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DIETARY BEHAVIOR, OLFACTORY AND GUSTATORY FUNCTION IN A UNIVERSITY STUDENT POPULATION

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ABSTRACT

Many studies have looked at biological differences between females and males, from brain chemistry to development to sensory differences in gustatory function. Conversely, few studies have focused on differences in transgender populations relative to cisgender populations. This research explores the influence of gender identity on dietary behavior, gustatory and olfactory function in young adults. Recent neuroimaging studies suggest brain patterns align with gender identity, rather than sex assigned at birth. Prior research has found differences in the intake of gender non-conforming and gender-conforming peers. The National Health and Nutrition Examination Survey (NHANES) started including chemosensory tests in 2011. Although this aspect of the NHANES was restricted to adults 40 years and older, there are important clinical implications regarding a loss of taste or smell even in college-aged students. For example, detecting the odor of smoke is vital for safety. Previous research regarding taste intensity has concluded mixed results when determining if one sex perceives one of the basic tastes more intensely than the other. Here, I hypothesize that dietary behavior, gustatory and olfactory function will be aligned with self-identified gender rather than sex assigned at birth, using a dietary behavior questionnaire and sensory evaluation of 3 prototypical tastes and 4 olfactory stimuli. While not reaching statistical significance ($p < 0.05$) gender non-conforming (GNC) participants had a lower desire to eat than cisgender participants ($F_{(2, 12.4)} = 1.13$, $p = 0.355$) and a high degree of restrained eating ($F_{(2, 11.8)} = 2.59$, $p = 0.117$). None of the participants presented anosmia, and no gender differences were observed among the 4 odorants used. The gender non-conforming participants rated lower intensity scores for the 0.18 mM quinine, 0.32 M sodium chloride, and 1 M sucrose solutions. Cisgender males (CM) rated the 1 M sucrose solution more intense than cisgender females (CF) or GNC ($F_{(2, 9.99)} = 7.43$, $p = 0.011$). CF liked the 1 M sodium chloride significantly more than CM or GNC ($F_{(2, 9.81)} = 10.55$, $p = 0.004$). There was not enough

evidence to support my hypothesis, however, more research is needed to understand dietary behavior, gustatory, and olfactory function in a gender diverse population.

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Chapter 1 - Background Information

Transgender Identity

Many studies have looked at biological differences between females and males, from brain chemistry to development to sensory differences in gustatory functions. Until recently, biological sex has been equated to gender identity. Biological sex is defined as the primary and secondary sex characteristics a person has. Gender identity is how someone perceives and identifies themselves. A transgender person may or may not experience gender dysphoria (GD), listed in the Diagnostic and Statistical Manual of Mental Disorders – fifth edition (DSM-5). The keystone of a GD diagnosis is marked by an incongruence between the gender identity and the biological sex characteristics in a person. Some transgender people may wish to seek medical treatments such as hormone replacement therapy or surgeries to correct the incongruence (Davy, 2015). In 2017, a study estimated that 13% of Americans aged 18 to 24 identified as transgender (Herman et al., 2017). When a person does not experience an incongruence between their gender expression and natal sex, the term cisgender is used. Few studies have focused on differences in transgender populations compared to cisgender populations. Zubiaurre-Elorza et al. (2013) was one of the first to publish neuroimaging data supporting a structural basis for transgenderism. Their study examined male-to-female transgender (MTF) and female-to-male transgender (FTM) participants using magnetic resonance imaging (MRI). In male-to-female transgender (MTF) people, the white matter is feminized, but not completely; the volume of white matter was between the average for cisgender males (CM) (who share the same biological sex) and cisgender females (CF) (who share the same gender identity). The white matter volume was significantly different from CM but not significantly different from CF. In female-to-male transgender (FTM) participants, a similar effect was found: this time the white matter volume was incompletely masculinized, again between the average volumes of CM and CF, and differing

significantly from CF but not so with CM (Zubiaurre-Elorza et al., 2013). In both MTF and FTM, the grey matter was more closely aligned with gender identity opposed to natal sex (Zubiaurre-Elorza et al., 2013).The results of this study suggest that transgender people have different neuroanatomical differences and patterns than their cisgender peers. This may also influence how transgender people perceive and process information around them.

Eating Behavior

Eating behaviors are developed in adolescence and adulthood. A person's self-esteem can either positively or negatively influence their eating behavior. Eating behavior can also be influenced not only by stress, anxiety, and depression levels, but also social relationships with family and friends (Lin et al., 2002). VanKim et al. (2019) was the first study to show that gender expression (how someone is socially and culturally perceived as masculine or feminine) and sexual orientation also have effects on eating behavior in adolescents and young adults. People who were gender-conforming were reported to have a lower diet quality than those who were less gender-conforming. Lin et al. (2002) aimed to identify factors in Malaysian college students that affected their dietary behaviors. Some of these factors included body mass index (BMI), indices of eating patterns, as well as an understanding of psychological and physical self. A negative self-image may lead to poor eating behavior habits, such as skipping meals.

Different aspects of eating behavior were evaluated using the Three Factor Eating Questionnaire (TFEQ), first described by Stunkard and Messick (1985). This questionnaire identifies three different factors: restrained eating, uninhibited eating, and desire to eat. The index of restrained eating (RE; 12 Questions; **Table 1**) was used to determine how much or how often someone restricts the intake of food. Restricting intake is one method used to consciously control bodyweight (Stunkard & Messick, 1985). The index of uninhibited eating (UE; 12 Questions; **Table 2**) was used to determine how much someone allows themselves to keep eating, even if they are full. This indicates a lack of control when a person is

around food (Stunkard & Messick, 1985). In Stunkard and Messick's (1985) work, the frequency of perceived hunger was termed "susceptibility to hunger" and later named "desire to eat." The index of desire to eat (DE; 10 Questions, **Table 3**) was used to determine how frequently someone experiences perceived hunger and the ramifications of eating behaviors.

The index of desire to eat (DE; 10 Questions; **Table 3**) was used to determine how frequently someone experiences perceived hunger, called "susceptibility to hunger." (Stunkard & Messick 1985). A person who shows an increase in restrained eating will likely show an increase in desire to eat; the opposite for someone who has uninhibited eating.

Overall, Lim et al. (2002) found significant gender differences between the female and male college students surveyed only for the Restrained Eating (RE) index, where women students were significantly more likely to restrain their eating compared to the men (Females mean 6.6 out of 12; Males mean 5.5 out 12). No significant sex difference was observed for the two other indices of uninhibited eating and the desire to eat (Lin et al., 2002). Jáuregui-Lobera et al. (2014) found similar results, while Gallant et al. (2010) found no significant sex differences among all three categories.

Surveying cisgender females and male students, this work indicates that at least some part of eating behavior is affected by either gender and/or biological sex. However, it is unclear whether this effect is due to gender identity and/or biological sex. VanKim et al. (2019) reported that gender-non-conforming individuals (aged 10-23) showed a lower caloric intake. It is unknown whether transgender and gender-non-conforming college students would follow the same pattern.

Anxiety and Depression

In the United States, anxiety affects nearly a third of the population, and depression affects nearly 17% of the population (Budge et al., 2013). A review in 2013 reports that at any given time, up to 20% of students will report psychological distress, including anxiety and depression (Kumaraswamy, 2017) Lin

et al. (2002) found in their cisgender college student population overall mild levels of anxiety (Females mean 8.32; Males mean 7.95; score from 0-7 indicated mild anxiety, out of 21 points), but no depression (Females mean 4.31; Males 5.19; score below 7 indicates normal levels of depression, out of 21 points).

Compared to cis-gender and gender-conforming populations, within the transgender community, anxiety and depression levels are significantly elevated. In the current literature, anxiety levels are reported from 26% to 38%, while depression levels range from 48% to 62% (Budge et al., 2013). One study found that 47% of transgender men and 40% of transgender women, aged 18 to 78 (mean age of 40), experienced anxiety, higher than previously reported. In addition, about half of both transgender men (48%) and transgender women (51%) were reported to experience depressive symptoms (Budge et al., 2013). Transgender people early on in their transition are more likely to experience the most amount of anxiety and depression, as at this point, their experience with gender incongruence is at the most intense, although many other factors play a role in anxiety and depression within this community (e.g., societal pressure, support of family and friends, access to mental health treatments, etc.). In general, as transgender individuals transition further, and settle into their new gender roles, a higher degree of well-being is reported (Budge et al., 2013). Anecdotally, people seek medical transition at the end of puberty or in adulthood, after experiencing gender dysphoria with primary and secondary sex characteristics. This study aims to look at the anxiety and depression levels of transgender and gender-non-conforming college students compared to cisgender college students.

Physical Activity

Physical activity is another factor that can influence eating behaviors. According to the Department of Health and Human Services (DHHS), adults are recommended to get 150 mins of moderate intensity exercise per week. One way to estimated exercise intensity is to use metabolic equivalents of a task (MET), which is based on how much energy is used to complete a task. As a

baseline, 1 MET is used while sitting at rest. Moderate intensity activities are defined as 3.0-5.9 METs, and include activities like biking, brisk walking, and gardening ("Physical Activity Guidelines for Americans.," 2008). Meeting this recommendation can reduce the risk of developing chronic disease (of which, gender non-conforming and transgender people may be of higher risk (VanKim et al., 2019) and improve symptoms of depression ("Physical Activity Guidelines for Americans.," 2008). Previous research reports that cisgender males have the highest rate of physical activity, followed by gender-non-conforming participants, then cisgender females. Societal pressures and gendered stereotypes (such as men must go to the gym) could influence physical activity levels of all people, regardless of gender identity (VanKim et al., 2019).

