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Preliminary Research into the Sustainable Responsibility of Teaware Design—A Fs/QCA Analysis of the Influence of the Smell and Taste of Tea through Visual and Tactile Perception

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Abstract: Most studies concerned with sustainable design issues focus on product design to change user behavior, increase the product lifespan, reduce energy waste, or employ the user experience to influence the behavior of other users. Rarely do they discuss how to design products that meet the real needs of consumers and reduce design waste and excessive consumption. Teaware designers and producers have invisibly created a considerable carbon footprint with regard to nonrenewable clay and energy waste due to excessive production. Therefore, this research uses visual and tactile research into the Chinese drinking cup to integrate user experience and the designer's thinking and methods to ensure the sustainable value of the design and industry. This research uses experimental methods to collect and analyze the data with a fuzzy set qualitative comparative analysis (fs/QCA). The research found that the visual, tactile, and sensory perceptions of general consumers and tea professionals have different influencing factors on the taste system. This research provides evidence that the size of the tea-drinking container and the thickness of the cup's rim will affect the perception of the tea's taste and smell. This research provides new thinking for the design of Chinese tea-drinking utensils. It could solve social problems and dilemmas through design and contribute to the sustainable development of the design.

Keywords: visual perception; tactile perception; sustainability; sustainable behavior; design thinking; tea culture; fuzzy set qualitative comparative analysis; sustainable design

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1. Introduction

1.1. Background Information

Various cups have been developed for the world's three major non-alcoholic beverages, i.e., tea, coffee, and cocoa, with different heat-resistant materials and shapes due to the different brewing methods and cultures. Because the coffee brewing method is a one-time process and the coffee cannot be flushed twice, coffee cups in Western countries are primarily larger capacity and have handles. Meanwhile, tea can be called the national drink of the Chinese; Chinese tea culture is part of people's daily lives. Over history, tea drinking has gradually changed and developed with the evolution of tea. However, no matter how the tea leaves or the method of making tea evolved, making a good cup of tea is still inseparable from "tea utensils" and "water". The "tea book" of the Ming Dynasty recorded that "tea nourishes in water, and water performs well through utensils, and it completes by fire." The four factors must meet each other, and the lack of one means that the tea is incomplete [1]. In other words, besides good water quality, tea utensils play essential roles in making good tea. Due to the complicated process of making Chinese tea, the tea can be brewed many times. Through the control of time and temperature, the content of tea can be released time by time, so the tea aroma and taste are presented differently at each brewing. Therefore, the teacups are mostly small and without handles.

According to data from the China Business Industry Research Institute and the China Tea Exchange Association, new tea-drinking styles have inspired young people's consumption habits and vigorously promoted the consumption of Chinese tea. In 2017, China was the largest tea-consuming country globally, accounting for more than 1/3 of the world's tea production [2]. Recently, a tea ceremony with tea making and tea utensils arrangement for tea table design has gradually become popular. In addition to the tea carrier's functioning, the tea utensils serve the function of social communication, aesthetic education, and additional value for tea flavor.

In terms of communication during the tea ceremony, the teacup is the leading tea utensil that directly comes into contact with guests. Therefore, the teacup can carry the tea liquid, promote the tea quality, and be the medium for delivering visual aesthetics. Functionally, teacups must be embodied through touch with the hands and touch with the lips to reflect the tea taste and the warmth of the teacups. Therefore, the visual and tactile design considerations of teacups are becoming more critical.

1.2. Motives and Goal

Kreifeldt [3], in a study of the tactile aesthetics of aesthetic design, proposed that the object should be designed to give people a pleasant experience through its appearance or image. The appearance and image of the object can evoke the appropriate imaginary tactile feeling through vision. In other words, people's visual image of an object evokes psychological feelings and stimulates the corresponding tactile feelings. While most research focuses on the multisensory taste perception of chemical sensory stimulation and the physical content of the food itself [4], the proverb "you are eating with your eyes" [5] shows another meaning of visual influence on food taste. Visual images evoke appropriate imaginary tactile sensations and affect the taste of food. Studies have found that in addition to the tactile characteristics of foods that impact the judgment of several flavors [6], the external tactile information of packaging materials or containers also impacts the flavor and taste of food and beverages [7–9]. Van Rompay et al. [10] found that the visual and tactile stimulation of food or beverage containers in restaurants or supermarkets is closely related to the deliciousness and charm of food [11].

Human sensory receptors receiving external stimuli do not operate independently but are compounded and engaged simultaneously. While we are eating food, the smell and taste of the food itself, as well as our eyes, ears, and skin, also help to form a "flavor system" [11]. Many studies have found that consumers' perceptions of red wine, soda drinks, juice, coffee, and hot cocoa, consumer behavior, and the shape and color of the container are highly correlated [9,12–15]. Spence et al. [16] stated that, although there is a large population of tea drinkers globally, few studies explore tea's visual and tactile perception. In particular, there is a lack of in-depth investigation and research into Chinese teacups. From the environmental perspective of consumers' collective behavior, empirical investigation of the appropriate teacups for Chinese tea is necessary given the lack of published research on this issue, especially because China's tea consumption ranks first globally and the tea-drinking population is prevalent. Recent studies have found that some consumers, tea merchants, and tea art teachers focus on the material selection and the firing method of ceramic teacups. Although designers also focus on visual form innovation, the lack of research on sensory perception and teacup visual image leaves the designers without a design reference [17]. Under the policy of "industry culturalization" and the development of tea culture, the ceramic industry has turned to the production of tea utensils, seeking changes and innovations in design to increase competitiveness, and constantly creating all kinds of tea utensils [18]. However, continuous innovative designs have raised production costs and caused energy waste issues that undermine ceramic tea utensils' durable and environmentally sustainable properties. Social and environmental problems, such as stimulating consumption, energy, and resource waste, have attracted many scholars [19,20]. Especially in recent years, Taiwanese ceramic teaware creators have been keen on time-consuming and energy-consuming wood-firing teaware. The impact of environmental damage from an ordinary wood-burning kiln that requires at least 3 tons of firewood and smoke generated for at least 3 days of burning should not be underestimated.

Moreover, currently, there are 600 wood-firing kilns in Taiwan alone. The accumulated high energy consumption and endless environmental pollution problems must be reconsidered. In recent years, ceramic artists have introduced environmentally friendly wood-burning technology and built environmentally friendly wood-burning kilns to avoid air pollution caused by smoke and dust [21,22]. However, it still needs to consume a lot of wood energy to pursue beauty and artistic value. In addition, pottery clay materials are not renewable and reusable, and the environmental problems of high fuel and resource consumption make the ceramic industry an economic sector with a large carbon footprint.

In the current post-consumption era of excessive consumption, the artistic and practical evaluation of product design is crucial to add value to the design and solve the potential social crisis. From the viewpoints of design thinking regarding practical aesthetics and sustainable development, the researcher believes that understanding the relationship between the cup shape and the tea taste can assist in the design of practical tea utensils. In addition to embodying the concept of Kreifeldt [3] in his aesthetic design, that product appearance design provides people with a pleasant feeling, it can also contribute to the development of the tea industry and promote sustainable development. Therefore, this study aims to find the relationship between the factors influencing users' preference and tea tasting cognition and provide a user-centered design reference for tea designers, creators, and manufacturers.

