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Cold Cookies & Culturalism: Influences of Korean-American Culture and Food Temperature on Taste

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ABSTRACT

Of our many sensory modalities, discussions on taste perception are widely fueled by its unconventional qualities. Gustation is unique in that it is inherently biological yet cultural. Sugar perception, particularly, has been a significant area of research in the field of taste perception—its historical, cultural, and scientific dimensionality parallels the unique qualities of taste perception as a whole. While our biology predisposes us to perceptive similarities, cultural dichotomies, especially between Eastern and Western societies, have embodied the divergence in gustatory preferences. To analyze how such dichotomies interact with a widely unresearched scientific factor— temperature—a mixed-method study was conducted between Korean and American participants, measuring how temperature and cultural background influenced the taste perception (hedonic value and taste intensity) of a classic American dessert staple—the chocolate chip cookie. Guided by quantitative measurements, a qualitative interview portion was conducted, where background information and verbal analyses contextualized the results from phase 1. Results revealed a positive correlation between cookie temperature and taste intensity as well as hedonic value. Additionally, it was also discovered that international travel served as a gustatory transition for both groups and historical events had a direct impact on dessert 'staple' choices by Koreans. Elements of nostalgia were exclusive factors to Americans when selecting childhood staples or expressing sentiments towards unconventional foods. When investigating perceptive changes through foreign residency, The American tendency to perceive a 'forced change' in eating habits reflected notions of Westernization and embodied historical interactions with colonization, the sugar industry, and the Korean peninsula.

Introduction

Cultural upbringing plays a significant role in determining lifelong food habits. From childhood, we are heavily influenced by the food we receive; our differing cultures predispose us to different eating patterns. Sugar, in particular, has been a common artifact of many childhoods. Influenced by tides of war and industrialization, sugar became a primary example of how historical, political, and biological influences impact our contemporary diets. Our interactions with sugar are not limited in a cultural context. We are biologically engineered to perceive 'good food'—the ability to experience satisfaction, or the 'hedonic value' from eating, is embedded into our neurobiology. (Chaudhari & Roper, 2010; Garcia-Bailo et al., 2009; Jayasinghe, 2017). Sugar is especially particular to this notion—of the 5 tastes, we are naturally drawn to sweetness' endorphin-inducing flavor (Yudkin, 1972). Culturally and scientifically relevant in contemporary society, sugar is a hallmark of gustatory research. It asks how different predispositions influence our understanding of a universally pleasant and historically significant substance—and as such, its implications spur from the beginning of human history to our foreseeable culinary future.

Taste has also raised inquiries on its specific qualities. Why do we appreciate warm, sweet dishes as opposed to cold, bitter ones? One particular sensory factor, temperature, was shown to have a strong influence on the way we perceive certain foods. In particular, temperature's interaction with sweetness demonstrated its

significance to our hedonic perception (Lipscomb et al., 2016). How both cultural and scientific factors influence our sugar reception has been a widely disregarded topic—exclusive focus on statistical analyses of health and sugar consumption trends have limited cultural interpretations (Bernstein et al., 2005; Han & Lisa, 2014).

Psychological research shows that anecdotal storytelling often trumps statistical analyses when resonating with the reader (Boris, 2019). An eclectic analysis involving individual taste experience, upbringing, and cultural background when analyzing quantitative aspects of sugar consumption could offer a more restorative conclusion to the field, adding insight to culturalism and its relationship with our contemporary palates and lifestyle in sugar research.

Literature Review

Taste is both inherently biological and cultural. Yet, there is a lack of literature that compares both cultural and scientific implications—especially surrounding taste-temperature interactions—of sugar consumption (Green, 1993). Culinary differences are clearly exhibited in dichotomies of East-West societies. An interesting exception, however, is present between two such dichotomous countries. Notably, South Korea and the U.S. exhibit clear cultural distinctions yet share notable overlaps in their history (Barthes, 2012; Bok, 2007; Lee, 2018; Lee, 2019). Although previous sugar research surrounding Korean-American differences exists, no investigation approached the topic by incorporating both qualitative cultural elements with scientific interpretations (Green, 1993). The importance of a mixed-method investigation is highlighted by the nature of consumption and food studies—as much as our taste is a biological, sensory modality, it is also a hallmark of sociocultural influences. How these factors intertwine in both contexts will be explored in the following literature review.

Socio-Cultural Perspectives

Socio-cultural factors play a large role in our consumption choices (Birch & Hind, 1980). Sugar has gained significance in various cultures' culinary and nostalgic heritage—our eating patterns during childhood often determine our future consumption patterns from an early age (Mikkilä et al., 2004; Barthes, 2012).

In Western cultures, it is typical for dishes to be sweeter and saltier in comparison to their Eastern counterparts (Barthes, 2012). Dietical dichotomies are especially evident among desserts that hold cultural significance. For example, typical American desserts require large amounts of refined flour, fat, and white sugar to make, whereas in many East Asian cultures, desserts are traditionally sweetened with alternatives such as honey or maltose and made with grains and nuts (Perry et al., 2002; Parks, 2017; Lee, 2018).

Our upbringings show insight into culturally influenced eating, but historical conversations offer objectivity to biology-driven behaviors. The saccharine history of the U.S. dates far back to its colonial era. Sugar as an American commodity can be attributed to its significance as what foreign policy professor April Merleaux calls the 'spoils of victory.' In one candy store in Iowa, a replica of the battleship *USS Maine* was created through candied glass, sweets, and hills of pastry—even decades after the war had occurred (Merleaux, 2015). Even in times of political unrest, liberalism in commercial affairs remained prevalent, driven by waves of uprisings against 'undemocratic principles' (Merleaux, 2015; Sussman, 1994). With a sugar industry built upon fundamentally American ideals, Merleaux would go so far as to say that sugar, on the granular level, is embedded into American culture.

Korean saccharine history differs significantly from its American counterpart. Initially isolated from the rest of the world, Korea's economy was under Japanese control through the 1910s and 1940s—much of its developments could be characterized by what UC Berkeley researcher Young-Suk Lee calls 'colonial modernity.' The modernization of Korea, he says, was not necessarily self-sustaining; a parallel to American colonialism under British rule. The implications of South Korea's independence continue to affect contemporary Ko-

rean society. According to Eun-hee Lee, a professor at Yonsei University and author of *Sugar: The Contemporary Revolution*, sugar became a commodity far later than its American counterpart. Whereas the U.S. had to sanction protection laws like the Jones-Costigan Sugar Act due to sugar oversupply in the 1920s (Krueger, 1988), sugar in South Korea was a scarce luxury up until the post-colonial 1940s.

Sugar was provided as part of the American relief system for postcolonial South Korea in compensation for the abolishment of Japanese control of the rice industry (Lee, 2018). Such systems, however, were often invasive to the instability of the freshly liberated South Korean market. In October of 1945, the U.S. military government suspended all remaining Japanese control of the South Korean rice industry in an attempt to instate a capitalistic market (Lee, 2018). However, rice prices skyrocketed as a result due to supply shortages. Faced with a crisis, the US abandoned this system and instead sanctioned a nationwide rice collection and rationing system. This was a significant event for Korean sentiments towards America—many farmers resisted this collection as it paralleled a Japanese collection system where no rations were returned to Korean citizens.

