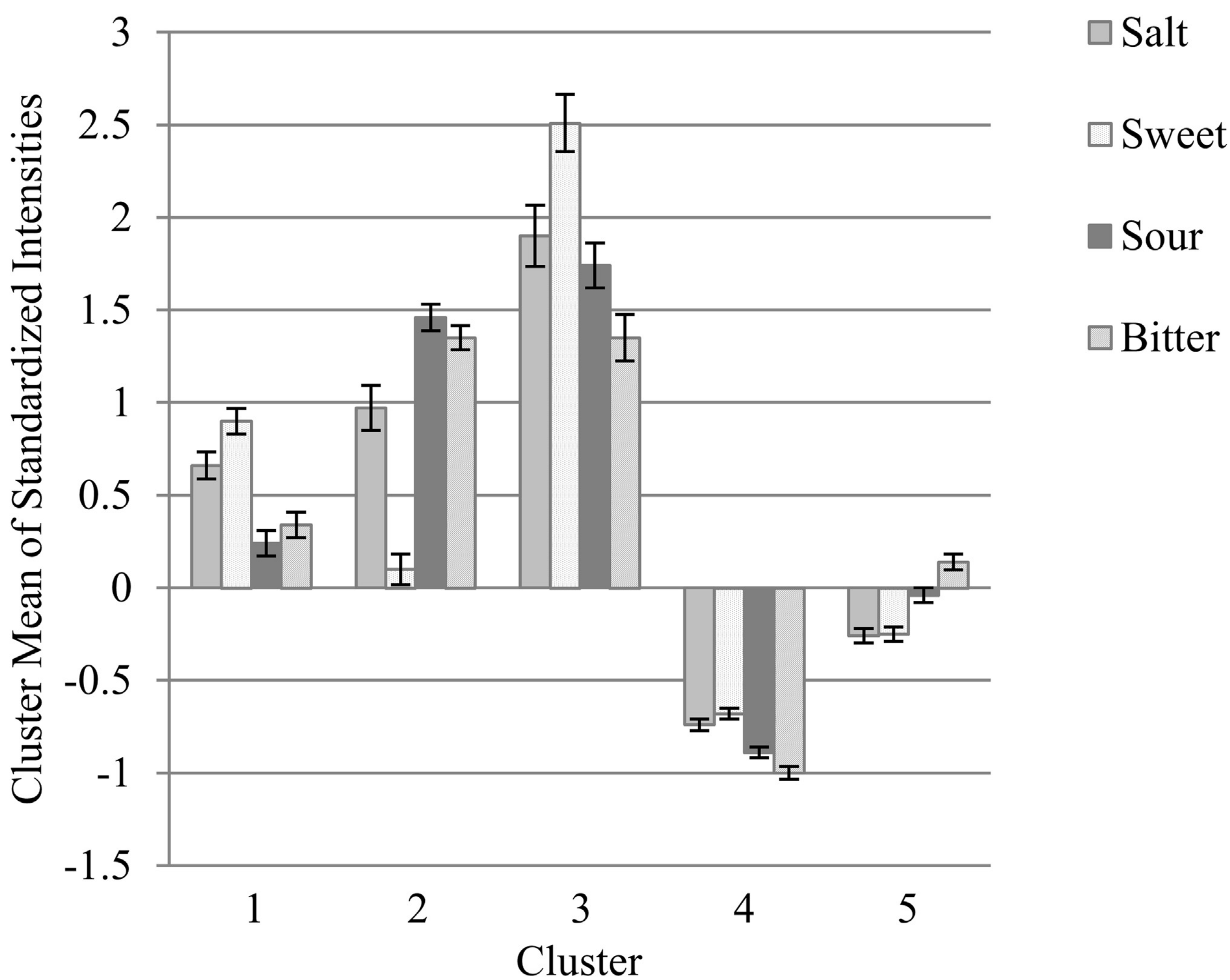

Figure. Cluster means of standardized taste intensities: Beaver Dam Offspring Study, 2005-2008.