2. Literature Review

"Feeling refers to the immediate and physiological response of the sensory system when it receives an external stimulus" [23], while the sensation is the "primitive experience" of the senses. The accumulation of these "primitive experiences" is the basis for the human construction of knowledge. The sensation can be divided into three stages: the physiological response of nearby stimuli, neural transduction, and the psychological response of consciousness (Figure 1) [24].

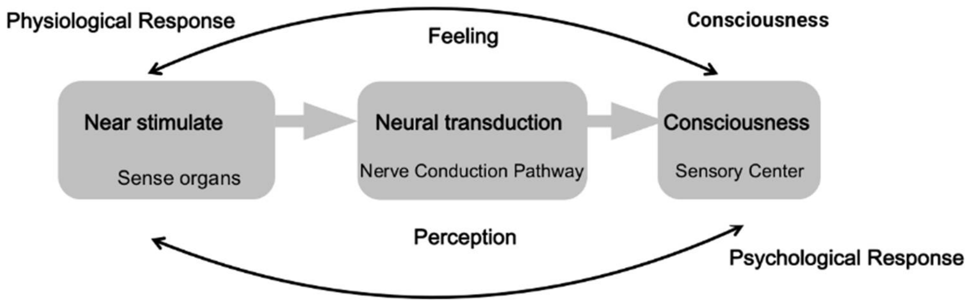

Figure 1. Three stages of the sensory process.

In this three-stage process, the sensation is completed by sensory organs, nerve conduction pathways, and the sensory center of the brain. Human eyes, ears, nose, tongue, and skin perform the senses of vision, hearing, smell, taste, and touch. From a physiological point of view, these sensory organs interpret as receptors, which are the entrance to the mental activity of information. The receptors convert the received stimulus energy into codes and then process these information codes into sensations with various properties and strengths that people experience. Vision is made possible by the visual system's external sensory organs to receive the stimulus of the optical energy of the external environment through the relevant parts of the brain's visual center to distinguish and see the subjective sensation of the impact [25]. The horizontal movement of the eyes is fast and comfortable, so it accounts for nearly 90% of the cognition of various sensations. Therefore, people distinguish things and rely mainly on optical transmission to obtain various types of information. People's first impression of contact with food is based on vision, so it plays a significant role in the sensory evaluation of food.

Sense of touch is a sensation for which the skin is responsible via the perception of pressure [26]. The skin is the sensor of touch and the largest sensory organ of the human body. The sensor of touch and pressure is the highest in the nose, lips, and fingertips. In the process of eating food, the touch of the mouth is still a significant experience [25]. Therefore, the object of this research is the teacup design, emphasizing the sensory experience generated in the mind after the lips touch the teacup.

Taste is a near sensation produced by direct contact between receptors and chemical stimuli. Common taste concepts include taste perceptions, such as sour, sweet, salty, bitter, and umami, and physiological stimuli triggered by different chemical substances. Eating occurs in the oral cavity, so taste activity is significant, but food taste does not depend on taste alone. Taste often interacts with other sensations [26]. "Perception refers to the process by which an individual selects, organizes, and explains the sentimental information through the brain's integration and cooperation based on the information collected by the sensory organs in response to the environmental stimuli" [26]. When we receive stimuli in our daily lives, the sensory organs transmit information to the brain and sensations. The brain begins to classify, understand, and interpret these sensations. When people's brains receive sensory stimuli, these repetitive sensory stimuli become experiences, and memories form a knowledge structure in the brain. Therefore, when the brain receives similar stimuli, these memories will be evoked in the cognitive structure of the brain. In this complex process, the five senses each have a division of labor and interact and influence each other.

Spence et al. [27] found that people's response to taste usually comes from the complex information processing of product experiences, such as smell, vision, taste, and touch, forming a sense of taste. In the complex integration of multisensory visual senses, the first senses reaching food produce pleasant expectations, transform and awaken other sensory perceptions, and enhance and obtain satisfying and pleasant memories and hedonic experiences. Extrinsic cues, such as the packaging and container, have exerted an influence on our perception of flavor. More empirical research is showing that the shape of product containers, also applied to drinking receptacles, demonstrates a strong association with consumer behavior and taste experience [13,15,28]. Studies have found that the shape of the glass had little effect on the perception of the aroma of wine when the subject could not see or touch the glass.

On the other hand, if the subject saw and held the glass, the shape of the glass had a considerable influence on the perception of the aroma and taste of the wine [29–31]. Delwiche and Pelchat [29] evaluated the aroma of four different glasses of wine in a blind test and found that the wine glass's shape had a subtle effect on the aroma. In addition, studies have found that even professional wine or tea tasters will still be affected by the shape of the glass, including their perception of taste and aroma [32,33]. Hummel et al. [34] studied whether wine glasses of the same height and caliber, but with different shapes, directly affect the aroma and taste of wine. The study found that two-thirds of the subjects believed they had consumed more than one type of wine, which means that one-third believed they had consumed one type of wine. Research has also found that the grade of wine is affected by the shape of the glass. In other words, the shape of the wine glass affects consumers' perception of wine aroma and taste. Compared to other drinking receptacles, the shape of the beverage (or wine) container has received more attention [10,35,36]. Cavazana et al. [9] studied the influence of the smell and taste of cola in different containers, and the results showed a multisensory interaction between the smell and taste of the beverage and the container type. Compared to cola in incompatible containers (such as water cups or plastic bottles), participants felt that cola in a typical cola cup was sweeter, stronger, and more pleasant.

Li et al. [37] used 1100 Chinese and 100 Americans as subjects to conduct a cross-cultural study on the influence of the visual appearance of the container on the subjective evaluation and taste expectations of tea. To subjects, they showed photos of Chinese and British tea sets filled with green tea of Chinese and British brands. The subjects then discussed their feelings about each cup of tea and evaluated the taste expectations. The study found that the tea set affected the bitterness of the Chinese participants' expectations of their tea and the tea pleasure of the Chinese participants. This research showed that Chinese and British tea sets create different visual perceptions of tea due to the complex cognitive process. Through personal tea-drinking experience, emotions, and social and cultural interaction, these results further support the view that human perception is influenced by visual senses regarding the shape and material of the container, which significantly affects the consumer's drinking experience.