The U.S. responded to protests by dedicating aid imports to foreign biscuits and candies worth $150,000 USD, which was again followed by public outrage. “We struggle to buy real meals for ourselves these days, how do they expect us to pay huge sums of ration money just for us to receive an unnecessary luxury like candy?” quotes a 1946 article in the Korean Freedom Press (자유신문) (Lee, 2018). There was a belief that an American ‘mouth washing’ of Korean citizens would permanently Westernize Korean society—leading many to believe the U.S. would transform Korea into its economic colony (Lee, 2018). As a result, sugar became a primary commodity to avoid importing for socioeconomic independence in times of uncertainty—a sentiment strongly influenced by U.S. involvement in rebuilding Korea.

The cultural standpoint of both nations differs in a more anthropological context. History shaped both food cultures, but the American notion of a ‘unified’ food culture has been discredited (Wallach, 2012; Merleaux, 2015). The U.S. is antithetical to homogenous Korea in that racial diversity and immigration were what characterized the ‘American-ness’ of its cuisine (Wallach, 2012; Merleaux, 2015). Similar principles apply in the context of desserts— ’American’ sugar consumption patterns are, by definition, prone to more variability in comparison to Korea. As a result, a sole cultural analysis, at least in the context of American consumption, is not holistic enough to contextualize sugar on an accurate basis. However, taste can be understood more quantitatively—often through a scientific context.

Scientific Perspectives

Scientific perspectives occupy a unique niche in the field of taste research. Taste is defined, according to Barry Green of Yale University, as the “oral experience produced during the ingestion of a food or beverage.” A product of our rich evolutionary history, our taste was developed as a “sensory modality” that guides organisms to avoid toxins and consume nutrients (Chaudhari & Roper, 2010). Amidst patterns of cultural divergence, our biological heritage has remained vastly similar, and our ability to habituate to different tastes remains present (Theunissen et al., 2000).

One interesting variable, temperature, has been investigated specifically on its role in sugar hedonics. Researchers like Green proposed a U-shaped curve among the four basic tastes—sour, salty, bitter, and umami—where as a function of temperature, taste detection was done most effectively with the least amount of stimuli between 20°c and 30°c. According to his findings, foods or beverages heated to temperatures above 30°c inhibited the effectiveness of reception.

Sweetness, however, played a more unique role when interacting with temperature. Keri Lipscomb and their colleagues at Clemson University investigated how the perceived intensity of sweet taste was affected by serving temperature. With foods served at 60°c being perceived as more intense than when served at room temperature or cold (3°c), These results aligned with the findings of Bartoshuk et al. (1981), Calvino (1983), Schiffman et al. (2000), and Talavera et al. (2005). Green’s findings also revealed that the perceived sweetness

of sugars increased within the range of 20°c and 36°c. Yet, contrary to Lipscomb et al., this pattern was inversely related to the taste intensity of the food product itself—too strong of a taste stimulus would lessen the effect of temperature on taste perception. These interactions between sweetness intensity and temperature are significant and provide insight as to why much remains to be learned about temperature-taste interactions (Green, 1993.) Though not considered a sole determinant of hedonic perception, previous data clearly situate temperature to be a factor interacting with sweetness intensity.

Method

To explore the scientific, historical, and cultural influences on taste perception, an experimental study was constructed measuring the differences in taste perception of an American 'staple' food—chocolate chip cookies—in Korean and American adult individuals. I hypothesized that with higher temperatures, there would be a significant positive correlation between taste intensity and hedonic value.

Selection of the 'Korean' and 'American' groups occurred through availability, evident East-West dichotomies in both groups, and personal proficiency in the two cultures. The goal of the experiment was to determine how a quantitative scientific variable—temperature perception—interacted with cultural upbringing (Korean/American) to influence a participant's taste perception of an American staple, the chocolate chip cookie.

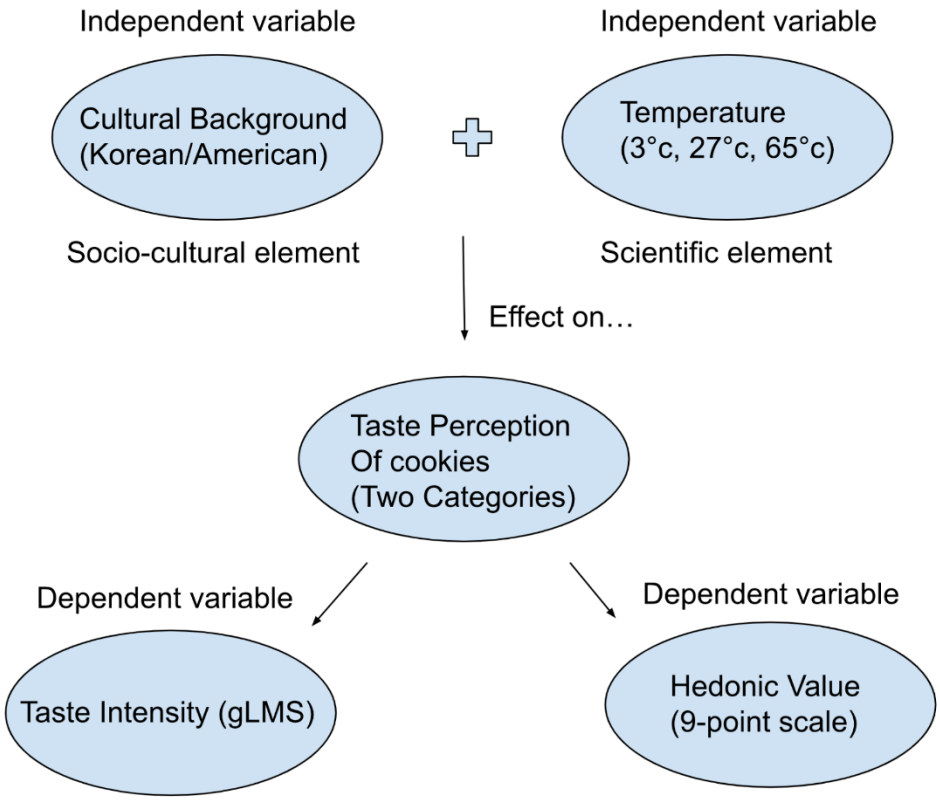

Figure 1. Overview of Research Design

The study was divided into two phases, involving a mixed-method experimental design. The first phase was a quantitative study using two measurement systems, allowing participants to rank taste perceptions of the different cookies. The scales measured taste perception, which was divided into two categories: taste intensity and hedonic value. The second phase involved a verbal interview that contextualized the quantitative information through a personal analysis of the participant's experiences (Appendix B). This phase also acted as a precautionary measure to identify outlying experiences that may have influenced the participant's perception ranking of the cookie.

14 staff members—7 Korean, and 7 American—were selected on availability from a staff sampling pool at [redacted]. A survey (Appendix A) was distributed electronically to gather participants. A participant's cultural background was determined through years of residence in one's home country (minimum of 10 years since birth), a decision made to maximize the cultural variables that could contribute to eating habits. To minimize confounding variables that could affect taste perception, those who have been/are pregnant in the past 3 months, diagnosed with a nasal/oral condition, been/are infected with COVID-19, and have a known metabolic illness were prohibited from participating.