In the United States, only 1 in 5 adults (aged 18-34) meet the physical activity recommendation set by DHHS. Huang et al. (2003) reported that college students did aerobic activity nearly 3 days out of the week, suggesting college students are not meeting the physical activity recommendation. Downes reports that only 13.4% of college student participants met the guidelines for physical activities (Downes, 2015). Male students were reported to do more aerobic exercise compared to female students (Huang et al., 2003). The trends seen in Huang et al. (2003) is similar to what Downes (2015) reported.

Olfactory Function

While testing for olfactory function is not generally considered routine at doctor appointments, such as an annual physical, there is mounting evidence that a decrease in olfactory function can point towards several neurological conditions, such as Alzheimer's Disease, as well as acute virus infection with COVID-19 (Pierron et al., 2020). Several olfactory function tests have been developed to determine normosmia (a normal sense of smell). A study in 2016 determined the minimum number of odorants needed to determine a normal sense of smell was 3, although many scratch-and-sniff odor identification cards have 4 odors (Hoffman et al., 2016; Lötsch et al., 2016). In 2011, the National Health and Nutrition

Examination Survey (NHANES) started including chemosensory tests to gather data about the prevalence of anosmia (loss of smell) in American adults 40 and older (Hoffman et al., 2016) Using two 4-item smell cards (8 total odors) as used in the NHANES, Hoffman et al. (2016) found that males were less likely to correctly identify the smoke (8.1% vs. 11.1%) and natural gas (13.3% vs. 15.6%) odors than females, which is cause of concern from a public health perspective. Males were also three times more likely to have anosmia than females. In neither the NHANES survey nor the Hoffman study, details about the gender identity of the participants was collected, thus, it is unclear whether this difference between men and women aged 40 and older is due to biological sex or gender identity. In addition, olfactory acuity and perception is known to be affected by gender, age, smoking habit, BMI, race/ethnicity, and in general inter-individual olfactory variation (Hoffman et al., 2016).

Overall, the effect of gender identity versus sex assigned at birth on olfactory function is unknown. Although olfactory tests have been conducted on a college student population, there is a lack of thorough understanding of olfactory function in a younger population.

Gustatory Function

While there have been noted differences between sex and gustatory functions, the findings in literature are still inconsistent (Michon et al., 2009). All five of the prototypical tastes – sweet, sour, salty, bitter, and umami – have been studied with males and females. To my knowledge, no studies have investigated gustatory function in transgender and gender-non-conforming individuals. One study found no significant sex difference between cisgender males and cisgender females in 22-year-olds, which tasted sweet, salty, sour, and bitter solutions and rated the intensity of the solutions (James et al., 1997). In another study, females rated the perceived intensities of sucrose and quinine solutions higher than the male participants, although statistical significance ($p < 0.05$) was only reached for the highest concentrations (1.0 M sucrose and 0.04 mM quinine hydrochloride) (Michon et al., 2009).

A study from 2018 found significant sex differences with regards to liking of sour, bitter and salty solutions (Barragán et al., 2018). When asked about how much a participant liked a taste, cisgender males liked bitter more than cisgender females (Barragán et al., 2018). While there appears to be a gender effect on both the liking and the perceived intensity of basic taste qualities of salty, bitter, and sour, it is also known that personal preference may affect these ratings. For sweet taste, Iatridi et al. (2019) described three different phenotypes for sweetness liking; gender does not have an impact to affect neither perceived intensity nor liking ratings of sucrose solutions.

The NHANES study also included gustatory function to its battery of tests starting in 2011, with the aim to generate data and determine how variation with gustatory function is related to dietary and lifestyle behaviors. In the protocol, salty and bitter solutions were used. Previous research supports that salty and bitter tastes correlate well to the function and perception of the other tastes (sweet, sour, and umami) (Hoffman et al., 2016).(Hoffman et al., 2016) Women rated the intensity of the quinine solution higher than men ($p<0.06$) (Hoffman et al., 2016; Rawal et al., 2015).

Aims of This Study

There is a lack of sensory science research that includes gender diverse participation. This study aims to investigate how gender impacts dietary behavior, olfactory and gustatory function. Previous research supports that the brain develops in patterns matching gender identity opposed to sex assigned at birth (Simon et al., 2013; Zubiaurre-Elorza et al., 2013) .

Hypotheses

- Gender-non-conforming individuals will differ significantly from cisgender participants who share the same biological sex in dietary behavior

    - Ex. transgender men will differ significantly from cisgender females
    - Ex. transgender men will not differ significantly from cisgender males
- Gender-non-conforming individuals will differ significantly from cisgender participants who share the same biological sex in gustatory and olfactory function
    - Ex. transgender men will differ significantly from cisgender females
    - Ex. transgender men will not differ significantly from cisgender males

Chapter 2 Materials and Methods

Participants

Participants were recruited via email newsletters at multiple universities. In addition to Penn State, participants were recruited from Cornell University (Ithaca, NY), the University of California – Davis (Davis, CA), the University of Missouri – Kansas City (Kansas City, MO), and the Virginia Polytechnic Institute (Blacksburg, VA). A link to the questionnaire was provided and the survey was open for 2 months. All participants gave their informed consent before screening and answering the screener survey and diet questionnaire. Inclusion criteria were being reportedly healthy, no known problems regarding taste, smell, or salivation production, and were not pregnant or breast feeding. Exclusion criteria included being a smoker, and having a history of taste, smell, salivation, or swallowing problems. This study was approved by the Pennsylvania State University Institutional Review Board (Study 16591). Participants who completed the study were entered into a drawing to win Amazon gift cards.

Questionnaires

Eating Behavior

Stunkard and Messick (1985) includes 51 questions that load onto three distinct factors: Factor 1 – restrained eating (RE), Factor 2 – uninhibited eating (UE), and Factor 3 – desire to eat (DE). The questions are separated into two parts. The first part consisted of 36 “true” or “false” questions. The second part consisted of the remaining 15 questions, 14 of which was on a scale from 1-4, and one on a scale from 0-5. Lin et al. (2002) modified this questionnaire down to 12 items for restrained eating and uninhibited eating and 10 items for desire to eat. All 34 questions were modified to be answered as “true” or “false”. The ‘Index of Restrained Eating’ (**Table 2**) refers to how much a person restricts the amount or

the type of food they regularly consume. The 'Index of Uninhibited Eating' (**Table 3**) refers to how much someone allows themselves to eat, even if they full or not hungry. The 'Index of Desire to Eat' (**Table 4**) indicates how frequently someone experiences perceived hunger or wishes to eat. Some of the questions in each index were reverse-coded, per best practice; these were back-coded before summing the final score. Each positive statement answered "true" was coded with 1 point and 1 point was given for each negative statement answered "false". The possible range of each index ranged from 0 to 12, with a high score representing a high degree of restrained eating, uninhibited eating or a strong desire to eat (Lin et al., 2002). Neither Stunkard and Messick (1985), nor Lin et al. (2002) provided cutoff scores to categorize eating behavior patterns.

Rapid Assessment of Physical Activity

Topolski et al. (2006) conducted a literature review which led to the creation of a nine-item questionnaire to assess the physical activity levels of older adults. The questionnaire, termed the Rapid Assessment of Physical Activity (RAPA) assesses strength training, flexibility training, physical activity frequency and intensity. The first 7 statements (RAPA1) ask about the frequency and intensity of aerobic physical activity and are posed as "yes" or "no" questions. To the highest statement number marked as "yes", that is the same number of points given (refer to Table 5). For example, statement 6 asks, "I do 30 minutes or more a day of **moderate** physical activities, 5 or more days a week." A person who marks this as "yes" would be given 6 points. According to the assessment, 6 or 7 points in the first part of the assessment is optimal. The remaining two questions (RAPA2) assess strength and flexibility training. One point is given to those who marked "yes" to strength training. Two points were given to those who answered positively to flexibility training, for a total of 3 points in the second section (Oliver, 2019).

Anxiety and Depression

In 1982, Zigmond and Snaith (1983) created the Hospital Anxiety and Depression (HAD) scale as a quick non-psychiatric assessment of anxiety and depression. Within the questionnaire, there are 7 items each for anxiety and depression. The questions are answered on a scale of 0-3, with 0 meaning "never" and 3 meaning "always". Anxiety and depression could influence eating behavior and therefore were included in study by Lin et al. (2002). The responses of each questionnaire were summed for a total possible score of 21. A score below 7 indicates normal levels of anxiety or depression. Between 8 and 10 represents mild anxiety or depression, between 11 and 14 represents moderate anxiety or depression. A score above 15 indicates a severe level of anxiety or depression (Lin et al., 2002).

Olfactory and Gustatory Assessment

Olfactory Test

The test for olfactory function followed a similar protocol to the NHANES taste and smell protocol set forth in 2011. A 4-Item NHANES Pocket Smell Test™ (PST™, Sensonics, Inc., Haddon Heights, NJ) containing the odors of chocolate, strawberry, smoke and leather was used. Participants used a pen cap to scratch the odor strips in a "Z"-shaped pattern before smelling and identifying the odor from a choice of 4 options presented on a computer screen. Each item in the smell test was forced-choice and contained 4 options. Between items, the participant had a 30 second break to prevent odor fatigue during testing (Rawal et al., 2015). Normal olfactory function was defined identifying at least 3 of the 4 odors (Lötsch et al., 2016).