Another factor affecting taste is the sense of tactility between the human body and utensils, as human tactile receptors have the highest distribution density in the nose, lips, and fingertips [26]. The sensations that arise when these tactile sensations are in contact with the utensils, through the associative effect of the experience memory in the brain, produce psychological responses that affect the taste sense [26]. Bargh et al. [38] investigated the tactile experience in daily life, such as warmth, distance, hardness, and roughness. They explored the impact of the physical sensation of touch on psychological perception and the influence of cognition. The researchers found that the weight, surface characteristics, and hardness of materials felt by different tactile senses affect people's psychological feelings and even change people's thinking and decision making. Schifferstein [39] researched whether the tactile characteristics of containers affect consumers' judgments of beverage products. Participants were asked to evaluate the experience of drinking hot Earl Grey or iced lemon soft drinks in cups made of different materials such as glass, ceramic, opaque plastic, partially translucent plastic, and melamine. It was found that different cups significantly affected the judgment of sensory attributes such as "warm" and "sweetness." The tactile characteristics affect consumers' judgments of beverage products because of the differences in the color, weight, and texture of these cups made of different materials. Schifferstein found that the content material will affect the participant's experience of the drink content and that the participants preferred ceramic materials for the hot tea-drinking utensils.

The correspondence between the texture of the container surface and flavor has been proved. Van Rompay et al. [40] used a 3D printed surface pattern on the surface of the cup, which was an angular surface and a round surface. One hundred and sixty interviewees tested the bitterness and sweetness of sweet chocolate in the coffee cups with different surfaces. The cup with an angular surface produced a perception of the drink being more bitter and less sweet and seeming to have a more intense taste. In contrast, a cup with a round surface pattern elicited a sweeter taste evaluation and a less intense taste experience.

Tu et al. [8] applied the "sensation transference" theory proposed by Paras-Fiszman and Spence to study the influence of tactility on taste using packaging materials for traditional Chinese cold tea beverages. Blindfolded subjects tasted the same tea in glass, paper, and plastic cups with similar functions and sizes. The study found that the subject's touch of the container significantly affected their perception of the sweetness of the tea but did not affect the sourness or bitterness. At the same time, the test subjects felt that the tea in glass cups was colder than the tea in paper cups and plastic cups. Therefore, consumers' sense of touch has been shown to play a very important role in the stage of taste judgment.

Summing up the related research, the correspondence between the receptacle and taste attributes in Chinese tea remains essentially unknown. Hence, the present study was designed to investigate whether different shapes of teacups produce differences in perceptual evaluations (ratings of aroma and flavor attributes) of tea.

3. Methodology

3.1. Research Hypothesis

Based on the related literature discussion, to answer the research questions and achieve the research purpose, the research hypothesis is established to verify the relationship between the shape of the teacup and the tea test in a practical way. This research is divided into two parts: 1. The influence of the visual shape of the teacup on the taste and taste of tea. 2. The influence of the lip touch of the teacup on the taste and taste of tea.

The first part of the research explores the influence of the visual shape of the teacup on the tea taste. Li et al. [37] found that the difference in the visual shape of Chinese and western teacups and utensils subjectively affected the expectations of the tea taste. Other, related literature indicated that the visual style of the utensils impacts the taste perception of the drink [30,31], and the shape of the glass influences the aroma of wine [29]. Cavazana et al. [9] found that cola in a typical cola container feels sweeter and more robust than cola in a water or plastic cup. Therefore, this research proposes the following hypotheses:

Hypotheses 1 (H1). *The preference of the cup shape affects the taste and fragrance of the tea.*

Hypotheses 2 (H2). *The width difference of the teacup affects the taste and fragrance of the tea.*

Hypotheses 3 (H3). *The height difference of the teacup affects the taste and fragrance of the tea.*

The second part of this study is the touch influence of a teacup on taste and tea taste. The research found that the texture of the utensils with the touch of the skin has a significant impact on the sensory attributes "warm" and "sweetness" of hot Earl Grey tea or iced lemon drinks [14], and affects the bitterness of coffee and the sweetness of chocolate [40]. Tu et al. [8] took Chinese tea as a research object and found that utensils with different tactile effects affect tea's sweetness and cooling sensation. The touch sensation between the mouth and the teacup is the primary sensor of stimulation in this study. Therefore, this research proposes the following hypotheses:

Hypotheses 4 (H4). *The thickness of the teacup's rim affects the taste and fragrance of the tea.*

3.2. Experimental Design

In *The Practice of Social Research*, Babbie [41] mentioned that the experimental method is a mode of observation that enables researchers to explore causality and is particularly suited for research involving relatively limited concepts and propositions. The research hypothesis can be proved through the operation of various experimental designs. Because the experimental method focuses on determining causality, it is for explanatory rather than descriptive research purposes. Under the consideration of time-consuming operation, experiment site limitation, and the complicated evaluation standard between professional and general subjects, the quasi-experimental research method and no random sampling were adopted in this research. Nevertheless, the experiment is divided into two experimental and control groups. Because the purpose of the study is to explore whether there is a causal relationship between the shape of the cup and the taste and flavor of tea, the glazed teacup was used to avoid affecting the experimental results.

3.2.1. Experimental Materials

Generally, tea drinkers or consumers use personal experience to directly observe the tea color, smell the tea fragrance, and evaluate the taste of the tea. Their brewing methods and evaluation standards are different. Therefore, the Tea Industry Improvement Center of the Agricultural Committee of Taiwan invited experts to comment on and formulate tea taste as strong, umami, sweet, smooth, rich, mellow, plain, coarse but plain, coarse but astringent, immature but astringent, bitter, astringent, and watery tastes [42]. There are five basic tea tastes, namely, bitter, astringent, sweet, sour, and umami. Therefore, this study summarizes the taste reviews and descriptions of the tea tastes of the 12 comments above. Then we comprehensively sort out five groups of opposing taste and taste comments as follows: strong → watery; umami→ bitter and astringent; sweet → immature but astringent; sweet → coarse but astringent; and rich→ coarse but plain. This study uses the semantic difference method to make a semantic scale. Each group of taste and taste comments is divided into five levels of semantic space (see Table 1).

Table 1. Taste and aroma scale of tea.

Taste and Aroma of Tea		Scale Level					Taste and Aroma of Tea
		Very Much (5)	**A Little (4)**	**Normal (3)**	**A Little (2)**	**Very Much (1)**	
Taste	Strong	The taste is solid	The taste is a little strong	The taste is normal	The taste is a little light	The taste is very light	Watery
	Umami	The taste is solid with an umami taste	The taste is a little umami taste	The umami taste is normal	The taste is a bit strong, bitter, astringent	The taste is very strong, bitter, astringent	Bitter and astringent
	Sweet	The taste is delightful and refreshing	The taste is a little sweet and refreshing	The sweetness is normal	The taste is a bit grassy and astringent	The taste is very grassy and astringent	Immature but astringent
	Smooth	The taste is delightful and smooth	The taste is a little sweet and smooth	The smoothness is normal	The taste is a bit astringent and not smooth	The taste is very astringent and not smooth	Coarse but astringent
	Rich	The taste is delightful and rich	It tastes a bit sweet but not rich	The sweetness and richness are normal	The taste is a bit light and not rich	The taste is very light and not rich	Coarse but plain
Aroma	Fragrant	The aroma is very pure and not mixed	The scent is regular and pure but not high	Normal scent	A little bit mixed with the non-tea smell	Non-tea smell	Messy smell

In this study, high mountain tea grown at an altitude of over 1000 m was selected as the experimental material because the taste and aroma of the tea are the most prominent and easy to distinguish. Furthermore, according to the professionally accepted tea brewing method, 3 g of tea was immersed in a 150 cc white porcelain cup for 6 min with 100 °C water. The tea was used as the final material of the experiment.