Within each participant group (n=7), 6 were randomly assigned to an experimental group while 1 was assigned to a positive control group, given 'placebo' cookies of identical temperatures (65±3°c). Each cookie tasting was followed by room temperature water to cleanse the palate and ensure that tasting accuracy was maximized. The standard deviation and standard error equations were used to calculate the significance of the difference between results. Although the temperature of the tongue also impacts taste-temperature interactions, changes in such temperatures are difficult to produce under normal circumstances because of the tongue's frequent vascularization (Green, 1993). To accommodate for this issue, each participant gargled room-temperature water (27±3°c) for 10 seconds before tasting each sample.

Because my experiment is based primarily on food administration, ethical implications were prevalent. Latex gloves and masks were worn at all times, and surfaces were sanitized before and after baking. The pre-experimental questionnaire (Appendix B) ensured voluntary participation through its consent form, and participants with potential risk were excluded from the study. To ensure privacy, only nationality, age, and sex were disclosed, and all recordings of interviews were discarded after the experiment.

The cookies were baked using a recipe ('The Best Chewy Chocolate Chip Cookies') made by Tasty Co., an American food and recipe organization based on Buzzfeed Inc.. The specific recipe was denoted on the Appendices (Appendix C & D). Recipes were sought on the basis of their 'Americanness' to ensure participants received a true 'American' version of the American dessert staple—hence, the goal was to identify a popular recipe among Americans made by an American company, criterions that Buzzfeed's recipe satisfied. To ensure the reliability of cookie type, new batches were made the day before each experiment and the chocolate chunks in each cookie were measured to 12 grams and chopped into 12 equally sized pieces (Appendix E.)

The first phase involved the quantitative data collection phase, where 3 cookie samples of varying temperatures (8±3°c ('cold'), 27±3°c ('room temperature'), and 65±3°c ('hot'), respectively) were administered in random order to the participants. Each cookie was measured with a food thermometer then served immediately after in random order. Considering that minimal temperature changes could occur during transportation to the participant, a range of ±3°c for each temperature group was implemented. Participants were asked to rank the three different cookies based on their taste intensity (the perceived intensity of the sweetness and richness of the cookie. Richness was defined as the fattiness or oiliness of the cookie) and hedonic value.

Taste is frequently measured by a range of psychophysical measurements in the scientific community (Lipscomb et al., 1993). Among these measurements, taste intensity and hedonic value pertained widely to sweetness perception. To accurately measure both values, each subcategory had its respective measurement scale.

Table 1. Scales Used to Measure Taste Perception

Scales Used	Description	Reliability
General Labeled Magnitude Scale (gLMS) (Taste Intensity)	The general labeled magnitude scale is a scale that measures, from a scale of 0 to 95, the taste intensity of a food product. The key features of the gLMS are the unequal, quasi-logarithmic spacing of its verbal labels and the presence of the 'strongest imaginable' label as its upper bound.	The gLMS has been proven to be a valid tool to quantify gustatory intensity exclusive of pain and has been used in various research experiments regarding gustation (Cicerale et al., 2012 & Green et al., 1996).
9-point Hedonic Scale (Hedonic Value)	The 9-point hedonic scale is the most widely used scale to measure food acceptability. The equally spaced out 'points', ranging from 'Dislike Strongly' to 'Like Strongly', represents an equivalent psychological perception of the hedonic value of the food product.	The 9-point hedonic scale has been used for over 50 years and has been utilized as well as reappraised by many researchers ("The 9 Point Hedonic Scale" & Wichchukit & O'Mahony, 2014).

The Phase 1 form (Appendix F) included background information on the measurement scales and a brief introduction to utilizing the two scales appropriately.

The second phase was the interview portion consisting of a total of 8 questions (Appendix A). Interviews were conducted verbally and transcribed using transcription software. Participants were asked a set of questions that were divided into two categories: background questions and taste perception questions. The background questions were aimed to contextualize responses from the taste perception questions, serving as the foundation for the individualized, anecdotal element that I aimed to have as the essence of my research.

The Results & Analysis section was divided into smaller subsections following these distinctions. For Phase 1, results for 'taste intensity' and 'hedonic value' were organized both verbally and graphically, followed by an analysis. For phase 2, results were introduced thematically by 3 subsections (Sections 1.1, 1.2, and 2.1). Each subsection was followed by an individual analysis.

To condense question responses from each group, interview questions were referred to by the letter 'Q' followed by the question number (e.g. responses to question 5 would be denoted as 'Q5'). Similarly, interviewees were labeled based on their background, sex, and age (e.g. a 35-year-old American female participant will be denoted as AM/F/35). Any participants who did not wish to have their age disclosed had their age replaced by the acronym UND, followed by a number (such as UND1 and UND2.)

Results & Analysis

Phase 1 - Quantitative

Phase 1 Results

In American participants (n=6), taste intensity amounted to 8±3°c = 25.8*, 27±3°c = 30.67, and 65±3°c =59*. In contrast, Korean participants (n=6) recorded average taste intensity values of 8±3°c = 41.6, 27±3°c = 38.3, and 65±3°c = 66*.

*Samples where, if double the smallest value from the sample was less than the size of the second-smallest value, or if one half of the largest value was more than the value of the second-largest value, the sample was considered an outlier and excluded from the mean calculation process. No more than one sample was removed from each category.

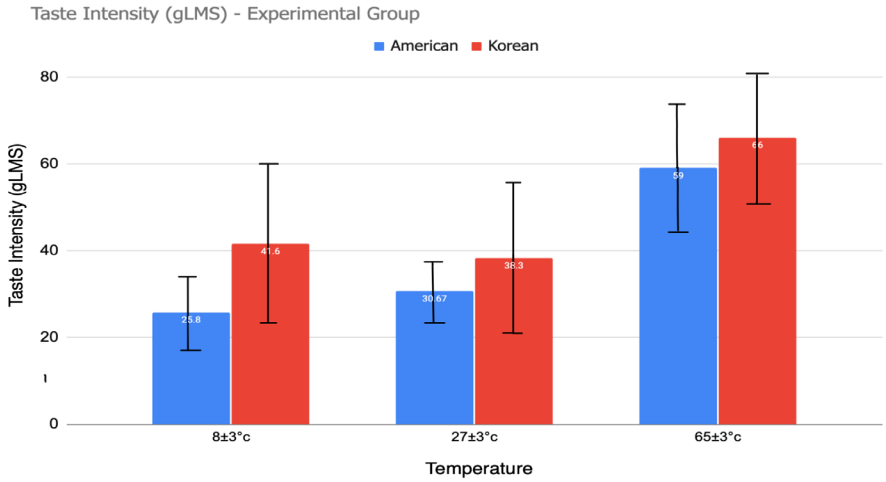

Figure 2. Taste Intensity Graph (Experimental Group; n=12)