Table 1. Baseline (2005-2008) characteristics and health measures, overall and by cluster: Beaver Dam Offspring Study

		Cluster[a]					
Characteristic or health measure	**Overall**	**1**	**2**	**3**	**4**	**5**	***P* value**
n	1,918	326	222	115	651	604	—
	← *mean±standard deviation* →						
Age (y)	48.8±9.7	50.1±10.3	49.8±10.1	49.7±8.9	47.7±9.4	48.6±9.5	<0.01
	← *%* →						
Male sex	45.2	45.4	29.7	35.7	54.7	42.4	<0.001
College graduate	36.4	37.6	25.2	23.5	41.2	37.2	<0.001
Smoking—current	15.2	15.0	19.8	13.9	14.3	14.7	0.36
Alcohol—past year	90.5	89.3	88.3	85.2	93.2	90.1	0.02
Olfaction impairment	3.8	6.1	2.7	6.1	2.9	3.5	0.07
Diet frequency							0.02
Never or rarely	61.5	61.3	54.5	52.2	66.7	60.3	
Sometimes	22.8	21.8	27.9	27.0	20.3	23.5	
Often or always	15.7	16.9	17.6	20.9	13.1	16.2	
***TAS2R38* diplotype**[b]							0.72
PAV/PAV (taster)	17.3	14.1	18.0	21.5	17.1	18.4	
PAV/AVI (heterozygote)	45.6	44.3	46.1	36.9	46.4	46.9	
AVI/AVI (nontaster)	37.1	41.6	35.9	41.5	36.5	34.7	
	← *least square mean (standard error)*[c] →						
Body mass index	30.0 (0.1)	29.8 (0.3)	29.7 (0.4)	30.0 (0.6)	29.9 (0.2)	30.2 (0.2)	0.80
Waist circumference (cm)	99.1 (0.4)	99.1 (0.8)	99.1 (1.0)	98.6 (1.3)	98.5 (0.6)	99.8 (0.6)	0.59
Systolic blood pressure (mm Hg)	125.4 (0.4)	126.0 (0.9)	126.9 (1.1)	126.7 (1.5)	124.7 (0.6)	125.1 (0.7)	0.36
Diastolic blood pressure (mm Hg)	73.6 (0.2)	73.1 (0.5)	74.5 (0.6)	74.1 (0.9)	73.1 (0.4)	74.0 (0.4)	0.18
Non-HDL[d] cholesterol (mg/dL[e])	153.4 (0.9)	150.7 (2.1)	152.9 (2.6)	154.1 (3.5)	154.7 (1.5)	153.3 (1.5)	0.67
Hemoglobin A1c (%)	5.37 (0.01)	5.39 (0.03)	5.39 (0.04)	5.37 (0.05)	5.34 (0.02)	5.38 (0.02)	0.68

[a]Cluster 1: slightly above average for salt and sweet and close to average for sour and bitter; Cluster 2: above average for salt, sour, and bitter, and average for sweet; Cluster 3: above average for salt, sour, and bitter, and very high for sweet; Cluster 4: below average for salt, sweet, sour, and bitter; Cluster 5: average for salt, sweet, sour, and bitter.

[b]Available for 1,027 participants 45 years of age and over at baseline with follow-up information (Cluster 1: n=185; Cluster 2: n=117; Cluster 3: n=65; Cluster 4: n=334; Cluster 5: n=326).

[c]Cluster means adjusted for age, sex, college graduate, any alcohol consumption in past year, and frequency of dieting.

[d]HDL=high-density lipoprotein.

[e]To convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.026. To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.7. Cholesterol of 193 mg/dL=5.00 mmol/L.

above-average mean intensities for salt, sour, and bitter; Cluster 2 had an average mean sweet intensity; and Cluster 3 had a very high mean intensity for sweet. Mean intensities for all four tastes were below average in Cluster 4 and were average in Cluster 5.