3.2.2. Participants

While the tea taste classification is shown in Table 1, it is hard for the general consumer or public to distinguish between tea taste and fragrance. To achieve accuracy and effectiveness, this research experiment was divided into experimental and control groups, and there are 17 people for each group. The test subjects in the experimental group were professionally trained tea experts, tea art teachers, or tea producers. The control group consisted of amateurs who have not generally received training in tea art. The data from the two groups are included in the analysis (see Table 2).

Table 2. Participant demographics.

Experimental Group		Control Group	
Variable	**Percentage (*N* = 17)**	**Variable**	**Percentage (*N* = 17)**
Gender (*N* = 17)		Gender (*N* = 17)	
Male	29% (5)	Male	41% (7)
Female	71% (12)	Female	59% (10)
Age		Age	
35–44	24% (4)	15–24	12% (2)
45–54	47% (8)	25–34	29% (5)
55–64	35% (5)	55–64	59% (10)
Education		Education	
University	41% (7)	University	82% (14)
Post-Graduate	59% (10)	Postgraduate	18% (3)
Frequency		Frequency	
Every day	82% (15)	Every day	35% (6)
Sometimes	18% (2)	Sometimes	65% (11)

3.2.3. Experimental Products

The main object of this research is to explore the visual and tactile impact of the teacup shape on the taste of the tea. Therefore, the selection of the cup shape is based on the part of the teacup that comes into contact with the eyes and lips. The selection criteria were the visual shape height (deep abdomen and shallow abdomen), the caliber of the teacup (wide abdomen and narrow abdomen), and the thickness of the cup's rim. In this study, 5 teacups (A–E) were selected: (A) narrow abdomen (diameter width: 6.6 cm, height: 4 cm, thickness: 0.4 cm), (B) open narrow abdomen (diameter width: 6.7 cm, height: 3.5 cm, thickness: 0.3 cm), (C) constricted shallow belly (caliber width: 6.3 cm, height: 3.8 cm, thickness: 0.4 cm), (D) open deep belly (caliber width: 4.9 cm, height: 4.2 cm, thickness: 0.25 cm), and (E) open narrow shallow abdomen (caliber width: 5.4 cm, height: 2.6 cm, thickness: 0.2 cm), serially numbered as A–E (Figure 2). Because past studies have found that color is also one of the visual variables that affect taste, the five teacups were white porcelain cups.

(A) **(B)** **(C)** **(D)** **(E)**

Figure 2. Cups (**A**–**E**).

3.2.4. Questionnaire

According to Table 1, the questionnaire was classified into (a) the intensity of tea liquid, (b) the intensity of tea umami, (c) the intensity of tea sweetness, (d) the intensity of tea smoothness, (e) the intensity of tea richness, (f) the degree of tea aroma, and (g) the preference of teacup shape according to a 5-point Likert scale.

3.2.5. Environments

The professional standard tea environment is better with natural lighting. The light is sufficient and uniform, and not direct. If the lighting is insufficient, fluorescent lamps can be installed to supplement the light. In this study, fluorescent lamps were used in the room to make it easier for the subjects to observe the color of the tea. The interior was maintained at a temperature of about 22~24 degrees and was clean, without odor interference.

3.2.6. Design and Procedure

The study was conducted in February 2021. This study adopted non-random sampling; snowball sampling was used. The majority of the professional participants were recruited from among the members of tea-related associations. The amateur participants were recruited from the community and were interested in the study. All the participants were informed that they would be tasting and evaluating tea and were led into a quiet, well lit, air conditioned testing environment. The maximum number of subjects participating in this study was five at a time. A glass of water was prepared for the subjects before the test to avoid intentional residue in the oral cavity. The process of the experiment and the content of the questionnaire was explained in advance. The subjects were given 10 min to fill in the first part of the questionnaire and read the reference content of the questionnaire. The tea in the Section 3.2.1 experiment was brewed in 10 min, poured into the teacups in order, and placed in front of the test subject. The test subject drank the tea in the given cup in sequence. Then the subject filled in the questionnaire regarding the taste of the tea consumed and the preference regarding the cup shape.

3.3. Data Analysis

Fuzzy set/qualitative comparative analysis (fs/QCA) is used for this study. Because the causal asymmetry of variables in the study exists, the complex integration of multi-sensory and the exploratory findings are subject to causal equifinality or asymmetry [43]. Equifinality is the idea that "a system can reach the same final state from different initial conditions and by a variety of different paths" [44]. The most significant difference from other statistical research methods is that fs/QCA supports equifinality between variables. In other words, each specific result (for example, affecting the intensity of tea taste) may be caused by different combinations of elements. The complex and independent multidimensional nature of visual and tactile perception rests not on a single attribute, but instead on the relationships and complementarities between multiple characteristics. In contrast to the common correlational understanding of symmetric causality, fs/QCA provides an understanding of asymmetric causality. That is, the causes leading to the presence of the outcome may be quite different from those leading to the absence of the outcome.

Three steps are required to implement fs/QCA. First, the original data must be converted into fuzzy numbers, called data calibration. The fuzzy set between 0 and 1 is converted into a continuous variable called the degree of membership. Therefore, a membership score of 0.5 is a member of what is known as the intermediate set. To calibrate the research variables of this study, the direct method set the values 0.95, 0.50, and 0.05 as three thresholds to ensure that the original data was not affected by the bias of sample characteristics [45,46].

Secondly, two steps are needed to construct the truth table of Bollinger's logic, including setting the number-of-cases threshold and the consistency threshold. Finally, fs/QCA software can produce three types of output: parsimonious solution, intermediate solution, and complex solution. The complex solution presents a large and impractical number of combinations [47], therefore, Ragin [48] suggested that the intermediate solution is superior to the other two. The results of the truth table are rules and results that summarize the sufficiency of all possible combination subsets of causal conditions [49]. Consistency and coverage are essential indicators to check the condition combination of fs/QCA's explanatory power. Consistency is like a significant level in quantitative analysis, and its purpose is to evaluate the degree of causality between conditional combinations. The consistency must be greater than 0.75. Coverage is the degree of interpretation of the condition combination and represents whether the event condition combination has strong explanatory power. Calibration is also helpful for qualitative research in interpreting relevant and irrelevant variation, and quantitative research inaccurately places cases relative to each other [47]. In this study, the appearance design of the teacup with incomplete duality led to a cross-modal perception of the interaction of multisensory perceptions. However, traditional variance-based methods focus on variables' relation and effect in a model to measure the unique contribution of each variable to the overall observation data. Instead, fs/QCA focuses on the complex and asymmetric relationship between the complexity of outcome and causality. It intends to discern the complex solutions and combinations of independent variables. Another benefit of employing fs/QCA is without the limitation of sample size, ranging from very small (<50 cases) to very large [45]. Therefore, fs/QCA, as a bridge between qualitative and quantitative research, is an appropriate approach to establish a truth table of causal conditions for this small-/middle-number case study [48].