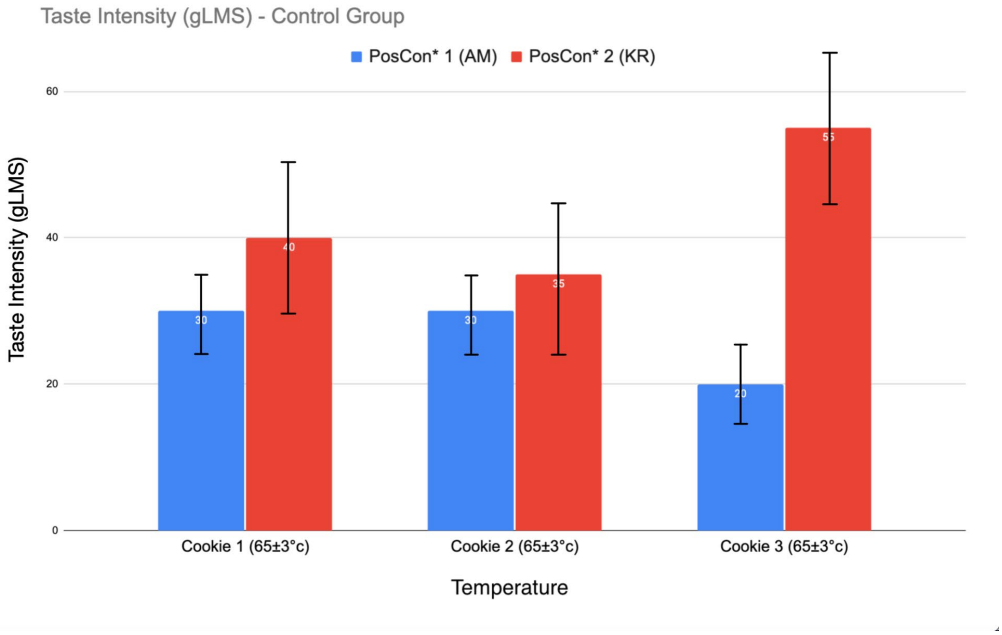

Figure 3. Taste Intensity Graph (Positive Control Group; n=2)
*PosCon: Positive Control

In American participants, the hedonic value was averaged per temperature range in this order: 8±3°c= 6, 27±3°c = 7, and 65±3°c = 6.83*. Responses from Korean participants showed similar results—8±3°c = 5.83, 27±3°c = 5, and 65±3°c = 8.

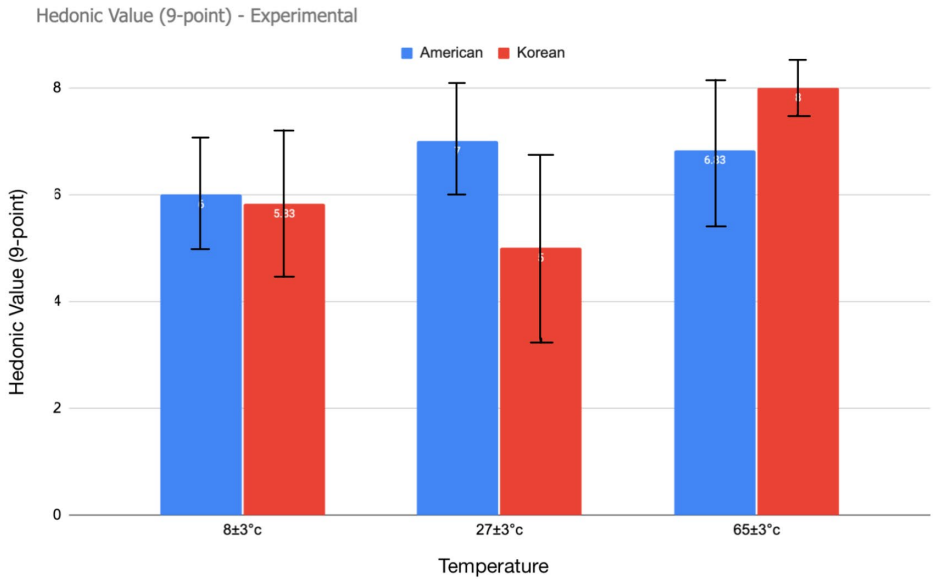

Figure 4. Hedonic Value Graph (Experimental Group; n=12)

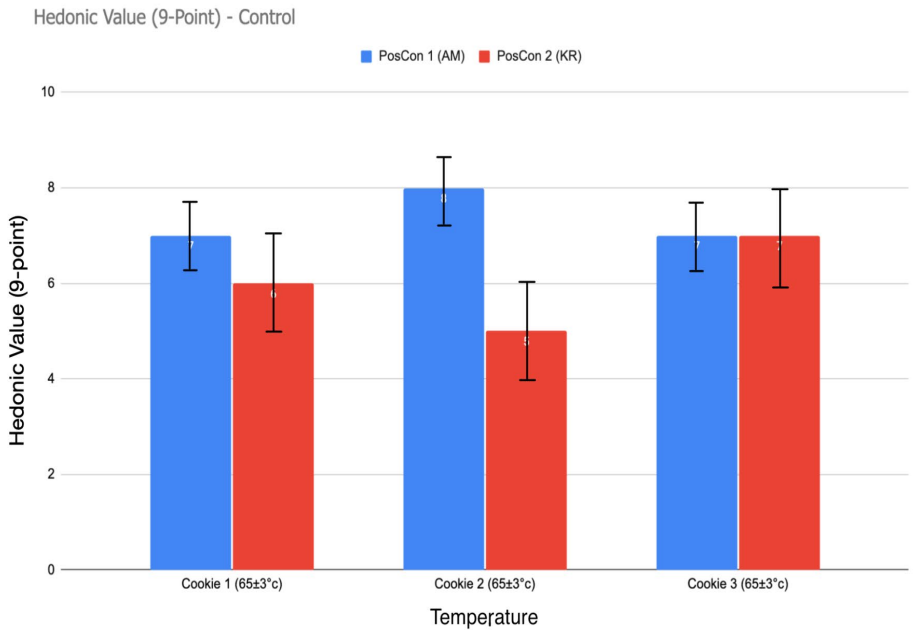

Figure 5. Hedonic Value graph (Positive Control Group; n=2)

Phase 1 Analysis

Results from phase 1 depicted that although a positive correlation was present between temperature and taste intensity, few significant differences were observed amongst different temperatures or among participant groups. Only one significant difference was observed—the taste intensity rankings for the hot cookie sample (65±3°c) in both Korean and American participant groups had significantly higher taste intensity values than

the 8±3°c or the 27±3°c sample in the American experimental group. The results partly aligned with my initial hypothesis, as well as the findings of Lipscomb et al., Bartoshuk et al., Calvino, Schiffman et al., and Talavera et al., which suggested that increased temperature would result in increased taste intensity. A significant difference in taste intensity between cold (8±3°c) and room temperature (27±3°c) cookies, however, was not present.

Hedonic value was similar in that one experimental group was exempt from the error bar overlap. The hot cookie (65±3°c) sample in Korean participants had a significantly higher hedonic value than the two other temperature groups. Unlike taste intensity, hedonic value and temperature had a much weaker positive correlation, especially among American participants. However, the significance only applied to Korean participants exclusively unlike taste intensity measurements. This contradicted my initial hypothesis that cookies of higher temperatures would produce a significantly higher hedonic value. However, the confounding variable of texture (addressed in detail at section 2.1) was proven to alter the cookies' hedonic value significantly.