Taste Tests

Before tasting solutions, participants were instructed on how to use a generalized labeled magnitude scale (gLMS) using references from everyday life, such as the bitterness from black coffee or the brightest light they have ever seen (Hayes et al. (2013); Appendix B). A total of 5 different samples were provided to the participants in 15 mL plastic centrifuge vials with screw caps. Representative compounds for the basic taste qualities of sweet (1 M sucrose), bitter (0.18 mM quinine), and salty (0.32 M or 1 M sodium chloride) were used (Iatridi et al., 2019; Rawal et al., 2015). The participants sipped 10 mL of each solution, swished for 5 seconds and then identified the basic taste, rated the perceived intensity and the liking on the gLMS scale. After answering the questions, the participant spit out the solution and rinsed with water before continuing to the next solution. A duplicate of the 0.32 M sodium chloride solution was included similar to the NHANES protocol (Rawal et al. 2015).

Statistical Analysis

Participants were divided into three categories based on their self-reported gender identity: cisgender males (CM), cisgender females (CF), and other genders, including nonbinary and transgender identities (grouped into gender-non-conforming; GNC). One-way Analysis of Variances (ANOVA) were performed followed by a Tukey post-hoc comparison test on the dietary questionnaire and the taste intensity scores using Minitab 19 (Minitab LLC., State College, PA). Statistical significance was set at $p \leq 0.05$.

Chapter 3 Results

Recruited Participants

Of the 184 recruited participants, 58 of them qualified for the study (31.5%). Of those, 46 participants completed the dietary questionnaire (79.3%). The demographic information is listed in Table 1. 64.8% of people who responded identified as white, a significantly higher proportion were represented the GNC and CM groups ($p = 0.023$). All but one of the GNC participants (85.7%) were receiving hormonal treatment (either birth control or testosterone compared, to 38.2% of CF on birth control. The BMI range of the participants was from 15.9 to 39.0 kg/m^2. In the cisgender population (CM and CF), the median BMI was within the healthy weight category (CM 24.9; CF 23.0), defined by the CDC (2020) (refer to **Figure 1**). The median BMI for GNC was categorized as overweight (25.9) (CDC, 2020). Nearly 60% of participants identified as heterosexual with about 30% identifying as bisexual or pansexual.

Figure 2 shows the study design. 44 participants were invited to take part in the at-home sensory evaluation test; 25 participants completed the evaluation (CM N =5; GNC N=3; CF N = 17).

Table 1: Participant Characteristics

	CM n = 12	GNC n = 7	CF n = 34	Total n = 54
Ethnicity, N (%)				
White/Caucasian	10 (83.3%)	7 (100%)	18 (53.0%)	35 (64.8%)
Black/African American	-	1 (14.2%)	3 (8.82%)	4 (7.41%)
Asian	1 (8.33%)	-	14 (41.2%)	15 (27.8%)
American Indian or Alaskan Native	-	-	1 (2.94%)	1 (1.85%)
Native Hawaiian or Pacific Islander	-	-	1 (2.94%)	1 (1.85%)
Hormone Status, N (%)	0 (0%)	6 (85.7%)	13 (38.2%)	20 (37.0%)
BMI[A] (Median), in kg/m^2	19.2-27.2 (24.9)	19.4-35.7 (25.9)	15.9-39.0 (23.0)	15.9-39.0 (23.7)
Sexual Orientation				
Heterosexual	8 (67.1%)	0 (0%)	24 (69.1%)	32 (59.1%)
Homosexual	3 (25.1%)	2 (29.1%)	0 (0.1%)	5 (9.1%)
Bisexual/Pansexual	1 (8.1%)	5 (71.1%)	10 (29.1%)	16 (30.1%)
Self-Reported Normal Sense of Smell, N (%)	11 (91.7%)	7 (100%)	31 (91.2%)	49 (90.7%)

[A] 11 CM, 8 GNC, and 33 CF provided BMI information

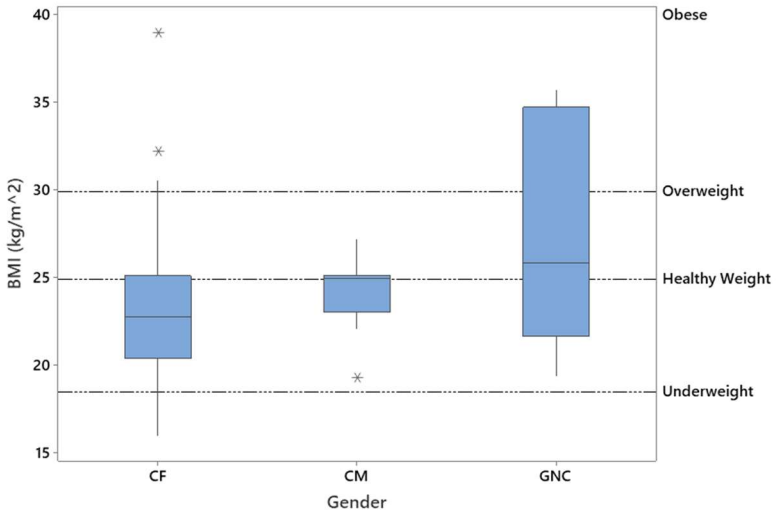

Figure 1: Boxplot of BMI by Gender

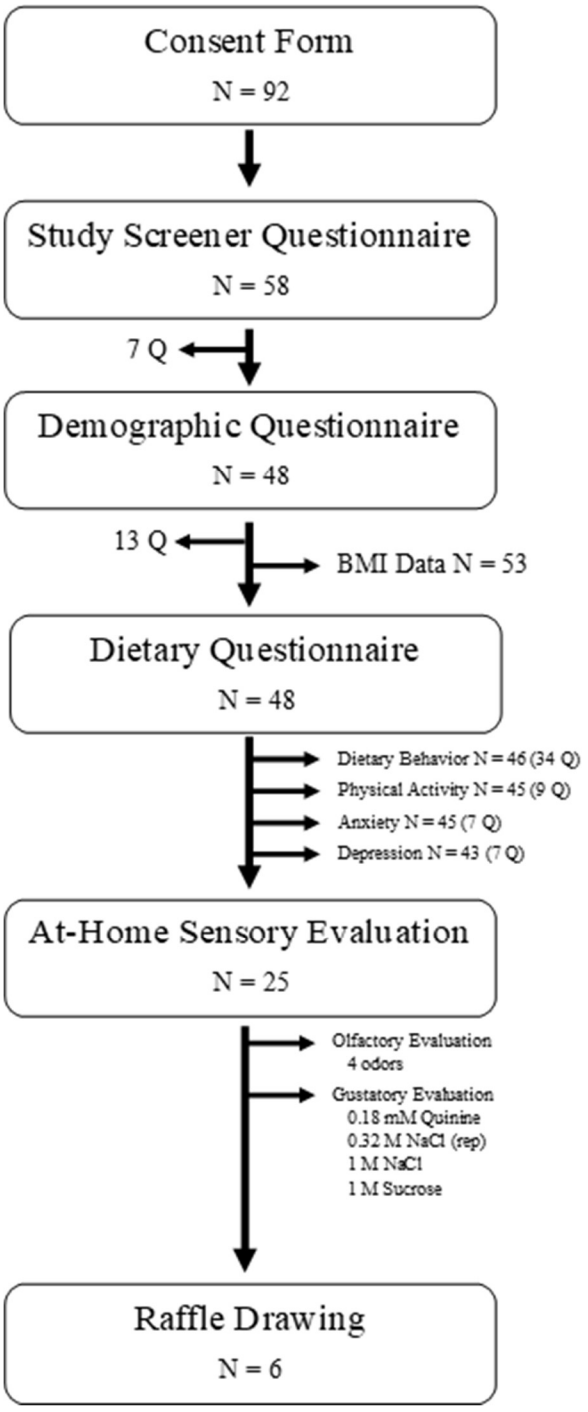

Figure 2: Study of Design

Questionnaires

Dietary Behavior

Three aspects of dietary behavior were assessed with the questionnaire, including restrained eating (RE), uninhibited eating (UE), and desire to eat (DE). Each index was calculated from the responses given by the participants and are summarized in **Tables 2-4**. The higher the index, the more inclined a person would be to retrain their eating, mindlessly eat, or experience hunger.

For the restrained eating (RE) index, no significant difference between the three gender groups was observed ($F_{(2, 11.8)} = 2.59$, $p = 0.117$) (**Table 2**). Questions 1 and 3 were answered true by the highest percentage of cisgender males (CM; n = 9, 66.7%). Questions 1, 6, and 9 were answered true by the highest percentage of those in the gender non-conforming (GNC; n = 6) group. Questions 9 and 10 were answered true by the highest percentage of cisgender females (CF; n = 31, 61.3%). The questions for the Index of Restrained Eating are listed in **Table 2**.