Because fs/QCA does not test for construct reliability and validity, before applying fs/QCA, the author used variance-based methods to examine the net effect between variables in a model. All independent variables were set as predictors of one dependent variable in PLS-SEM analysis. Using SmartPLS software to examine the models was significant (Figure 3, R^2 = 0.929, 0.940), indicating that the model of a cause-effect relation between tea taste and the shape of teacups is significant. In other words, the shapes of teacups are determinants of tea taste and fragrance. The explanation of sufficient or necessary conditions of the factors of teacup shape to the outcome would be identified by fs/QCA in the following section.

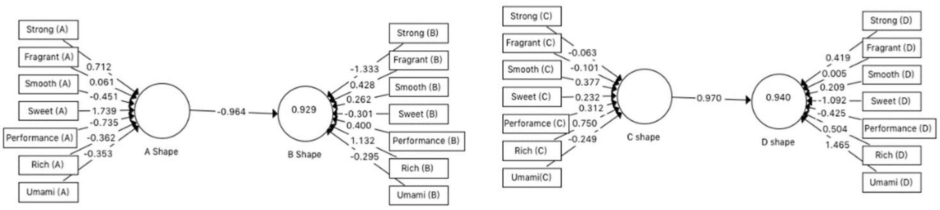

Figure 3. Finding from PLS-SEM analysis.

4. Results and Discussion

4.1. Descriptive Statistical Analysis

Tea taste data from the 34 subjects for both groups were analyzed. The case number is 17, and the missing number is 0 for both groups. The descriptive statistical analysis (Tables 3–10) found that the experimental and control groups had different responses to the vigorous-intensity of tea. The average number of D cups was the highest in the experimental group, and the average number of B cups was the highest in the control group. In the tea freshness and sweetness experiment, the experimental group had the highest average number of B cups, while the control group had the highest average number of A cups. In terms of tea smoothness, richness, and overall performance, the experimental group had the highest average number of D cups, and the control group had the highest average number of A cups. The tea fragrance experiment found that the experimental group and the control group had a consistent consensus. The average number of A cups was the highest, and the standard difference was between 0.5–0.8, which is not significant. In the experimental group of teacup preference, the average number of open deep abdomen cups was highest in D cups. The average number of B cups in the control group was the highest.

Table 3. Descriptive statistical analysis of strongness of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3 (2.941)	1.085 (0.998)	1 (1)	5 (5)
B	2.882 (3.471)	0.832 (0.915)	1 (1)	4 (5)
C	2.765 (3.176)	1.059 (0.922)	1 (1)	4 (5)
D	3.118 (3.411)	0.758 (0.974)	2 (1)	5 (5)
E	2.471 (3.352)	0.915 (0.967)	1 (2)	4 (5)

Table 4. Descriptive statistical analysis of umami of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3.412 (3.471)	0.844 (1.091)	2 (1)	5 (5)
B	3.647 (2.941)	0.588 (1.161)	3 (1)	5 (5)
C	3.412 (3.294)	0.600 (1.072)	2 (2)	4 (5)
D	3.353 (3.294)	0.904 (1.072)	2 (2)	5 (5)
E	3.235 (3.0589)	0.9412 (0.998)	2 (1)	5 (5)

Table 5. Descriptive statistical analysis of sweetness of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3.059 (3.529)	1.162 (1.091)	1 (1)	5 (5)
B	3.412 (3.235)	0.844 (1.165)	2 (1)	5 (5)
C	3.118 (3.235)	0.832 (1.165)	2 (1)	5 (5)
D	3.412 (3.352)	1.032 (1.026)	1 (2)	5 (5)
E	2.824 (3.059)	0.856 (0.998)	2 (1)	5 (5)

Table 6. Descriptive statistical analysis of smoothness of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	2.941 (3.647)	1.056 (0.967)	1 (2)	5 (5)
B	3.058 (3.235)	0.872 (1.112)	2 (1)	5 (5)
C	3 (2.824)	0.907 (0.923)	2 (1)	5 (4)
D	3.118 (3.235)	0.900 (1.113)	2 (2)	4 (5)
E	3 (3.059)	0.907 (0.872)	2 (2)	5 (5)

Table 7. Descriptive statistical analysis of richness of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	2.941 (3.529)	0.802 (0.848)	2 (2)	5 (5)
B	2.824 (3.294)	0.9843 (1.015)	1 (1)	4 (5)
C	2.529 (3.235)	0.9151 (1.059)	1 (1)	5 (5)
D	3.235 (3.118)	0.807 (0.900)	2 (1)	4 (5)
E	2.647 (3.353)	1.026 (0.836)	1 (2)	5 (5)

Table 8. Descriptive statistical analysis of fragrance of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3.88 (4)	0.471 (0.840)	3 (2)	5 (5)
B	3.529 (3.412)	0.848 (0.974)	2 (1)	5 (5)
C	3.412 (3.235)	0.771 (0.941)	2 (1)	5 (5)
D	3.353 (3.471)	0.836 (0.848)	2 (1)	5 (5)
E	3.412 (3.529)	0.771 (0.606)	2 (3)	5 (5)

Table 9. Descriptive statistical analysis of overall performance of tea.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3.471 (3.706)	0.696 (0.892)	2 (2)	4 (5)
B	3.412 (3.471)	0.691 (1.091)	2 (2)	5 (5)
C	3.353 (3.353)	0.681 (0.967)	2 (2)	5 (5)
D	3.706 (3.529)	0.892 (1.036)	2 (2)	5 (5)
E	3.294 (3.352)	0.892 (0.9037)	2 (2)	5 (5)

Table 10. Descriptive statistical analysis of teacup preference.

Variable	Mean Exp/Ctrl	Std. DEV Exp/Ctrl	Minimum Exp/Ctrl	Minimum Exp/Ctrl
A	3.118 (3.471)	0.831 (0.696)	1 (3)	4 (5)
B	3.412 (3.647)	0.600 (0.836)	2 (2)	4 (5)
C	3.588 (3.471)	0.974 (0.848)	2 (2)	5 (5)
D	3.941 (3.176)	0.725 (0.922)	2 (2)	5 (5)
E	3.235 (3.059)	0.807 (0.937)	2 (1)	5 (5)

The standard deviation (Std. DEV) of each variable in Tables 3–10 shows the degree of disagreement among the subjects. The standard deviation is between 0.470 and 1.165, which means that the participants' tea taste perception and teacup preference were quite different from each other. Thus, the participant's tea preference perception was subjective. Through fs/QCA software, the researcher can find the causal relationship of the variables.

4.2. Fs/QCA Data Analysis

Dependent variables (y) are tea tastes classified into seven variables, y1 to y7. They are, separately, the strongness, umami, sweetness, smoothness, richness, fragrance, and overall tea performance. The independent variables (x1 to x4), the appearance of the cup, are defined as the teacup preference, the width of the teacup's diameter, the height of the teacup, and the thickness of the teacup's rim (shown in Table 11). Fs/QCA is used to analyze the causal relationship between the teacup's appearance and the preference with the taste perception of tea. The function formula is Y = F (X). The functions are summarized in Table 12.