The clusters were significantly different with respect to age, sex, education, alcohol consumption in the past year, and frequency of dieting (Table 1). Participants in Cluster 4 were younger and more likely to be male and have a college degree than participants in the other clusters. Clusters 2 and 3 had the lowest percentages of males and college graduates. Cluster 4 also had the highest percentage of participants consuming any alcohol in the past year and the lowest percentage dieting often or always. Clusters did not differ significantly with respect to olfaction impairment, or *TAS2R38* diplotype. There were also no significant differences between clusters for baseline adiposity-related health measures after adjustment for age, sex, college degree, alcohol consumption, and frequency of dieting. The observed baseline similarities and differences between clusters were consistent with findings from previous work evaluating the factors related to taste intensity in this cohort.[41]

Significant differences were observed between clusters for the 5-year change in the adiposity-related health measures (Table 2) even after adjustment for covariates. Participants in the clusters with above-average intensities had greater increases in BMI, waist circumference, and HbA1c than participants in the cluster with average intensities. With multivariable adjustment, the mean increase in BMI was significantly (P=0.02) greater in Cluster 2 (+0.9) than in Cluster 5 (+0.4), and the average increase in waist circumference was significantly (P=0.045) greater in Cluster 1 (+3.0 cm) than in Cluster 5 (+2.0 cm). Cluster 5 also

Table 2. Five-year change in health measure,[a] least square mean change (standard error) overall, and by cluster: Beaver Dam Offspring Study[b]

		Cluster[c]					
Health measure	**Overall**	**1**	**2**	**3**	**4**	**5**	**Significant pairwise comparison ($P\leq0.05$)**
n[d]	1,918	326	222	115	651	604	
	←——*least square mean change (standard error)*——→						
Body mass index	0.6 (0.1)	0.7 (0.2)	0.9 (0.2)	0.8 (0.3)	0.5 (0.1)	0.4 (0.1)	2 vs 5
Waist circumference (cm)	2.5 (0.2)	3.0 (0.4)	2.9 (0.5)	2.7 (0.7)	2.7 (0.3)	2.0 (0.3)	1 vs 5
Systolic blood pressure (mm Hg)	1.9 (0.4)	1.4 (1.0)	2.6 (1.2)	2.2 (1.6)	2.6 (0.7)	1.2 (0.7)	—
Diastolic blood pressure (mm Hg)	1.9 (0.2)	2.0 (0.5)	2.3 (0.6)	1.7 (0.9)	2.3 (0.4)	1.4 (0.4)	—
Non-HDL[e] cholesterol (mg/dL[f])	−7.7 (0.8)	−7.9 (2.0)	−6.2 (2.5)	−2.7 (3.3)	−8.1 (1.4)	−8.3 (1.5)	—
Hemoglobin A1c (%)	0.26 (0.01)	0.24 (0.03)	0.29 (0.04)	0.34 (0.05)	0.28 (0.02)	0.20 (0.02)	2 vs 5 3 vs 5 4 vs 5

[a]Change=Examination 2 value (2010-2013)—Examination 1 value (2005-2008).
[b]Cluster means adjusted for age, sex, college graduate, any alcohol consumption in past year, and frequency of dieting.
[c]Cluster 1: slightly above average for salt and sweet and close to average for sour and bitter; Cluster 2: above average for salt, sour, and bitter, and average for sweet; Cluster 3: above average for salt, sour, and bitter, and very high for sweet; Cluster 4: below average for salt, sweet, sour, and bitter; Cluster 5: average for salt, sweet, sour, and bitter.
[d]Number for study population; number of participants included in the analyses of health measure changes ranged from 1,604 for change in hemoglobin A1c to 1,747 for changes in systolic and diastolic blood pressures.
[e]HDL=high-density lipoprotein.
[f]To convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.026. To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.7. Cholesterol of 193 mg/dL=5.00 mmol/L.

demonstrated a significantly lower increase in HbA1c than Clusters 2, 3, and 4. After participants with a history of diabetes at baseline were removed from the analyses, a significant (P=0.02) difference between Cluster 3 (+0.34%) and Cluster 5 (+0.20%) remained. There were no significant differences in change in blood pressure or non-HDL cholesterol across clusters.