Both control groups with 3 positive control cookies (65±3°c) showed that there was no significant difference in taste intensity or hedonic value, implying that the results depicted in the experimental group were significant. However, confounding variables in the control group will be further discussed in the limitations section.

Phase 2 - Qualitative

1.Background

Even with shared backgrounds, the 14 participants had noticeably different experiences, ranging from family traditions to overseas residency. In Phase 2, participants were asked questions regarding their background, childhood dessert staples, and international travel. This section serves to contextualize, to a personal level, the results and analysis of Phase 1. Through thematic and verbal analysis, participant anecdotes were characterized into relevant topics.

1.1 Background. Childhood Upbringing and Food and Dessert Preferences: Geographical upbringing was varied in both Korean and American participants. 2 of the 7 Korean participants were based in Seoul, the capital, while every other participant was raised in different Korean districts such as Pohang, Gwangju, Ilsan, and Busan. Americans showed more dispersion in upbringing—no two participants originated from the same state.

Table 2. Thematic Analysis of Section 1.1

Theme	Description	Quote
'Store-bought' phenomenon (KR)	When asked questions (Q3) about favorite sweet dishes from childhood, the tendency for Korean participants (3 of 7) to answer with store-bought pastries and dessert products (e.g. Sablé (사브레)' Biscuits, 'Chic-	"I saw chocolate chip cookies (Chic-Choc), the most famous ones, and I would just go eat them and buy them because it was easy." (KR/F/29) "My mom used to buy a chocolate cake from Paris Baguette on a regular basis. It was my favorite." (KR/F/UND2)

	Choc (칙촉)' cookies, and 'Paris Baguette (파리바게트)' Chocolate Cakes)	"Do you know Sablé? It was my favorite dessert from the store growing up." (KR/F/UND1)
Pie phenomenon (AM)	When asked questions (Q3) about favorite sweet dishes from childhood, the tendency for American participants (4 of 7) to answer with some sort of 'pie'	"I like apple-flavored desserts because it reminds me of family Thanksgiving dinner and gets me nostalgic. So apple crisp or apple pie, I would say." (AM/F/33) "My favorite dish growing up was egg pie. It was like an egg tart, but it was a family recipe." (AM/F/38) "I probably liked cherry apple pie the most. It was a holiday staple." (AM/M/32) "My mother was a good cook, and she'd make this thing called a peanut butter pie. It was, and still is, my favorite." (AM/M/38)
Tradition and Nostalgia (AM)*	Tendency in American participants to select favorite childhood staples based on family tradition, nostalgia, or psychological attachment	"The recipe [for egg pie] kind of passed down through the family and, you know, there's only one person in the family that could cook it right, and we're always trying to learn how to do it…That person has passed away, so having the pie kind of triggers those memories. It was my favorite dish and everybody knew it and I would always try to eat it the most." (AM/F/38, Alabama, U.S.) "My favorite dessert growing up was chocolate cake with mint frosting. My mother had made it once and I really liked it, and it must've become a family tradition." (AM/M/70, Boston, Massachusetts, U.S.) "I used to have blackberry or blueberry or peach cobblers because that's what my grandma would make after church every Sunday, and they were amazing. I just grew into it, and it was nostalgic." (AM/M/31, Jacksonville, Mississippi, U.S.)
Predisposition to chocolate chip cookies (AM/KR)	Participant attitudes towards chocolate chip cookies before their tasting—less likely to be attributed to cultural background	KR/F/30, KR/F/UND1, KR/F/26, AM/M/70, AM/M/32, and KR/F/UND2: "do not necessarily seek out chocolate chip cookies unless given" All participants excluding KR/F/47 and AM/F/38

	or upbringing, suggesting variability in preferences	suggest chocolate chip cookies were not a regular staple of their diet
Enjoyment of sweet dishes (AM)	Tendency for American participants (5 of 7) to say that they 'regularly enjoy eating sweet dishes' (Q4), whereas only 1 of the 7 Korean participants agreed with the statement	"I like [sweet dishes] immensely, and I eat them every week, if not every day." (AM/M/31) "Oh, goodness. At least 2 or 3 times a week. I love sweet things." (AM/F/37) "I don't like sweet things as much… If I'm feeling dizzy, maybe a small piece of chocolate, that's all. So I barely eat much [sweet dishes] in a week." (KR/F/UND1)

*Location of upbringing included next to participants to better contextualize tradition and/or geographically-oriented staple choices

1.1. Analysis: Results from subsection 1.1 pointed to varying topics of significance. The 'store bought' phenomenon exhibited by Korean participants versus the 'pie' phenomenon exhibited by American participants embodied the culturally influenced motives behind dish selection. Naming pie (another American staple) as a childhood staple reflected the nostalgic and traditional element valued by the majority of American participants; there was an element of complexity, where family tradition, nostalgia, and 'staples' were involved, an element unpresented in Korean participants.

Topics discussed in the literature review pose an explanation for these patterns: in the midst of globalization and increasing sugar consumption trends, most Koreans may have interpreted the term 'sweet dish' in a more Westernized context. Reflected by the findings of Lee (2018) and the Korean Liberation Press (자유신문), The selection of dessert staples by Korean participants centered around products such as cookies and cakes—usually unpopular, or at least uncommon, to eat on a Korean household basis. As Lee suggested, the Korean selection of 'store-bought' desserts, as opposed to American participants, suggests the correlation with the remnants of colonialism. The American effort of reconstructing Korean society post-Japanese occupation introduced foreign desserts to Korean society, standardizing the Western notion of contemporary desserts.

While these participants have likely tried traditional Korean desserts, these staples may have lost their significance under the general umbrella term of 'sweet dishes'. In an American context, the use of the term 'sweet dish' is more prevalent in the historical and traditional aspects of contemporary American culture. Trends of globalization support the Americanized definition of 'sweet dishes', with Western desserts being predominant in foreign markets (Lee, 2018). As Merleaux suggested, sugar as an American commodity is embedded at a granular level into 'traditional' American desserts (Merleaux, 2015). Korean households did not have the impetus of globalization nor the resources post-colonization to preserve Korean staples (Lee, 2018).

The majority of participants also indicated that they did not actively seek chocolate chip cookies nor had them as a staple of their diet. This could be attributed to a multitude of factors—first, the vast availability of desserts, American or not, likely deterred participants from regularly seeking the chocolate chip cookie exclusively. Second, the chocolate chip cookie is limited in its application. Unlike pies, a staple customizable in various aspects, the definition of a chocolate chip cookie is inflexible—it must have both chocolate and flour-based dough, and it must only include those two ingredients to remain in the parameter of its identity. Thus, the application of the chocolate chip cookie by its definition is limited, contributing to the lack of its regular desirability.

1.2. Background. International Travel or Residency as an Influence on Taste Perception: Travel affected both groups in varying manners. “I felt more accustomed to Western food than Korean food, to be honest … I didn’t like spicy food … so I actually liked Western cuisine more.” said KR/F/30, who moved to America at age 12. Another Korean participant, KR/M/55, lived in Japan for 4 years, where he tried pizza for the first time. “I tried it once, and I liked it so much,” he began, “and it was something I didn’t try back in Korea.” KR/F/26, who immigrated to India for 6 years during her late teens, shared a similar experience to KR/M/55. “I only ate Korean lunch when I was young … When I went to India, I had so many different foods, like pizza then Korean food [for another].” However, the branching of culinary preferences was not the only quality brought by international travel. KR/F/47, who lived in France, shared her experience with illness. “I lived in France, and the food was very buttery and cheesy. Korean food is much healthier, but it was completely unavailable. My health declined rapidly.”