The first step in fs/QCA analysis is to calibrate the dependent and independent variables into fuzzy or clear sets. The process followed to convert continuous variables into fuzzy sets is based on the method proposed by Ragin [45]. The direct method set the values 0.95, 0.50, and 0.05 as three thresholds [45]. Because this study used a 5-point Likert scale to measure the structure, they are calibrated as fuzzy sets. Therefore, the intersection point is set at 3. By performing two separate fs/QCA analyses, a truth table of 2^k rows was generated, where k represents the number of predictors and each row represents a possible combination (solution). The results of the fuzzy set analysis are summarized and shown in Tables 13 and 14.

Table 11. Definitions of variables.

Variables	Definitions
y	Tea test
y1	The strongness of tea
y2	The umami of tea
y3	The sweetness of tea
y4	The smoothness of tea
y5	The richness of tea
y6	The fragrance of tea
y7	The overall performance
x	The appearance of a teacup
x1	The preference for a teacup
x2	The width of the teacup's diameter (the caliber size of a teacup)
x3	The height of the teacup
x4	The thickness of the teacup's rim (the thickness of the cup at the mouth)

Table 12. Visual and tactile functions.

Function	Remarks
y1 = f (x1, x2, x3, x4)	The relationship between the **strongness** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y2 = f (x1, x2, x3, x4)	The relationship between the **umami** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y3 = f (x1, x2, x3, x4)	The relationship between the **sweetness** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y4 = f (x1, x2, x3, x4)	The relationship between the **smoothness** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y5 = f (x1, x2, x3, x4)	The relationship between the **richness** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y6 = f (x1, x2, x3, x4)	The relationship between the **fragrance** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)
y7 = f (x1, x2, x3, x4)	The relationship between the **overall performance** of the tea (result) and cup preference, cup diameter width, cup height, and rim thickness (condition)

The exact two causal relationship solutions were found for the seven causal relationship functions for the control group. According to the literature, there is a positive correlation between the perceived aroma intensity and the opening diameter of the wine glass [50]. Given the research that has been documented on coffee [51], one might expect that the physical properties of the cup may affect the perception of complex tastes and aromas in tea. The first solution is x2 * ~x3. When one is drinking tea, if the height of the cup is not considered, the diameter of the cup (that is, the size of the cup) influences the strongness, sweetness, smoothness, richness, fragrance, and overall performance of the teacup. The interpretation of this solution agrees with Hummel et al.'s [34] study, suggesting that the shape of a wine glass may affect the perceived bouquet and taste of the wine.

Table 13. Control group fs/QCA result.

Function	Causal Solution	Raw Coverage	Unique Coverage	Consistency
y1 = f (x1, x2, x3, x4)	x2 * ~x3	0.552	0.109	0.839
	x1 * x2 * x4	0.405	0.049	0.839
y2 = f (x1, x2, x3, x4)	x2 * ~x3	0.520	0.085	0.769
	x1* x2 * x4	0.415	0.065	0.838
y3 = f (x1, x2, x3, x4)	x2 * ~x3	0.516	0.095	0.787
	x1 * x2 * x4	0.399	0.060	0.832
y4 = f (x1, x2, x3, x4)	x2 * ~x3	0.538	0.095	0.791
	x1 * x2 * x4	0.400	0.065	0.842
y5 = f (x1, x2, x3, x4)	x2 * ~x3	0.538	0.090	0.829
	x1 * x2 * x4	0.422	0.059	0.887
y6 = f (x1, x2, x3, x4)	x2 * ~x3	0.500	0.086	0.846
	x1 * x2 * x4	0.400	0.063	0.923
y7 = f (x1, x2, x3, x4)	x2 * ~x3	0.509	0.091	0.845
	x1 * x2 * x4	0.402	0.064	0.909

Table 14. Experimental group fs/QCA result.

Function	Causal Solution	Raw Coverage	Unique Coverage	Consistency
y1 = f (x1, x2, x3, x4)		**No solution**		
y2 = f (x1, x2, x3, x4)	x2 * x4	0.454	0.073	0.895
	x2 * ~x3	0.567	0.016	0.913
y3 = f (x1, x2, x3, x4)	x2 * x4	0.456	0.070	0.806
	x2 * ~x3	0.568	0.013	0.823
y4 = f (x1, x2, x3, x4)	x2 * x4	0.462	0.063	0.764
	x2 * ~x3	0.570	0.010	0.773
y5 = f (x1, x2, x3, x4)		**No solution**		
y6 = f (x1, x2, x3, x4)	x2 * x4	0.461	0.099	0.948
	x2 * ~x3	0.523	0.012	0.880
y7 = f (x1, x2, x3, x4)	x2 * x4	0.455	0.082	0.910
	x2 * ~x3	0.538	0.011	0.880

The second solution is x1 * x2 * x4. When one is drinking tea, among all factors, the diameter of the cup, the thickness of the cup's rim, and the preference for the cup will affect the strongness, sweetness, smoothness, richness, fragrance, and overall performance of the tea.

The finding in this solution corresponded to Doorn et al.'s [52] cross-cultural research on the shape of coffee cups. Visual information, such as the size and height of the coffee cup, could affect the consumer's sensory expectation. The effect of preference for the cup found in this solution could be related to emotional responses to the stimuli. Spence and Gallace [53] mentioned that a consumer's emotional response elicited by a tactile aspect of the receptacle might influence the expectation of the drinking experience. The feeling regarding the experience of drinking mineral water has been related to the pleasantness of the container [39].

There were different combinations of causal relationships among the seven functions of tea taste perception for the experimental group. In the experimental group, the teacup's appearance and preference had no causal relationship to the strongness and richness of the tea taste because the consistency is lower than 0.75. The others had two sets of the same causal relationship combinations. The first solution x2 * ~x3 is similar to the first one of the control group. It was found that for professionals, without considering the height of the cup, the caliber size of the teacup had a significant impact on the umami, sweetness, smoothness, fragrance, and overall performance of the tea but not on the strongness and richness of the tea taste. It can be explained that the width of the diameter of the cup is a sufficient condition for affecting the umami, sweetness, smoothness, fragrance, and overall performance of the taste.

The second solution is x2 * x4. When one is drinking tea, among all factors, the diameter of the cup and thickness of the cup's rim will affect the umami, sweetness, smoothness, fragrance, and overall performance of the tea. The effect of preference for the cup was not found in this solution, which is not related to emotional responses to the stimuli in this group. Unlike the amateurs, the professionals' taste perception tended to not be influenced by their preferences regarding teacups.

The findings for both groups indicate that the mouth-feel of teacups (i.e., thickness of the cup's rim) has effect on the taste and flavor of tea. In a similar line of reasoning, and close to our findings, Van Rompay et al. [10] showed that a sour lemon sorbet ice cream was evaluated as even sourer when sampled from a cup with a sharp-feeling (rather than a smooth) surface texture.