The taste clusters differed significantly with respect to the liking of several food items (Table 3). The differences, adjusted for covariates, were particularly strong for the items representing sweetness (sweets, strawberries, and milk chocolate) and saltiness (pretzels, sausage). Generally, participants in Cluster 4 (below-average taste intensities) displayed the lowest mean hedonic score for these items followed by participants in Cluster 5 (average taste intensities), Cluster 1 (average or slightly above average taste intensities), and Clusters 2 and 3 (above-average taste intensities). There was little difference between clusters for the remaining food items, namely mayonnaise, whole milk, black coffee, dark chocolate, and grapefruit juice, which served as examples of creaminess, fat, bitterness, and sourness. There was also no significant difference between clusters with respect to frequency of vegetable and fruit consumption (χ^2=4.73; P=0.79).

Previous work investigating the relationship between taste preferences and weight change suggested that higher hedonic ratings for sweet and creaminess were associated with greater weight gain during an average of 5 years of follow-up.[51] These results are compatible with our finding that the clusters with the highest mean hedonic ratings for the sweet and salty food items demonstrated greater mean increases in BMI, waist circumference, and HbA1c. But many factors besides preference are involved in food choice and consumption.[9-13] Overall, without consideration of taste cluster, there were no significant associations between change in the adiposity-related health measures and hedonic ratings except for a relationship between liking whole milk and an increase in systolic blood pressure ($B_{adjusted}$=+0.23 mm Hg per +10 units on hedonic scale; P=0.02) and between liking milk chocolate and a decrease in systolic blood pressure ($B_{adjusted}$=−0.27 mm Hg per +10 units on hedonic scale; P=0.049) (data not shown). Therefore, although some taste clusters differed with respect to liking certain food items and with respect to changes in adiposity-related health measures, evidence of a direct association between the liking of the food items and the adiposity changes was not found. The lack of evidence is not surprising given the limited number of food items evaluated and the number of factors involved in the path of going from food liking to purchase to consumption and, finally, to adiposity-related change.

This study is likely the first investigation of taste and adiposity to evaluate all four basic tastes and to use cluster analysis to distinguish groups of people based on

Table 3. Food hedonics[a] overall and by cluster, least square mean (standard error): Beaver Dam Offspring Study, 2005-2008[b]

		Cluster[c]					
Food item	**Overall**	**1**	**2**	**3**	**4**	**5**	***P* value**
n[d]	1,918	326	222	115	651	604	
	←least square mean (standard error)→						
Mayonnaise	16.1 (0.7)	17.0 (1.5)	19.6 (1.9)	18.2 (2.6)	14.3 (1.1)	15.8 (1.1)	0.13
Whole milk	4.6 (0.9)	7.3 (2.1)	0.9 (2.6)	6.6 (3.6)	4.6 (1.5)	4.2 (1.6)	0.41
Black coffee	−2.3 (1.2)	−2.1 (2.9)	−3.2 (3.6)	−3.8 (4.9)	−1.4 (2.1)	−2.9 (2.2)	0.98
Dark chocolate	30.7 (0.9)	34.3 (2.2)	30.9 (2.7)	33.2 (3.8)	28.1 (1.6)	31.4 (1.6)	0.22
Salted pretzels	29.2 (0.5)	30.7 (1.3)	33.5 (1.6)	34.0 (2.2)	26.1 (0.9)	29.4 (1.0)	<0.001
Grapefruit juice	6.0 (0.8)	7.0 (2.0)	1.4 (2.4)	7.4 (3.3)	7.5 (1.4)	5.7 (1.4)	0.26
Sweets	45.2 (0.6)	48.8 (1.5)	53.6 (1.8)	53.9 (2.5)	39.7 (1.1)	44.6 (1.1)	<0.001
Strawberries	47.0 (0.6)	48.5 (1.5)	53.8 (1.8)	61.6 (2.5)	41.6 (1.1)	46.6 (1.1)	<0.001
Sausage	30.3 (0.7)	33.4 (1.6)	33.0 (1.9)	40.2 (2.6)	26.6 (1.1)	29.8 (1.1)	<0.001
Milk chocolate	46.0 (0.7)	50.0 (1.6)	53.7 (1.9)	53.5 (2.7)	41.0 (1.1)	45.0 (1.2)	<0.001