One Korean participant was an exception to this consensus of travel. KR/F/UND2, who had never lived abroad, responded to the question of residency and its impact on her food habits (Q5) differently. “When I was really young, I was always thinking about going on a diet,” she began, “because all the K-POP idols and television shows would tell us to do it. Now, I eat because I have to survive,” she said.

All American participants had resided in at least 1 country outside of the U.S. AM/F/37, who enjoys sweet foods regularly, detailed her experience in the Swahili island of Zanzibar. “There weren’t a lot of processed or sweetened foods in Zanzibar, so my dessert options were often just M&Ms,” she said. AM/M/70, who lived on the small Korean island of Geoje, detailed a contrasting experience. “The allowance for each meal was 300 won (approximately $2 USD, with inflation) … my protein of the day was maybe an egg, with some rice. I lost 25 pounds in about 3 months.” AM/F/38 also shared a similar experience as an American immigrant in Korea. “[When I came to Korea], I didn’t eat rice, so I lost about 10kg just from not eating processed food. Pastries … were also not as sweet as I was accustomed to. Price of American goods was a bigger problem than availability.” AM/M/32 also explains his change in diet in Afghanistan. “Fresh produce was difficult … we had to soak everything in iodine water to sanitize it from bacteria and parasites. We ate poorly for two years with lots of carbs and little to no vegetables.”

The adaptability of our taste was a prominent topic in AM/M/38’s experiences. “Living in Montenegro, foods were largely raw or grilled with no seasoning on them, even salt and pepper. Even that was considered spicy,” he began. “But, my taste buds adjusted to that blandness. When we moved to [the country of] Georgia, we had a lot of intense flavors and spice, which overwhelmed me at first.”

To further the understanding of how taste perception was affected by residency, participants were also asked to name a dish they initially disliked but were accustomed to and now enjoy eating. ‘Vegetables’ were a shared answer among two participants—KR/F/30 and AM/M/38. “Leafy greens, probably. I never had salad until I was 18 years old. I thought it was rabbit food and horrible—my diet growing up was white bread, ham, and mayo.” said AM/M/38. “I had never eaten any sort of international food before I lived abroad,” said AM/M/30. “I’ve never tried curry or Thai food until I was 21 but my roommate introduced it to me,” said AM/F/33. “In college, my roommates made ramen, and I thought it smelled gross…” began AM/F/37, “ but I really like it now.”

Korean participants showed an evident pattern of disliking and being accustomed to traditional Korean dishes. “I hated hong-eo (a Korean dish made of fermented stingray), it smelled disgusting”, said KR/F/29.“I hated Chung-guk-jang (a Korean stew dish made of fermented beans) but I like it now,” said KR/F/47. In contrast, none of the American participants had named an American dish they had disliked but became accustomed to.

1.2. Analysis: Our upbringing predisposes us to our culinary choices, but taste as a sensory modality is inherently malleable. With the experiment being conducted in an international school setting, international travel and residency after childhood was a significant experience among the majority of participants.

Most of the Korean participants agreed, when asked about international residency and food habits, that their eating was impacted in both positive and negative manners. In the case of KR/F/UND1 and KR/F/47, who agreed that their eating habits became 'greasier' after their international experience, a standard level of 'greasiness' that the Korean participants were accustomed to was implied. This Korean tendency reflected Barthes' (2012) and Birch & Hind's (1980) discovery regarding psychosocial perception differences based on upbringing, especially in East-West societies. American participants characterized their foreign food habits in a more limiting light—most Americans implied a forced change in their preexisting food habits involved with eating abroad. This was another notion that could be attributed to the Westernization of global cuisine. Whereas Korean participants previously limited to Korean cuisine were more likely to see a difference in food culture as an act of diversification, American participants saw it as a limitation from their previously American cuisine. Korean participants, in contrast, showed an evident pattern of initially disliking and being accustomed to Korean dishes. Both KR/F/29 and KR/F/47 support this claim—while none of the American participants named an American dish as something they had disliked, some Korean participants indicated an accommodation to their own country's dish. Such a tendency reflects a contemporary change, or at least an eccentricity, in Korea's traditional dishes. Although a cause-and-effect relationship cannot be assumed, the suggestion of a Westernized palate correlates to the normalization of Westernized dishes in postcolonial Korea, as suggested by Lee (2018) and Lee (2019) and in Analysis 1.1.

Additionally, KR/F/UND2's lack of experience with international travel and interactions with Korean 'diet culture' point to a distinctly Korean cultural experience. Her residency specifically in Korea influenced her attitude towards food consumption—KR/F/UND2's experience is a prime example that illustrates how cultural elements and residency significantly interact with one's perception towards food and eating, as reflected by the findings of Birch and Hind (1980).

2: Perception

Verbal analysis of perception questions helped situate quantitative data from phase 1 in a personalized context, in addition to identifying significant confounding variables.

2.1. Perception. Verbal Analysis of Intensity and Hedonic Value by Participant

Table 3. Thematic Analysis of Section 2.1

Theme	Description	Quote
Temperature Polarization and Taste Intensity (AM/KR)	Pattern of high-temperature extremities as an *unintended* confounding variable to taste intensity, and low-temperature extremities yielding *intended* results.	"The first one was pretty hot—it was hard to discern any flavor at first. But as it cooled down, it was more intense. The cold one was similar—at first, [all I could feel was] 'cold'. Then the flavor started to come through …" (AM/M/30) "The warmth of the cookie made the taste intensity more evident. I had to spend more time 'unlocking' the sweetness in the cold ones. But both were enjoyable to some degree," (KR/F/47)

Temperature Polarization and *Skewed* Hedonic Value (AM)	High-temperature extremities as an *unintended* confounding variable to hedonic value.	"The hot one was a little too hot, so I was like, whoa! It's a little too hot, so I guess in that way, I enjoyed it less because it was starting to burn my tongue." (AM/M/70)
Texture as a confounding variable (AM/KR)	Tendency for participants to name texture as an *unintended* confounding variable to taste perception. Of the 14 participants, 10 indicated texture as a confounding variable.	"The hardness of the cold cookie made me focus on sensing the textures more than the taste," (KR/F/47) "The texture for the hot one was kind of mushy, but the cold one felt a little dry," (AM/M/70)
Exceptions and Outliers (AM/KR)	Outliers to the hypothesis that a positive correlation is present between temperature, hedonic value, and taste intensity	"I liked the cold and hot one better than the room temperature one." (AM/F/33) "I thought the room temperature cookie was the best—I grew up eating lukewarm cookies." (AM/F/38) "I found the cold cookie much better." (KR/F/47)

2.1. Analysis: Both groups had a general consensus that warmer cookies were more intense than colder cookies—however, concurrent with the results from phase 1, the hedonic value was prone to more variation. Through the use of perception questions, several confounding variables relevant to my study were identified. Firstly, the two temperatures—the hot, 65°c cookie, and the cold, 8°c cookie—evidenced a decrease in taste intensity for some (3/14) participants. The decrease in taste intensity and hedonic value was characterized by temperature extremities. The 3 participants indicated that the intensity of the temperature made the cookie initially unpleasant. Illustrated especially by AM/M/70, the 'hot' cookie was perceived by multiple participants to be 'too hot'. Although the limitation in intensity and hedonic value of the 'cold' 8°c cookie was initially hypothesized, the 'hot' 65°c sample was not selected to account for the unpleasantness of its temperature. Especially in regard to taste intensity, those who studied the gLMS scale explicitly implied that gLMS has been proven to be a valid tool only at the exclusion of pain (Cicerale et al., 2012, Green et al., 1996). Therefore, the selection of 65°c as the 'hot' sample, initially expected to show the highest amount of taste intensity, undoubtedly skewed the results for both hedonic value and intensity at least in part.