Table 2: Index of Restrained Eating

	% of Subjects who Answered TRUE			
	CM N=9	GNC N=6	CF N=31	All N=46
1. When I have eaten the amount of food, I think I should eat, I am usually good about not eating any more	66.7	66.7	58.1	63.0
2. If I eat food that I know I should not eat, I eat less of other foods for a while to make up for it	44.4	50.0	45.2	46.0
3. I eat anything I want, anytime I want	66.7	16.7	51.6	50.0
4. I consciously don't eat too much at meals in order not to gain weight	33.3	50.0	41.9	41.0
5. I often stop eating when I am not really full as a way of limiting the amount of food that I eat	44.4	50.0	16.1	26.0
6. I have a fairly good idea of the number of calories in foods I usually eat	55.6	83.3	45.2	52.0
7. I do not eat some foods because they make me fat	33.3	50.0	32.3	35.0
8. I deliberately take small helpings to control my weight	33.3	66.7	12.9	24.0
9. I pay a lot of attention to changes in my body shape	55.6	83.3	61.3	63.0
10. Life is too short to worry about dieting	22.2	50.0	61.3	52.2
11. I enjoy eating too much to spoil it by counting calories or watching my weight	22.2	16.7	54.8	43.5
12. I count calories as a way of controlling my weight	22.2	33.3	22.6	23.9
Average Index	5.78 ± 2.33	7.67 ± 3.01	4.68 ± 2.97	5.28 ± 2.97

Maximum score of 12, 1 point for each positive statement answered true, and 1 point for each negative statement answered false (3, 10, 11).

The Index of Uninhibited Eating (UE) was not significant between gender groups ($F_{(2, 12.6)} = 0.78$, $p = 0.477$). The highest percentage of cisgender females and those in the gender non-conforming group answered true to the first question (77.4% and 66.7%, respectively). The second question was the one in which most cisgender males answered true (77.8%). All of the cisgender males answered false to the last two questions in this index, about counting calories. The questions for the Index of Restrained Eating are listed in **Table 3**.

Table 3: Index of Uninhibited Eating

	% of Subjects who Answered TRUE			
	CM N=9	GNC N=6	CF N=31	All N=46
1. Sometimes things just taste so good that I keep on eating even when I am no longer hungry	66.7	66.7	77.4	74.0
2. It is difficult for me to leave something on my plate	77.8	50.0	67.7	67.0
3. I usually eat too much when I go out e.g. at parties or picnics	22.2	33.3	45.2	39.0
4. When I smell or see French Fries, I feel hungry, even if I have just finished eating	44.4	16.7	41.9	39.0
5. Without even thinking about it I take a long time to eat	22.2	50.0	32.3	33.0
6. When I am lonely, I eat to make myself feel better	11.1	50.0	29.0	28.0
7. When I feel anxious, I find myself eating	44.4	16.7	45.2	41.0
8. When I feel depressed, I often overeat	44.4	33.3	35.5	37.0
9. Sometimes when I start eating, I just can't seem to stop	22.2	16.7	35.5	30.0
10. When I am with someone who is overeating, I usually overeat too	55.6	16.7	51.6	48.0
11. I have gone on slimming diets more than once because my weight goes up and down*	0.00	16.7	22.6	17.0
12. When I am on a diet, if I eat food that is not allowed, I often then eat lots of other food that is not allowed	0.00	16.7	9.70	8.70
Average Index	4.11 ± 2.14	3.83 ± 2.23	4.94 ± 2.78	4.63 ± 2.54

Maximum score of 12, 1 point for each positive statement answered true, and 1 point for each negative statement answered false (2, 5). *indicates $p < 0.05$

No significant difference was found between gender groupings with respect to desire to eat ($F_{(2, 12.4)} = 1.13$, $p = 0.355$). Cisgender males are more likely to eat more than three times a day compared to those in the GNC group ($F_{(2, 12.3)} = 3.78$ $p = 0.052$). However, cisgender females are significantly more likely to eat something if they are hungry than either of the other groups ($F_{(2, 11.5)} = 9.38$, $p = 0.004$). Both of the cisgender groups responded that dieting is hard for them because they often experience hunger ($F_{(2, 17.6)} = 7.23$, $p = 0.005$). Overall, all three groups had the highest percentage of true responses to the first

question, about getting hungry and eating at certain times of their day (CM = 88.9%, GNC = 50.0%, CF = 80.6%). Half of the participants in the gender non-conforming group responded true to getting hungry late in the evening or nighttime as well.

Table 4: Index of Desire to Eat

	% of Subjects who Answered TRUE			
	CM N=9	GNC N=6	CF N=31	All N=46
1. At certain times of the day, I get hungry because I am used to eating at that time	88.9	50.0	80.6	78.0
2. I sometimes get very hungry late in the evening or at night	66.7	50.0	51.6	54.0
3. When I see something really nice, I often get so hungry that I have to eat it right away	33.3	16.7	35.5	33.0
4. Being with someone who is eating often makes me hungry enough to eat too	33.3	16.7	58.1	48.0
5. I am always hungry enough to eat at any time	44.4	16.7	41.9	39.0
6. I am usually so hungry I eat more than three times a day*	77.8	16.7	41.9	46.0
7. I get so hungry that my stomach often feels like a bottomless pit	22.2	16.7	29.0	26.0
8. I am always hungry so it is hard for me to stop eating before I have finished the food on my plate	22.2	16.7	19.4	20.0
9. I often feel so hungry that I just have to eat something*	0.00	33.3	38.7	30.0
10. Dieting is hard for me because I just get too hungry*	11.1	0.00	35.5	26.1
Average Index	4.00 ± 1.87	2.33 ± 2.88	4.32 ± 3.00	4.00 ± 2.83

Maximum score of 10 points, 1 point for each statement answered true. *indicates $p < 0.05$

Physical Activity

No significant differences were found in the physical activity levels between the groups, both for aerobic exercise ($F_{(2, 10.5)} = 0.17$, $p = 0.845$) and in the type of exercise they do. Most of the cisgender males (33.3%) do 20 minutes or more of vigorous exercise at least three times weekly. Half of those in the gender non-conforming group (50%) does moderate intensity exercise for at least 30 minutes five or

more days of the week. Most cisgender females responded saying they do some light physical activity each week (26.7%). Over half of the men (55.6%) and a majority of the gender non-conforming group (83.3%) reported that they do strength training at least once a week. More females said they do flexibility training at least once a week (61.3%). The number of participants who participate in physical activities are listed in **Table 5**.

Table 5: Index of Physical Activity

RAPA 1: Aerobic Activity	CM N=9	GNC N=6	CF N = 30	All N=45
1. I rarely or never do any physical activities.	0	0	0	0
2. I do some **light** or **moderate** physical activities, but not every week.	0	0	2	2
3. I do some **light** physical activity every week.	2	1	8	11
4. I do **moderate** physical activities ever week, but less than 30 minutes a day or 5 days a week.	1	1	6	8
5. I do **vigorous** physical activities ever week, but less than 20 minutes a day or 3 days a week.	1	0	2	3
6. I do 30 minutes or more a day of **moderate** physical activities, 5 or more days a week.	2	3	6	11
7. I do 20 minutes or more a day of **vigorous** physical activities, 3 or more days a week.	3	1	6	10
Index of RAPA 1	4.78 ± 2.17	5.33 ± 1.51	4.67 ± 1.67	4.78 ± 1.74
RAPA 2: Strength and Flexibility				
1. I do activities to increase muscle **strength**, such as lifting weights or calisthenics, once a week or more.	5	5	3	13
2. I do activities to improve **flexibility**, such as stretching or yoga, once a week or more	4	3	19	26
Index of RAPA 2	1.44 ± 1.51	1.83 ± 1.33	1.75 ± 1.11	1.70 ± 1.21

RAPA 1: Maximum score of 7, the highest question answered yes is the number score.
RAPA 2: Maximum score of 3, 1 point for answering yes to strength training, 2 points for answering yes to flexibility.

Anxiety and Depression

Gender did not have a significant effect on the levels of anxiety ($F_{(2, 8.3)} = 1.70$, $p = 0.241$) and depression ($F_{(2, 12.87)} = 2.42$, $p = 0.128$) on the participants. Overall, the males had a normal level of anxiety whereas the cisgender females had mild anxiety levels and the gender non-conforming group had moderate levels of anxiety. Cisgender males were more likely to report having the ability to relax and be at ease than the cisgender females or the gender non-conforming group ($F_{2, 11.8)} = 5.25$, $p=0.023$). The gender non-conforming group reported significantly higher levels of panic than either cisgender group ($F_{(2, 10.0)} = 6.57$, $p=0.015$). The gender non-conforming group had the highest reports of restlessness, worry, and tenseness compared to the other groups.

Table 6: Index of Anxiety

	CM N=9	GNC N=6	CF N=30	All N=45
1. I can sit at ease and feel relaxed*	0.78	1.8	1.1	1.2
2. I get a sort of frightened feeling as if something awful is about to happen*	0.44	1.6	0.67	0.73
3. I feel restless as if I have to be on the move	1.0	2.3	1.3	1.4
4. Worrying thoughts go through my mind	1.1	1.7	1.6	1.5
5. I get sudden feelings of panic	0.67	1.2	1.1	1.0
6. I feel tense or "wound up"	1.1	1.7	1.5	1.4
7. I get a sort of frightened feeling like "butterflies" in the stomach	0.89	1.3	0.87	0.93
Average Index	6.01±5.11	11.31±5.51	8.11±3.71	8.11±4.41

Scores are summed to create the anxiety index. Maximum of 21 points. *indicates $p < 0.05$

Only the gender non-conforming group registered levels of mild depression, although this was not significant ($F_{(2, 12.9)} = 2.42$, $p=0.128$). The gender non-conforming group responded significantly differently than the cisgender males in the first question, about enjoying the things they used to enjoy ($F_{(2, 10.7)} = 3.92$, $p=0.053$). They also were significantly different from cisgender females in their response to

enjoying a good book or TV program ($F_{(2, 16.5)} = 24.29$, $p<0.01$). Overall, the gender non-conforming group were least likely to enjoy the things they used to enjoy as well as experiencing an overall feeling of cheerfulness. Cisgender females were most likely to feel slowed down.