4.3. Testing for Predictive Validity

To examine how well the model predicts the dependent variable and outcome in additional samples, the test of predictive validity is necessary [47]. The first step for predictive validity is to divide the sample randomly into a subsample and a holdout sample. The second step is to run the fs/QCA analysis for the subsample. Then the findings obtained should be tested against the holdout sample. The benefit of testing for predictive validity, including holdout samples, is that it always substantially increases the added value for both empirical positivistic and interpretative case studies [46]. After the findings are obtained from the subsample, the holdout sample must proceed with predictive validity testing. Then the author computes every solution from the findings from the testing with the subsample. Finally, the new variable is plotted against the outcome of interest using the holdout sample. The numbers below the "Plot" button show set-theoretic consistency scores [54]. If one of these two numbers indicates high consistency, the other can be interpreted as a coverage score. In this study, the solutions from the subsample for the control group are shown in Table 15, and the test of models from the subsample using data from the holdout sample for the control group is in Table 16. It can be said that models in the control group in this study have high predictive validity.

Table 15. Solutions from subsample for control group.

Function	Causal Solution	Raw Coverage	Unique Coverage	Consistency
y1 = f (x1, x2, x3, x4)	x2 *~x3 * x4	0.360	0.007	0.823
	x1 * x2 * x4	0.403	0.054	0.831
	x1 *~ x3 *~ x4	0.572	0.007	0.821
	x1 * x2 *~ x3	0.479	0.006	0.811
y2 = f (x1, x2, x3, x4)	x2 *~ x3 * x4	0.361	0.007	0.769
	x1 * x2 * x4	0.413	0.065	0.809
	x1 *~ x3 *~ x4	0.557	0.009	0.760
y3 = f (x1, x2, x3, x4)	x2 *~ x3 * x4	0.353	0.008	0.793
	x1 * x2 * x4	0.386	0.044	0.753
	x1 *~x3 *~ x4	0.564	0.009	0.767
y4 = f (x1, x2, x3, x4)	x2 *~ x3 * x4	0.370	0.009	0.832
	x1 * x2 * x4	0.416	0.0572	0.811
	x1 *~ x3 *~ x4	0.598	0.009	0.814
	x1 * x2 *~ x3	0.499	0.009	0.779
y5 = f (x1, x2, x3, x4)	x2 *~ x3 * x4	0.352	0.007	0.887
	x1 * x2 * x4	0.405	0.062	0.886
	x1 *~ x3 *~ x4	0.571	0.008	0.872
	x1* x2 *~ x3	0.485	0.008	0.848
y6 = f (x1, x2, x3, x4)	x2*~ x3 * x4	0.340	0.006	0.885
	x1 * x2 * x4	0.391	0.060	0.884
	x1 * ~ x3 *~ x4	0.558	0.007	0.881
	x1 * x2 *~ x3	0.474	0.008	0.857
y7 = f (x1, x2, x3, x4)	x2 *~ x3 * x4	0.352	0.008	0.858
	x1 * x2 * x4	0.4	0.059	0.847
	x1 *~ x3 *~ x4	0.575	0.008	0.848
	x1 * x2 *~ x3	0.486	0.011	0.821

Table 16. Test of models from subsample using data from holdout sample for control group.

Function	Model	Consistency	Unique Coverage
y1 = f (x1, x2, x3, x4)	Model1	0.804	0.68
	Model2	0.804	0.687
y2 = f (x1, x2, x3, x4)	Model1	0.919	0.34
	Model2	0.919	0.34
y3 = f (x1, x2, x3, x4)	Model1	0.964	0.337
	Model2	0.89	0.547
y4 = f (x1, x2, x3, x4)	Model1	0.964	0.337
	Model2	0.834	0.555
y5 = f (x1, x2, x3, x4)	Model1	0.910	0.344
	Model2	0.909	0.321
y6 = f (x1, x2, x3, x4)	Model1	0.909	0.321
	Model2	0.909	0.321
y7 = f (x1, x2, x3, x4)	Model1	0.858	0.518
	Model2	0.946	0.32

The test of predictive validity for the experimental group was operated by the previous process, and the results are shown in Tables 17 and 18. Compare the consistency and coverage and show that models in the experimental group in this study have high predictive validity.

Table 17. Solutions from subsample for experimental group.

Function	Causal Solution	Raw Coverage	Unique Coverage	Consistency
y1 = f (x1, x2, x3, x4)	x2 * x3 * x4	0.431	0.038	0.760
	~x3 * x4	0.531	0.0380	0.745
	~x1 * x2 * x4	0.41	0.0486	0.753
y2 = f (x1, x2, x3, x4)	x2 * x4	0.453	0.137	0.911
	x1 *~x3 *~x4	0.580	0.140	0.881
y3 = f (x1, x2, x3, x4)	x2 * x4	0.462	0.128	0.822
	x1 *~x3 *~x4	0.613	0.158	0.824
y4 = f (x1, x2, x3, x4)	x2 * x4	0.447	0.122	0.833
	x1 *~x3 *~x4	0.611	0.160	0.861
y5 = f (x1, x2, x3, x4)	~x1	0.693	0.0418	0.753
y6 = f (x1, x2, x3, x4)	x2 * x4	0.473	0.151	0.928
	x1 *~x3 *~x4	0.592	0.135	0.877
y7 = f (x1, x2, x3, x4)	x2 * x4	0.442	0.130	0.901
	x1 *~x3 *~x4	0.60	0.156	0.910

Table 18. Test of models from subsample using data from holdout sample for experimental group.

Function	Model	Consistency	Unique Coverage
y1 = f (x1, x2, x3, x4)	Model1	0.784	0.624
	Model2	0.871	0.282
y2 = f (x1, x2, x3, x4)	Model1	0.927	0.607
	Model2	0.871	0.282
y3 = f (x1, x2, x3, x4)	Model1	0.880	0.619
	Model2	0.801	0.278
y4 = f (x1, x2, x3, x4)	Model1	0.749	0.645
	Model2	0.730	0.310
y5 = f (x1, x2, x3, x4)	Model1	0.759	0.628
	Model2	0.740	0.301
y6 = f (x1, x2, x3, x4)	Model1	0.950	0.566
	Model2	0.950	0.566
y7 = f (x1, x2, x3, x4)	Model1	0.947	0.607
	Model2	0.928	0.293

4.4. Hypothesis Result

The results of a causal relationship between the control group and experimental group variables and the hypothesis of this study are summarized, as shown in Table 19.

Table 19. Fs/QCA causality analysis table for visual, tactile, and taste perception.