Secondly, texture was also a confounding variable. Because this study involved baked goods sensitive to texture at different temperatures, the hedonic values of the cookies were skewed as temperature changes caused the cookies to deviate from their intended texture. The cold cookie was characterized by over 9 participants to be 'hard'—an unintentional result, considering the recipe used was intended to make 'chewy' chocolate chip cookies.

Limitations

Various limitations were relevant in my experiment. Cookies were made using Korean ingredients, while the goal of the experiment was to analyze the taste perception of an American staple. The use of these ingredients

may have altered the intended 'American' taste profile of the cookies. To minimize this issue and ensure experimental replicability, Appendix D indicates the specific ingredients used to make the cookies.

Chocolate dispersion was also a limitation. The nature of the chocolate chip cookie relies on the proper distributive ratio of chocolate chips to dough; to preserve the identity of the cookie, the chocolate must stay separate from the dough, while being evenly dispersed. Although measures were taken to make 12 equally sized pieces of chocolate chips, the baking process likely did not distribute the 12 chips to even areas in the single cookie, meaning that the 'bite' of the cookie per each participant may have had a slightly different amount of chocolate. To minimize such issues, cookies with highly uneven chocolate dispersion were discarded and re-baked.

Limitations were also present in the sampling process. The available sample pool of American participants was primarily of white European descent—only 1 of the 7 American participants was not ethnically white. Consequently, this sample pool may have been unrepresentative of the characteristic 'American' population, usually characterized by racial heterogeneity and multiculturalism (Wallach, 2012; Merleaux, 2015). Small sample size was also a limitation. No more than 7 participants for each group were available—to ensure that experimental results were as reliable as possible, a decision was made to include just 2 participants in the control group. This unreliability undoubtedly serves as a limitation to my experiment.

Conclusion and Future Directions

Our cultures are capable of diverging into delineated branches. The evolution of both our cultures and biology has molded our many artifacts, including our perceptive abilities. The results of my study reflect not only the significance of this divergence, but also the importance of understanding historical precedent and individual narratives to contextualize quantitative data. Understanding taste as both quantifiable and qualifiable allowed generalized conclusions: that taste is malleable (as depicted in Phase 2, Analysis 1.2), prone to predisposition through historical, cultural, and familial influence (Phase 2, Analysis 1.1, 1.2), and measurable in multilateral, quantitative aspects (Phase 1). Through elements of sweetness perception and Korean-American dichotomies specific to my research, results showed that 1. Elements of post-colonialism heavily influenced the Korean participants' staple selections and consumption, 2. Nostalgia and tradition were the primary elements of childhood staples among American participants, and that 3. Westernization and colonialism influences notions of culinary 'limitations' in Americans abroad, and the Korean tendency to understand 'sweet dishes' through a Westernized perspective. The implications of the results are not limited to an academic field. My findings reflect the importance of being conscious of our attitudes towards foreign cultures, especially when concerning food—my emphasis on a food's cultural significance shows that one 'staple' dish could mean more to one cultural group than another. It is evident how one's cultural attitudes may shift through upbringing and historical predisposition—through recognizing such attitudes, we gain consciousness of our prejudices.

My investigation also raised questions in further areas of research: how do these patterns reflected by colonialism and Westernization apply to the consumption culture of another colonized country? Further investigations could explore two different countries through a similar method, aiming to identify recurring patterns or new understandings. Additionally, an alternative sampling method or larger sample with a similar hypothesis could yield differentiated results—more reliability on quantitative data could enhance discussions on future Phase 1's of similar studies. The multidimensionality of sugar opens itself to boundless discussion on how our senses interact with our perception of the world. The notion that sensory abilities are characterized not only by its innateness but also by cultural factors that influence it, then, is an invaluable idea serving as a contemporary foundation for understanding the nature of why we perceive the way we do.

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References

Barthes, R. (2012). Toward a Psychosociology of Contemporary Food Consumption. *Food Culture,* (3), 20-27. DOI: https://doi.org/10.4324/9780203079751.

Bartoshuk, L. M., Rennert, K., & Stevens, J. C. (1982). Effects of temperature on the perceived sweetness of sucrose. Physiology and Behavior, 28, 905-910. DOI: http://dx.doi.org/10.1016/0031-9384(82)90212-8

Bernstein, D. M., Laney, C., Morris, E. K., & Loftus, E. F. (2005). False beliefs about fattening foods can have healthy consequences. *Proceedings of the National Academy of Science*, 102(39), 13724-13731. DOI: https://doi.org/10.1073/pnas.0504869102.

Birch, L. L., Zimmerman, S. I., & Hind, H. (1980). The Influence of Social-Affective Context on the Formation of Children's Food Preferences. *Child Development*, *51*(3), 856–861. DOI: https://doi.org/10.2307/1129474.

Bok, H. (2007). 조선시대 밥류의 종류와 조리방법에 대한 문헌적 고찰 [The Literary Investigation on Types and Cooking Method of Bap (Boiled Rice) During Joseon Dynasty (1400's~1900's)]. *Korean J. Food Culture*, 22(6), 721-741.

Bolhuis, D. P., Costanzo, A., & S. J. K. Russell. (2017). Preference and perception of fat in salty and sweet foods. *Food Quality and Preference*, 64, 131-137. DOI: https://doi.org/10.1016/j.foodqual.2017.09.016\

Boris, V. (2019). What makes storytelling so effective for learning?. *Harvard Business Publishing*. Retrieved November 21, 2021, from https://www.harvardbusiness.org/what-makes-storytelling-so-effective-for-learning/.

Bowser, S., Farnsworth, N., Russell, K., Schlechter, H., Bernstein, S., Courville, A. B., ... & Muniyappa, R. (2019). Sweet taste perception is greater in non-Hispanic black than in non-Hispanic white adults. *Nutrition*, *59*, 103-107.