Table 7: Index of Depression

	CM N=9	GNC N=6	CF N=28	All N=43
1. I still enjoy the things I used to enjoy*	0.44	1.3	0.73	0.76
2. I can laugh and see the funny side of things	0.33	0.67	0.57	0.53
3. I look forward with enjoyment to things	0.33	1.2	0.61	0.63
4. I can enjoy a good book or radio or TV program*	0.67	1.0	0.29	0.47
5. I feel cheerful	0.78	1.3	1.0	1.0
6. I feel as if I am slowed down	1.0	1.0	1.4	1.3
7. I have lost interest in my appearance	0.33	0.83	0.57	0.56
Average Index	3.91 ± 4.11	7.31 ± 2.41	4.71 ± 3.61	4.91 ± 3.61

Scores are summed to create the depression index. Maximum of 21 points. *indicates $p < 0.05$

Olfactory and Gustatory Function

Olfactory Function

All 28 participants correctly identified at least 3 of the 4 odors, classifying them as normosmic. No significance was found between genders for identifying the olfactory stimuli (Chocolate: $F_{(2, 3.78)} = 0.52$, $p = 0.630$; Strawberry: $F_{(2, 8.90)} = 0.87$, $p = 0.452$; Smoke: $F_{(2, 7.89)} = 0.48$, $p = 0.636$; Leather: $F_{(2, 7.89)} = 1.55$, $p = 0.270$). All participants correctly identified the chocolate odor (**Table 8)**. In cisgender males, strawberry was the most commonly missed odor (80% correctly identified this odor). In cisgender females, leather

was the most commonly missed odor (86% correctly identified this odor). All of the gender-non-conforming participants correctly identified all odors.

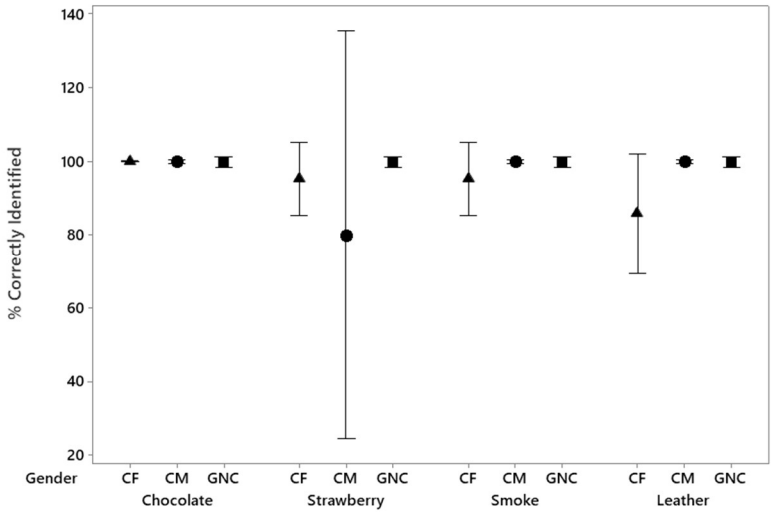

Figure 3: Percent of Odors Correctly Identified by Gender

Table 8: Percent of Participants who Correctly Identified Olfactory Stimuli

	CM N = 5	GNC N = 3	CF N = 20	All N = 28
Chocolate	100%	100%	100%	100%
Strawberry	80%	100%	95%	93%
Smoke	100%	100%	95%	97%
Leather	100%	100%	86%	90%

Gustatory Function

There was no observed gender differences in the intensity ratings of the quinine ($F_{(2, 12.2)} = 2.37$, $p = 0.134$), 0.32M sodium chloride ($F_{(2, 8.19)} = 1.09$, $p = 0.380$), and the 1M sodium chloride ($F_{(2, 7.0)} = 0.17$, $p = 0.850$) solutions. Cisgender males rated the 1M sucrose solution significantly more intensely than the cisgender females and the gender non-conforming participants ($F_{(2, 9.99)} = 7.43$, $p = 0.011$). The cisgender males and the gender non-conforming participants rated the 1M sodium chloride solution the most intense

(**Table 9**). The cisgender females rated the quinine solution the most intense. **Figure 4** shows an overview of intensity ratings by gender.

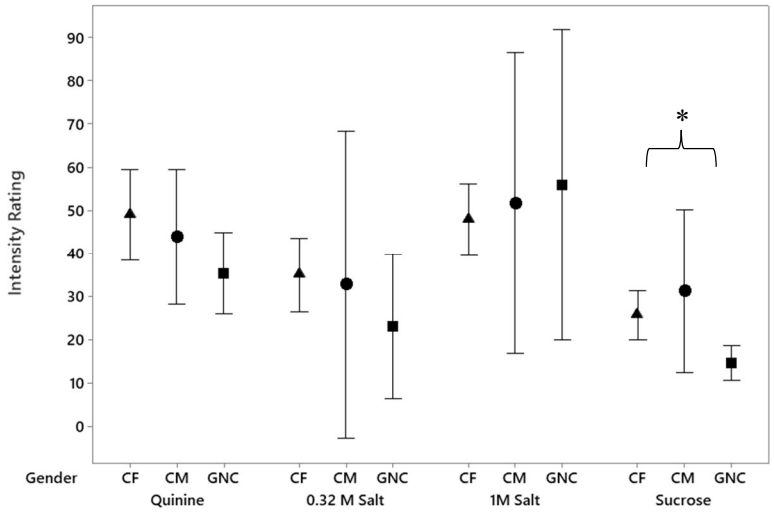

Figure 4: Overview of Intensity Data by Gender.*indicates $p<0.05$

Table 9: Intensity of Tasting Solutions

	CM N = 5	GNC N = 3	CF N = 22	All N = 30
0.18 mM Quinine	43.8 ± 12.6	35.3 ± 10.0	49.7 ± 27.8	47.3 ± 24.7
0.32 M Sodium Chloride	32.8 ± 28.5	23.1 ± 17.7	32.9 ± 22.9	31.9 ± 22.8
1 M Sodium Chloride	51.7 ± 28.0	55.8 ± 38.3	46.2 ± 22.8	48.1 ± 24.4
1 M Sucrose	31.2 ± 15.2	14.7 ± 4.3	26.0 ± 16.1	25.7 ± 15.4

There was no significant difference in the liking ratings for the quinine ($F_{(2, 9.18)} = 0.40$, $p = 0.683$), 0.32 M sodium chloride ($F_{(2, 8.82)} = 0.19$, $p = 0.827$), and 1M sucrose ($F_{(2, 7.34)} = 0.31$, $p = 0.740$). The cisgender females liked the 1 M sodium chloride solution significantly more than the other two groups ($F_{(2, 9.81)} = 10.55$, $p = 0.004$). Overall, the sucrose solution was rated the highest in liking scores. The cisgender males and cisgender females rated the quinine solution the least liked (**Table 10**). The gender non-conforming participants rated the 1M sodium chloride solution the least liked. **Figure 5** shows an overview of intensity ratings by gender.

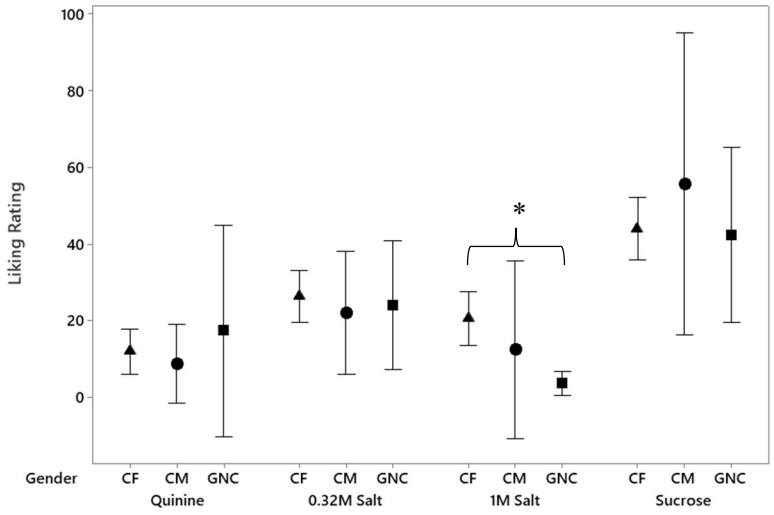

Figure 5: Overview of Liking Data by Gender.*indicates $p<0.05$

Table 10: Liking Scores of Tasting Solutions

	CM N = 5	GNC N = 3	CF N=22	All N=30
0.18 mM Quinine	8.7 ± 8.2	17.4 ± 29.4	10.0 ± 13.8	10.5 ± 14.6
0.32 M Sodium Chloride	22.1 ± 13.0	24.1 ± 17.9	26.4 ± 18.1	25.5 ± 16.9
1 M Sodium Chloride	12.4 ± 18.7	3.7 ± 3.4	20.7 ± 19.9	17.6 ± 19.2
1 M Sucrose	55.7 ± 31.7	42.5 ± 24.4	45.1 ± 22.3	46.6 ± 23.6

Based on the work of Iatridi et al. (2019), sweet taste liker status can be determined from the liking scores of a 1M sucrose solution. The participants were evenly distributed among the three phenotypes, sweet taste dislike (rating below 35 out of 100, area below red line in **Figure 6**), inverted-U (between 35 and 65 out of 100, area below yellow line in **Figure 6**), and sweet likers (above 65 out of 100, below green line in **Figure 6**). No gender difference was observed among the different phenotypes.