[a]Measured on a hedonic general labeled magnitude scale ranging from −100 (strongest imaginable disliking of any kind) to +100 (strongest imaginable liking of any kind).
[b]Adjusted for age, sex, college graduate, any alcohol consumption in past year, and frequency of dieting.
[c]Cluster 1: slightly above average for salt and sweet and close to average for sour and bitter; Cluster 2: above average for salt, sour, and bitter, and average for sweet; Cluster 3: above average for salt, sour, and bitter, and very high for sweet; Cluster 4: below average for salt, sweet, sour, and bitter; Cluster 5: average for salt, sweet, sour, and bitter.
[d]Number for study population; number of participants included in the analyses of individual food items ranged from 1,901 to 1,905.

similarities in the taste-intensity ratings. In a recent report, cluster analysis was used to group food items according to taste intensities of the foods.[52] Past studies of taste and adiposity have primarily concentrated on the association of adiposity with the phenotype or genotype for PROP taster status.[34,36] When particular basic tastes were considered with adiposity in past work, the investigations emphasized taste preference rather than intensity and were generally focused on one or two tastes, usually sweetness and bitterness.[44,53] Findings from these studies were not consistent.

Strengths

Strengths of this study included having perceived intensity data for the four basic tastes, along with information on a number of taste and adiposity-related covariates, including frequency of dieting. Data were from participants in the Beaver Dam Offspring Study, a large cohort investigation of the offspring of participants in the population-based Epidemiology of Hearing Loss Study. Adiposity-related health measures were available at two time points, with an approximate 5-year intervening period, which provided the opportunity to evaluate longitudinal change in the measures. Previous investigations of adiposity and taste assessed cross-sectional relationships and not longitudinal change in adiposity. Standardized protocols for obtaining the measures were followed by trained examiners at each time point so that the observed changes were likely not a consequence of a systematic measurement change. Whole-mouth taste testing provided an approximation of daily taste experience and the taste-testing protocol involved introducing the taste disks in a standard order to minimize context effects. The general labeled magnitude scale, which has been shown to be valid for across-group comparisons,[42] was used for rating intensity.

Limitations

Limiting this study is the fact that no formal dietary intake assessment information was available, the number of items included in the hedonic rating was small, and hedonic ratings were not based on presented foods. Previous work has found a relationship of diet and dietary patterns with adiposity,[4-8] and the sensation of taste has been identified as one of the most important factors in dietary choice and intake.[9,14] But it was not possible in the present study to evaluate the relationship between the observed taste-intensity clusters, food hedonics, and patterns of food consumption. A second consideration is that cluster analysis is dependent on the particular set of data being used and on the investigator's interpretation. Different taste clusters may be found in other study populations. However, using clusters to find common patterns of taste perception might be more useful for assessing the dietary and health consequences of taste than evaluating specific tastes. A third concern was that genotyping was performed only on participants 45 years of age and older and, consequently, the relationship between *TAS2R38* diplotype and taste cluster was not assessed for participants younger than 45 years. However, no significant difference in the *TAS2R38* diplotype−taste cluster relationship by age group was observed within the 45+ years subgroup. Finally, given the relatively young age of the population and only 5 years of follow-up, there was not adequate power to detect differences between the clusters in the incidence of disease outcomes, such as diabetes and cardiovascular disease.

CONCLUSIONS

Distinct patterns of response to suprathreshold concentrations of the basic tastes were observed in a large population. These clusters were found to be related to 5-year changes in adiposity-related measures, in particular BMI, waist circumference, and HbA1c, and to the hedonic ratings of some food items representing sweetness or saltiness. Given the reported associations of obesity and central adiposity with chronic disease,[1-3] finding factors related to adiposity change is of potential use in future health initiatives. Additional follow-up time is needed to evaluate the direct relationship between patterns of taste intensity and disease incidence.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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