Calvino, A. M. (1986). Perception of sweetness: The effects of concentration and temperature. Physiology and Behavior, 36, 1021-1028. DOI: http://dx.doi.org/10.1016/0031-9384(86)90474-9

Chaudhari, N. Roper, S.D. (2010). The cell biology of taste. *Journal of Cell Biology,* 190(3), 285–296. DOI: https://doi.org/10.1083/jcb.201003144

Chin, L., & Fang, N. (2016). Effect of Ingredient Ratio on the Texture Profile of Cookies. *Go Forth and Measure*, 1-10. Obtained from: https://lillych.in/files/ltchin_2671Paper.pdf

Cicerale, S., Riddell, L. J., & Keast, R. S. (2012). The association between perceived sweetness intensity and dietary intake in young adults. *Journal of food science*, *77*(1), H31–H35. DOI: https://doi.org/10.1111/j.1750-3841.2011.02473.

Dawes, C., & Watanabe, S. (1987). The effect of taste adaptation on salivary flow rate and salivary sugar clearance. *Journal of dental research*, *66*(3), 740-744.

Fiore, A., Dario Troise, A., Atac Mogol, B., Roullier, V., Gourdon, A., El Mafadi Jian, S. Hamzalioglu, B.A., Gokmen, V., & Fogliano, V. (2012). Controlling the Maillard Reaction by Reactant Encapsulation: Sodium Chloride in Cookies. *Journal of Agricultural and Food Chemistry*, 60(43), 10808-10804. DOI: 10.1021/jf3026953

Garcia-Bailo, B., Toguri, C., Eny, K.M., & El-Sohemy, A. (2009). Genetic Variation in Taste and Its Influence on Food Selection. *OMICS: A Journal of Integrative Biology,* 13(1), 69-76. DOI: 10.1089/omi.2008.0031

Green, B. G., Dalton, P., Cowart, B., Shaffer, G., Rankin, K., & Higgins, J. (1996). Evaluating the 'Labeled Magnitude Scale' for measuring sensations of taste and smell. *Chemical senses*, *21*(3), 323–334. DOI: https://doi.org/10.1093/chemse/21.3.323

Green, B. G. Institute of Medicine (US) Committee on Military Nutrition Research; Marriott BM, editor. (1993). Heat as a Factor in the Perception of Taste, Smell, and Oral Sensation. *Nutritional Needs in Hot Environments: Applications for Military Personnel in Field Operations. (9)*. Washington (DC): National Academies Press (US). Available from: https://www.ncbi.nlm.nih.gov/books/NBK236241/

Han, E., & M. P., Lisa. (2014). Consumption Patterns of Sugar Sweetened Beverages in the United States. *Journal of the Academy of Nutrition and Dietetics*, 113(1), 43-53. DOI: https://doi.org/10.1016/j.jand.2012.09.016

Jayasinghe, S.N., Kruger, R., Walsh, D.C.I., Cao, G., Rivers, S., Richter, & M., Breier, B.H. (2017). Is Sweet Taste Perception Associated with Sweet Food Liking and Intake? *Nutrients*, 9(750), 1–19. doi:10.3390/nu9070750

Jones, L.V., Peryam, D.R., and Thurstone, L.L. 1955. Development of a scale for measuring soldiers' food preferences. Food Research, 20, 512-520.

Lee, E. (2018). 설탕, 근대의 혁명: 한국 설탕 산업과 소비의 역사 [Sugar, the contemporary revolution: The history of Korea's sugar industry and consumption]. Seoul, South Korea: Jisik-sanupsa.

Lee, Y. (2019). Seeking Modernity in Twentieth-Century Korea through Sugar. *Cross-Currents: East Asian History and Culture Review*, 1(31), 263-268.

Lipscomb, K., Rieck, J., Dawson, P. (2016). Effect of Temperature on the Intensity of Basic Tastes: Sweet, Salty, and Sour. *Journal of Food Research*, 5(4), 1–8. doi:10.5539/jfr.v5n4p1

Merleaux, A. (2015). *Sugar and Civilization: American Empire and the Cultural Politics of Sweetness*. University of North Carolina press. DOI:10.5149/northcarolina/9781469622514.001.0001

Mikkilä, V., Räsänen, L., Raitakari, O. T., Pietinen, P., & Viikari, J. (2005). Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *British Journal of Nutrition*, *93*(6), 923-931.

Parks, S. (2017). *BraveTart: Iconic American Desserts*. W. W. Norton & Company.

Perry, J. M., Swanson, R. B., Lyon, B. G., & Savage, E. M. (2002). Instrumental and Sensory Assessment of Oatmeal and Chocolate Chip Cookies Modified with Sugar and Fat Replacers. *Cereal Chemistry*, 80(1), 45-51. DOI:https://doi.org/10.1094/CCHEM.2003.80.1.45

Sclafani, A. (2007). Sweet Taste Signaling in the Gut. *Proceedings of the National Academy of Sciences of the United States of America.* 104(38). 14887-14888. Available from: https://www.pnas.org/content/pnas/104/38/14887.full.pdf

Shen, W., Long, L. M., Shih, C.-H., & Ludy, M.-J. (2020). A Humanities-Based Explanation for the Effects of Emotional Eating and Perceived Stress on Food Choice Motives during the COVID-19 Pandemic. *Nutrients*, *12*(9), 2712. MDPI AG. Retrieved from http://dx.doi.org/10.3390/nu12092712.

Schiffman, S. S., Sattely-Miller, E. A., Graham, B. G., Bennett, J. L., Booth, B. J., & Desai, N. (2000). Effect of temperature, pH, and ions on sweet taste. Physiology & Behavior, 68, 469. DOI: http://dx.doi.org/10.1016/S0031-9384(99)00205-X

Stuckler, D., Reeves, A., Loopstra, R., & McKee, M. (2016). Textual analysis of sugar industry influence on the World Health Organization's 2015 sugars intake guideline. *Bulletin of the World Health Organization*, *94*(8), 566–573. https://doi.org/10.2471/BLT.15.165852

Sussman, C. (1994). Women and the Politics of Sugar, 1792. *Representations,* 48, 48-69. DOI: https://doi.org/10.2307/2928610

Talavera, K., Yasumatsu, K., Voets, T., Droogmans, G., Shigemura, N., Ninomiya, Y., Margolskee, R. F., & Nilius, B. (2005). Heat Sensitivity of TRPM5 Underlies Thermal Sensitivity of Sweet Taste. *Nature Publishing Group,* 438, 1022. DOI: doi:10.1038/nature04248

The 9-point hedonic scale. Society of Sensory Professionals. (n.d.). Retrieved November 2, 2021, from https://www.sensorysociety.org/knowledge/sspwiki/Pages/The%209-point%20Hedonic%20Scale.aspx.

Theunissen, M. J. M., Polet, I. A., Kroeze, J. H. A., & Schifferstein, H. N. J. (2000). Taste adaptation during the eating of sweetened yogurt. *Appetite*, *34*(1), 21-27.

Tournier, C. Sulmonot-Rossé, C., & Guichard, Elisabeth. (2020). Flavour Perception: Aroma, Taste, and Texture Interactions. *HAL Archives.* 1(2). 246-254.

Wallach, J.J. (2012). *How America Eats: A Social History of U.S. Food and Culture*. Rowman & Littlefield. DOI: https://doi.org/10.1111/jacc.12124

Wichchukit, S. & O'Mahony, M. (2014). The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. *Wiley Online Library.* DOI: 10.1002/jsfa.6993

Yudkin, J. (1972). *Pure, White, and Deadly*. DOI: https://doi.org/10.1136/bmj.e8612.