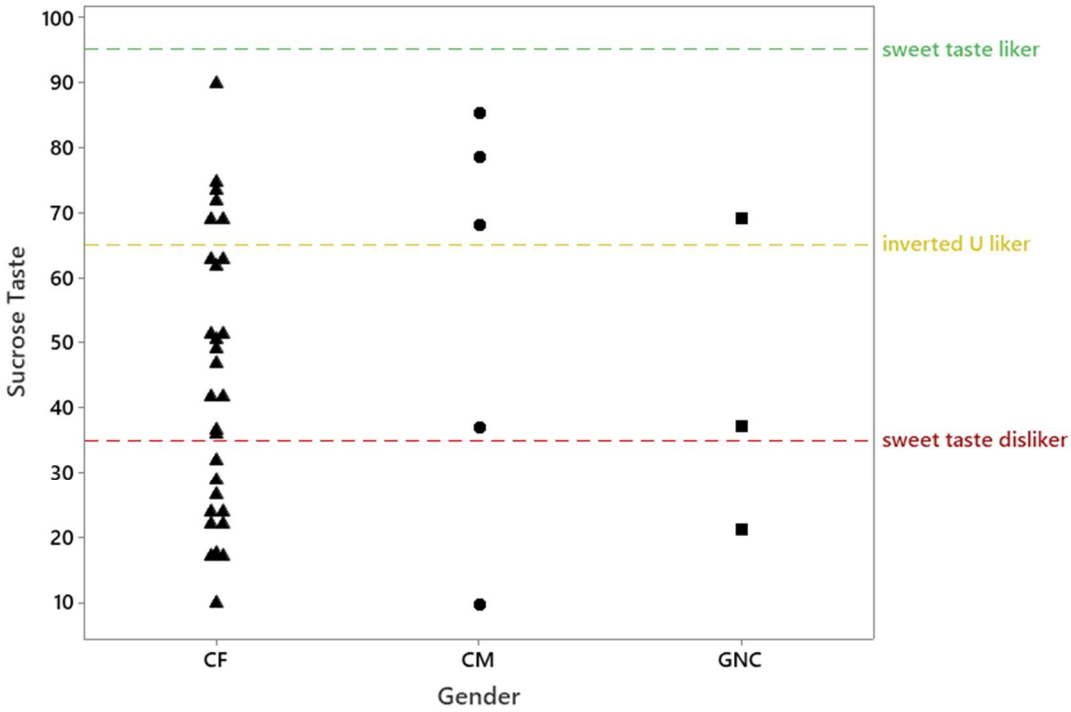

Figure 6: Sweet Taste Liker Status

Chapter 4 Discussion

Unlike the results found in Lin et al. (2002) cisgender females showed the least amount of restrained eating (6.6 vs. 4.68), followed by the cisgender males (5.5 vs. 5.78) and the gender non-conforming group (7.67) showed the highest degree of restrained eating. Many of the participants answered true to the question "When I have eaten the amount of food I think I should eat, I am usually good about not eating anymore." This is in alignment to what (Lin et al., 2002) found.

The participants in the present study showed less uninhibited eating compared to the Lin et al. (2002) study (CM 6.0 vs. 4.11; CF 5.5 vs. 4.94). That study found that the first question, asking "Sometimes things just taste so good that I keep on eating even when I am no longer hungry," was answered true by most participants (CM 71.1%; CF 66.7%) This was found true for cisgender females (77.4%) and the gender non-conforming group (66.7%). Cisgender males responded true to, "It is difficult for me to leave something on my plate" (77.8% compared to 46.7% in the Lin et al. (2002) study).

The gender non-conforming group showed the least desire to eat (2.33), although this was not statistically significant ($F_{(2, 12.4)} = 1.13$, $p = 0.355$). Along with the restrained eating index, GNC participants appear to want to consume less food, which is in alignment with previous literature (VanKim et al., 2019). The underlying cause of the gender-non-conforming group both restraining their food intake and having a lower desire to eat is unknown. One possible cause would be because of gender dysphoria and/or negative self-image. Cisgender females had a desire to eat index similar to what Lin et al. (2002) reported (4.3 vs. 4.32). Cisgender males had a lower desire to eat (4.9 vs. 4.00).

No prior literature on the rapid assessment of physical activity for the young adult population could be found. The three gender groups did not show any significant difference in the amount or type of physical activity they do. Huang et al. (2003) did not find a gender difference in physical activity among college students. The current CDC guidelines are for American adults to get 150 minutes or more of moderate-intensity physical activity weekly ("Physical Activity Guidelines for Americans.," 2008). In the RAPA, this correlates to a RAPA1 score of 6 or 7. Only 46.6% of participants in the present study fall

into this category, although this is above the national average for 18–34-year-olds (22.4%) (Huang et al., 2003) and what was previously reported (13.4%) (Downes, 2015).

Cisgender females appear to have mild anxiety (8.11), compared to the gender non-conforming group which has moderate anxiety (11.21). Cisgender males did not have elevated levels of anxiety (6.01). The anxiety levels of the cisgender females were close to what Lin et al. (2002) reports (8.32 vs. 8.11). Cisgender males reported higher levels of anxiety in the Lin et al. (2002) study (7.95 vs. 6.01). The gender non-conforming group also had mild levels of depression (7.31), whereas the cisgender groups had no sign of depression (CF 4.71; CM 3.91). This is in alignment with previous literature (CF 4.31 and CM 5.19 in Lin et al. (2002) (Budge et al., 2013)

All the participants in the sensory evaluation were normosmic. No gender difference was observed among the 4 different odors. From a public safety perspective, most of the participants (97%) were able to correctly identify the smoke odor.

With the exception of the 1M sodium chloride solution, GNC rated the intensities of the solutions less intense than CM or CF. The GNC group also liked the quinine solution more than CM or CF, although it did not reach statistical significance ($F_{(2, 9.18)} = 0.40$, $p = 0.683$). Although the cisgender females rated the 1 M sodium chloride solution the least intense of the three groups, they liked it the most ($F_{(2, 9.81)} = 10.55$, $p = 0.004$). This finding supports what was found in previous literature (Barragán et al., 2018). Cisgender males rated the 1M sucrose solution significantly more intense compared to CF and GNC ($F_{(2, 9.99)} = 7.43$, $p = 0.011$), and also liked it the most of the gustatory stimuli ($F_{(2, 7.34)} = 0.31$, $p = 0.740$). As Iatridi et al. (2019) stated, there was no difference by gender in the phenotype spread for sweet liker status (**Figure 6**). There is a need for further gustatory research on a gender-diverse population to further explore the research started here with larger sample size.

Chapter 5 Conclusion

This study aimed to determine if people who do not identify with their biological sex have similar dietary behaviors, olfactory and gustatory functions to their cisgender counterparts, with whom they share a gender identity. No statistical significance was achieved in any of the dietary or physical activity indexes (RE, UI, DE, RAPA1 and 2).

Some questions within an index were statistically significant among the gender groups. The gender-non-conforming group did not tend to be grouped with cisgender females more than cisgender males or vice versa. Although my hypothesis was that the GNC group would be closer aligned with the cisgender males, the data in the present study did not support this.

With the exception of the 1M sodium chloride solution, the GNC group rated the solutions less intensely than the cisgender participants; only the 1M sucrose solution reached statistical significance ($F_{(2, 9.99)} = 7.43$, $p = 0.011$). The GNC group liked the taste of the 1M sodium chloride solution significantly less than the cisgender female participants ($F_{(2, 9.81)} = 10.55$, $p = 0.004$).

This study had several limitations. First, due to the coronavirus pandemic, the number of recruited participants were low. The screener and questionnaire were only available online for 2 months which limited the number of participants available to the study. Within the gender-non-conforming group, all participants were assigned female at birth (2 transgender female-to-male, 1 agender, 1 genderfluid, 3 nonbinary participants). The agender, genderfluid and 1 nonbinary participant completed the at-home sensory evaluation. Future studies should not only include more transgender female-to-male participants, but also transgender male-to-female and assigned male at birth gender-diverse individuals.

Future research may also want to include the Teruel Orthorexia Scale (TOS; measures healthy orthorexia and orthorexia nervosa). Orthorexia nervosa is an unhealthy obsession with eating healthy foods. A dietary recall could also be implemented to compare caloric and nutrient intake among different genders. Finally, to minimize dropout rate due to a long questionnaire, the different indices should be separate questionnaires.

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Appendix A
Research Screener and Demographic Questions

What is your age?

- ☐ Under 18 yrs old [terminate]
- ☐ 18-25 yrs old
- ☐ 26-35 yrs old [terminate]
- ☐ 36-45 yrs old [terminate]
- ☐ 46-55 yrs old [terminate]
- ☐ 56-65 yrs old [terminate]
- ☐ Over 65 yrs old [terminate]

Do you smoke (within the last 30 days)?

- ☐ Yes [terminate]
- ☐ No

Do you consider yourself healthy?

- ☐ Yes
- ☐ No [terminate]

Are you currently taking medications that are known to alter taste or smell function?

- ☐ Yes [terminate]
- ☐ No

Do you have problems with your sense of smell or taste or salivation?

- ☐ Yes [terminate]
- ☐ No

Do you have a history of choking or difficulty swallowing?

- ☐ Yes [terminate]
- ☐ No

Are you currently pregnant or breastfeeding?

- ☐ Yes [terminate]
- ☐ No

Do you have an allergy or sensitivity to quinine (a component found in tonic water), salt or sugar?

- ☐ No
- ☐ Yes [not eligible for at-home testing but eligible for online questionnaire]

Are you currently on any hormone therapies (such as birth control, estrogen, or testosterone)?

- ☐ Yes ; Please fill in: _____
- ☐ No

How would you describe your race/ethnicity? (you may check more than one)

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Pacific Islander
- ☐ Indian
- ☐ Hispanic or Latino
- ☐ Caucasian
- ☐ Other; fill in _____

What is your sex?

- ☐ Female
- ☐ Male
- ☐ Other; fill in: _____
- ☐ Prefer not to answer

What is your gender?

** write in**

Are you transgender?

- Yes
- No
- Prefer not to answer

How do you identify with regards to your sexual orientation?

- Heterosexual
- Homosexual
- Bisexual/Pansexual
- Other
- Prefer not to answer

Check ALL of the following statements that apply to you now and estimate the date of onset:

- I have a normal sense of smell
- My sense of smell is distorted, that is, things smell peculiar
- I experience a smell when nothing is there (phantom smell)
- My sense of smell is heightened (hypersensitive)
- My sense of smell is diminished (partial loss)
- My sense of smell is absent (complete loss)

Have you ever had any head or facial injuries?

- No
- Yes

For the following questions, please circle a number from 1 to 7, with 1 being "not at all" and 7 being "absolutely". For the purposes of these questions, the word "perfume" denotes any artificial scent, such as perfume, cologne, essential oils, etc.

1. How sensitive are you to odor?
   (not at all)1 2 3 4 5 6 7 (absolutely)

2. Do you notice food smells?
   (not at all)1 2 3 4 5 6 7 (absolutely)

3. Do you notice the body odor or perfume of your partner, friends, family members, or others in general?

(not at all)1 2 3 4 5 6 7 (absolutely)

4. Do you wear perfume?

(not at all)1 2 3 4 5 6 7 (absolutely)

5. Do you think that someone's perfume influences the way you feel about them?

(not at all)1 2 3 4 5 6 7 (absolutely)

6. Do you notice the body odor of your romantic partner (current or most recent)?

(not at all)1 2 3 4 5 6 7 (absolutely)

7. Does your romantic partner (current or most recent) wear perfume?

(not at all)1 2 3 4 5 6 7 (absolutely)

8. Do you prefer your romantic partner to wear perfume?

(not at all)1 2 3 4 5 6 7 (absolutely)

9. Do you think about how you smell when you leave the house?

(not at all)1 2 3 4 5 6 7 (absolutely)

10. Do you think about how you smell when you meet someone new?

(not at all)1 2 3 4 5 6 7 (absolutely)

11. Do you think about how you smell when you meet a familiar friend?

(not at all)1 2 3 4 5 6 7 (absolutely)

12. Do you wear different scents/perfumes for different occasions?

(not at all)1 2 3 4 5 6 7 (absolutely)

13. Do you think you have a "signature scent"?

(not at all)1 2 3 4 5 6 7 (absolutely)

14. Do you think female body odor is different from male body odor?

(not at all)1 2 3 4 5 6 7 (absolutely)

15. Do you think female body odor is better than male body odor?

(not at all)1 2 3 4 5 6 7 (absolutely)

16. Do you think female body odor is worse than male body odor?

(not at all)1 2 3 4 5 6 7 (absolutely)

17. Do you feel comfortable if you are not wearing deodorant?

(not at all)1 2 3 4 5 6 7 (absolutely)

18. Do you feel comfortable if you are not wearing perfume?

(not at all)1 2 3 4 5 6 7 (absolutely)

Appendix B
Olfactory and Gustatory Evaluation Questions

Smell Rating Scale

Participants will be provided with a 4-item scratch-and-sniff card. The participant is asked to select one of 4 provided options. A total of 4 different odors (chocolate, strawberry, smoke, and leather) are tested.

Please scratch item #1 and smell it. This odor smells most like

Chocolate	Lemon	Smoke	Black Pepper
□	□	□	□

Please scratch item #2 and smell it. This odor smells most like

Garlic	Strawberry	Leather	Gasoline
□	□	□	□

Please scratch item #3 and smell it. This odor smells most like

Grass	Garlic	Smoke	Peach
□	□	□	□

Please scratch item #4 and smell it. This odor smells most like

Mint	Flower	Leather	Apple
□	□	□	□

Taste Solution Evaluation.

Before you begin, please find a quiet place and have a glass of water nearby.

Before you begin tasting samples, you will read the instructions for the scales. You will then practice using the scale by rating imagined or remembered sensations.

Please answer to the best of your ability as your answers will be used to help us interpret the results.

The scale you will use today starts at 'no sensation' (NS) on the left and ends at the 'strongest sensation of any kind' on the right. Think of what the strongest sensation is for you and remember it throughout this session. The top of the scale should not change, regardless of the sensation or quality you are rating. Adjectives are placed along the scale. You should use these to help make your ratings, but feel free to click anywhere along the scale.

When you are using the scale be sure to separate how intense something is from how much you like or dislike it. For example, if something is weakly bitter and you dislike bitter, don't be tempted to rate it as more bitter because you don't like it.

Finally, remember that the top is the strongest sensation of any kind which represents the most intense sensation you might experience across any type of sensation. What you perceive to be the strongest sensation of any kind should be consistent across items. It is very important that the same sensation is at the top of the scale for each sensation you rate.

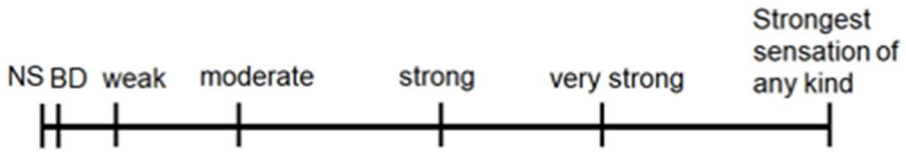
Before you begin tasting today, you will rate several remembered sensations in order to practice using this scale.

** Please rate these practice items to the best of your ability as your answers are used to interpret the results. **

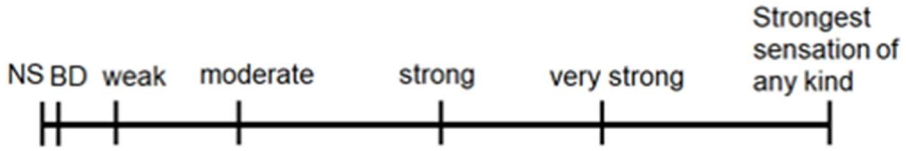
Please click the location on the scale that best represents the intensity of the sensations below.

NS = No sensation BD = Barely detectable

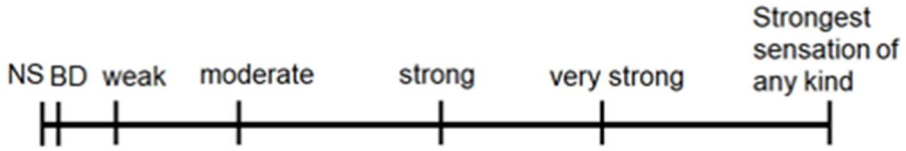
1. The loudness of a conversation



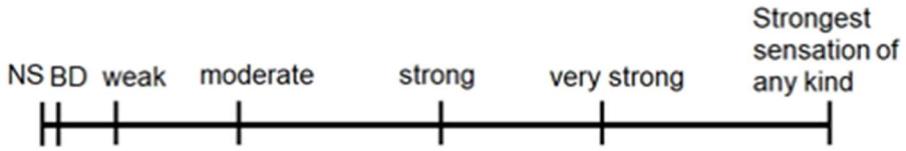
2. The pain from biting your tongue



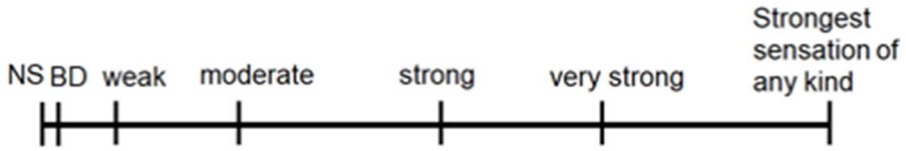
3. The brightness of a dimly lit room



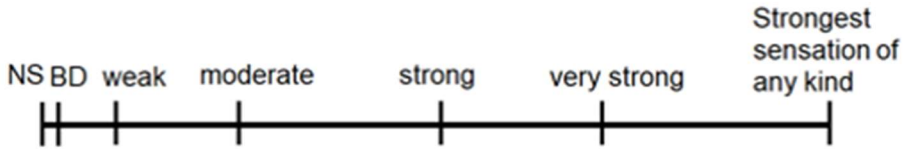
4. The sourness of a lemon



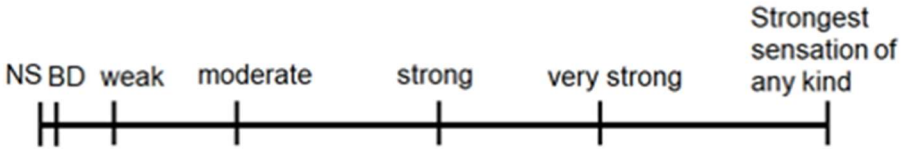
5. The strength of a firm handshake



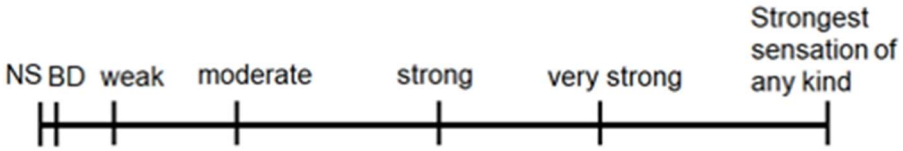
6. The loudness of a whisper



7. The brightest light you have ever seen



8. The bitter taste of black coffee



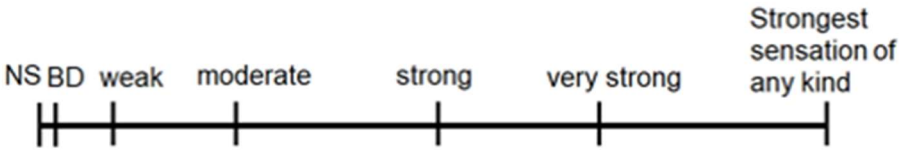
Now, take a sip of the water to cleanse your palate.

Please ensure that the sample code on the screen matches the sample code on the cup that you are about to evaluate.

Please place the entire volume of SAMPLE 1 in your mouth, swish for 5 seconds and rate the INTENSITY of and HOW MUCH YOU LIKE the sample, while the sample is IN YOUR MOUTH, then SPIT OUT the sample into the provided spit cup.

NOTE: If you do not experience anything, rate that attribute as “NS” or “no sensation”.

How intense is the taste?



How much do you like the taste?

Dislike extremely

Like extremely

Please select from the following the taste quality that you are experiencing from this solution:

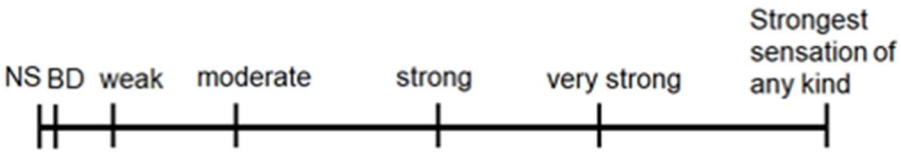
❑ Sweet ❑ Sour ❑ Bitter ❑ Salty ❑ Other: _____

Now, take a sip of the water to cleanse your palate. Please ensure that the sample code on the screen matches the sample code on the cup that you are about to evaluate.

Please place the entire volume of SAMPLE 2 in your mouth, swish for 5 seconds and rate the INTENSITY of and HOW MUCH YOU LIKE the sample, while the sample is IN YOUR MOUTH, then SPIT OUT the sample into the provided spit cup.

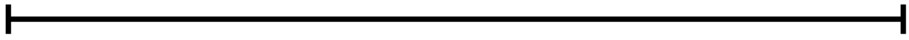
NOTE: If you do not experience anything, rate that attribute as “NS” or “no sensation”.

How intense is the taste?



How much do you like the taste?

Like extremely Dislike extremely



Please select from the following the taste quality that you are experiencing from this solution:

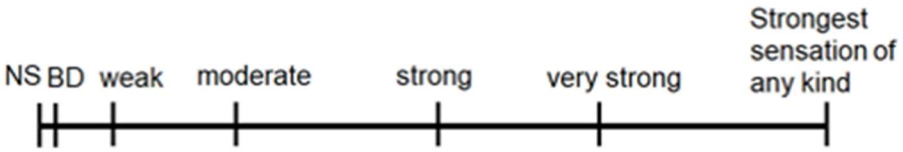
❑ Sweet ❑ Sour ❑ Bitter ❑ Salty ❑ Other: _____

Now, take a sip of the water to cleanse your palate. Please ensure that the sample code on the screen matches the sample code on the cup that you are about to evaluate.

Please place the entire volume of SAMPLE 3 in your mouth, swish for 5 seconds and rate the INTENSITY of and HOW MUCH YOU LIKE the sample, while the sample is IN YOUR MOUTH, then SPIT OUT the sample into the provided spit cup.

NOTE: If you do not experience anything, rate that attribute as “NS” or “no sensation”.

How intense is the taste?



How much do you like the taste?

Like extremely Dislike extremely

Please select from the following the taste quality that you are experiencing from this solution:

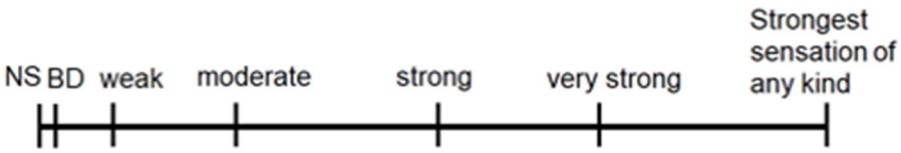
❑ Sweet ❑ Sour ❑ Bitter ❑ Salty ❑ Other: _____

Now, take a sip of the water to cleanse your palate. Please ensure that the sample code on the screen matches the sample code on the cup that you are about to evaluate.

Please place the entire volume of SAMPLE 4 in your mouth, swish for 5 seconds and rate the INTENSITY of and HOW MUCH YOU LIKE the sample, while the sample is IN YOUR MOUTH, then SPIT OUT the sample into the provided spit cup.

NOTE: If you do not experience anything, rate that attribute as “NS” or “no sensation”.

How intense is the taste?



How much do you like the taste?

Like extremely Dislike extremely

Please select from the following the taste quality that you are experiencing from this solution:

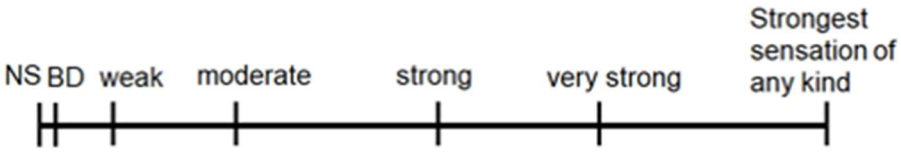
❑ Sweet ❑ Sour ❑ Bitter ❑ Salty ❑ Other: _____

Now, take a sip of the water to cleanse your palate. Please ensure that the sample code on the screen matches the sample code on the cup that you are about to evaluate.

Please place the entire volume of SAMPLE 5 in your mouth, swish for 5 seconds and rate the INTENSITY of and HOW MUCH YOU LIKE the sample, while the sample is IN YOUR MOUTH, then SPIT OUT the sample into the provided spit cup.

NOTE: If you do not experience anything, rate that attribute as “NS” or “no sensation”.

How intense is the taste?



How much do you like the taste?

Like extremely Dislike extremely

Please select from the following the taste quality that you are experiencing from this solution:

❑ Sweet ❑ Sour ❑ Bitter ❑ Salty ❑ Other: _____

Thank you for your participation, you have completed this study.

Academic Vita of Matthiew Haines

mzh687@psu.edu

EDUCATION

The Pennsylvania State University, University Park, PA May 2021

Bachelor of Science in Food Science
Millennium Scholar, Cohort Five
Undergraduate Thesis: Dietary Behavior, Olfactory and Gustatory Function in a University Student Population
Thesis Supervisor: Dr. Helene Hopfer

WORK EXPERIENCE

Product Development Specialist Intern June – Aug 2020

Nestlé USA, Solon, OH

- Worked with factories to develop a new formula for product without compromising taste
- Updated the product filing system to match the current portfolio and improve usability
- Evaluated products for sensory qualities to assist in product development

Commissary Packaging Specialist Nov 2019 – Current

The Berkey Creamery, University Park, PA

- Cut and package cheese and sausage for distribution
- Package dips, Paw Power Packs, and ice cream sandwiches for distribution
- Develop efficient methods of communication between the team and supervisors.

University of São Paulo, Faculty of Pharmaceutical Science May – July 2019

Research Intern, Dr. Eduardo Purgatto, São Paulo, Brazil

- Organized research position abroad in a post-harvest biology laboratory
- Secured nearly $4,000 in funding to support the cost of the research experience
- Analyzed the composition of *Eugenia brasiliensis* using solid-phase microextraction and gas chromatography-mass spectroscopy

Part-time Sensory Technician Sept 2018 – Current

The Pennsylvania State University, Sensory Evaluation Center

- Assist graduate students and faculty in conducting research and testing products
- Prepare and present samples to panelists
- Maintain laboratory cleanliness with good manufacturing practices

AWARDS AND PROFESSIONAL MEMBERSHIPS

Grants

- Spring 2020 College of Agricultural Sciences Undergraduate Research Proposal Award
- Summer 2019 MSP Summer Grant

Presentations

- Gamma Sigma Delta Research Expo 2020: Dietary Behavior, Olfactory and Gustatory Function in a University Student Population
- SACNAS 2020 and ABRCMS 2019: Aroma Characterization of *Eugenia brasiliensis* via Gas Chromatography-Mass Spectroscopy
- Conjuring the Past 2020: What's on the Medieval Menu?

Professional Memberships

- Institute of Food Technologists (IFT)
- Society for Advancement of Chicanos/Hispanics and Native Americans (SACNAS)