Experimental Group		Control Group	
Variables	**Hypothesis**	**Variables**	**Hypothesis**
x1 (Teacup shape preference)	H1 False	x1 (Teacup shape preference)	H1 True
x2 (Width of the teacup)	H2 **Partial True**	x2 (Width of the teacup)	H2 True
x3 (Height of the teacup)	H3 False	x3 (Height of the teacup)	H3 False
x4 (Thickness of the teacup)	H4 **Partial True**	x4 (Thickness of the teacup)	H4 True

Table 19 shows that teacup preference affects only the taste, fragrance, and overall tea performance in the control group. That is, non-professional tea drinkers' judgment regarding the taste and fragrance of tea tends to be influenced by their preference for teacups. For professionals of the experimental group, the taste, fragrance, and performance of the tea will not be affected by the teacup preference. The two groups of subjects unanimously found that visually observing the width of the teacup and the thickness of the teacup contacting or touching the lip will affect the umami, sweetness, smoothness, fragrance, and overall performance of the tea. One of the findings of both groups, the width of the teacup, is in line with Van Doorn et al.'s [52] research relating to the association of 'cup diameter', 'cup height', and 'cup thickness' with coffee taste expectations. They found that 'cup diameter' and 'cup height' influenced the coffee's characteristic aroma, bitterness, intensity, and sweetness, but the 'cup thickness' showed an impact on the temperature of the coffee only. In contrast to Van Doorn et al.'s work, the thickness of the teacup did have effect on the tea taste and fragrance in this present study. Despite some literature [52,55,56] suggesting that the flavor of coffee, beverage and tea is associated with the height of vessels, the present study found the height of teacup had no impact on tea taste and fragrance in both groups. Chinese tea is always hot, so the standard steps of drinking Chinese tea is to observe the tea color, smell it, and then taste it. It is possible the tall teacups do not seem easy for consumers to observe and smell, so hypothesis 3 is null.

This present study investigates the narrative statistical analysis (Table 20), indicating that the control group had a higher average score for tea taste and fragrance for Cup A.

Table 20. Percentage of measurement of tea performance results.

Experimental Group				Control Group			
Tea Taste Variables	**Cup Variables**	**f/Total**	**Pot**	**Tea Taste Variables**	**Cup Variables**	**f/Total**	**Pot**
Strongness	D	4/17	24	Strongness	B	8/17	41
Umami	B	10/17	59	Umami	A	9/17	53
Sweetness	B	7/17	50	Sweetness	A	10/17	59
Smoothness	D	8/17	41	Smoothness	A	11/17	65
Richness	D	8/17	41	Richness	A	7/17	50
Fragrance	A	14/17	82	Fragrance	A	13/17	76
Overall Performance	D	9/17	53	Overall Performance	A	11/17	65
Teacup Preference	D	14/17	82	Teacup Preference	B	9/17	53

Moreover, the fragrance for Cup A, the broadest and thickest cup shape among the five cups, also received the highest score for fragrance in the experimental group. Consistent with the results of Van Doorn et al. [52], the coffee in the broader cup was thought to be sweeter and aromatic but less intense. Van Doorn et al. also found that the effect of 'cup thickness' influenced coffee temperature expectations of participants from different countries. A seemingly logical interpretation of this study regarding 'cup thickness' is that the thicker the small Chinese teacup, the warmer the tea and the more intense and aromatic the tea. This is consistent with Harrar and Spence's [57] work on the association of spoon thickness and the perceived creaminess of the yogurt. Therefore, in terms of the performance of the tea taste, Cup A, with a constricted mouth and broad belly, can best express the taste and fragrance of tea for general consumers.

Although the teacup variables of the experimental group are relatively inconsistent, they still indicate some impact on different classes of tea taste. Delwiche and Pelchat [29] conducted a study with a blind test and found that professional wine tasters were also influenced by the visual image of the glass when judging the taste and aroma. Other related literature indicated that neither professionals nor amateurs could avoid being influenced by the tactile shape while tasting tea or wine [32,33].

Summing up, the following results are presented for both groups.

1. For those consumers who have no professional tea evaluation training, the larger the diameter of the cup, the taste and aroma of the tea will be better displayed. Also, the overall performance will be better if the height of the cup is not considered when one is drinking tea. Therefore, Cups A and B, which have only 0.1 cm difference in diameter and width, were the most recognized by general consumers regarding taste and olfactory perception of tea.
2. For regular consumers, their preference of teacup will directly affect the perception of all the tastes and fragrances of the tea. That is, the favorite cup shape will have a better tea taste and fragrance performance. Cup shapes that consumers like are affected by the diameter of the cup and the thickness of the cup's rim. The above data analysis found that the average preference of Cup A (3.471) and Cup B (3.647) was not much different, and Cup A in the tea soup taste and fragrance performance all stand out. Therefore, it is concluded that Cup A, with a large caliber and a thick rim, can adequately express the flavor and aroma of tea.
3. Data from the experimental group show that teacup preference is not in the causal combination. Therefore, it is concluded that professionals will not be affected by the taste and fragrance of tea due to teacup preference. However, in combination with factors affecting the taste and fragrance of tea, the diameter of the cup and the thickness of the rim of the cup are still sufficient conditions to affect the tea taste. Therefore, the researchers concluded that regardless of professional level, human vision and touch have a feeling of "sensation transference" to the taste system of taste and smell [35]. Cup D, with a relatively thin rim and smaller caliber, positively affected the tea test in the professional experimental group, but Cup A, with a thicker rim and larger caliber, also positively influenced the professional experimental group.
4. The experimental research found that consumers' vision and touch influence the taste system of taste and smell regardless of the degree of professionalism of tea, but the degree of influence is different. In particular, there are many types of Chinese tea, and the taste and fragrance are significant. Taking oolong tea in this study as an example, judging the quality of this tea is as crucial as judging its fragrance, so Cup A can be regarded as the best reference for the design of teacup shapes.

5. Conclusions

The essence of design is to solve the user's problem, make the user feel happy, and create a sense of happiness for the user. The essence of teacup design should be to solve the problem of drinking tea. The tea maker hopes to perfectly present tea tasting for consumers through a good cup design. Consumers hope that a good cup can make up for imperfect tea-making skills. Tea merchants who sell tea hope to satisfy consumers with tea taste through a good cup design and achieve a good sales performance of tea. However, the Chinese tea manufacturing process is complicated and the tea brewing technology is cumbersome. Therefore, in addition to solving the function of the tea carrier, the teacup design can change the user's sense of taste through the visual and tactile design of the teacup to produce pleasure and happiness, which is the value of the teacup design.

However, the current society faces a cultural crisis and a design crisis because many design practices are based on a small number of commercial interests and ignore potential system crises, similar to how the California government banned plastic toy ducks for causing cancer and congenital disability. Yet, the cultural and design background behind making such a product for children should be worth considering. Therefore, designers should rethink the environmental, social, and cultural responsibilities of product design. The concept of Actor-Network Theory (ANT; a social analysis method that believes that social science and social backgrounds interact with non-human actors to form a heterogeneous network, construct each other, and evolve), proposed by French sociologists Michel Callon and Bruno Latour in the mid-1980s, emphasizes the mutual construction and co-evolution of scientific practice and its social environment between people and non-human actors. The more highly modern society is, the more highly interactive the entanglement [58]. Therefore, nature and human society are not opposites but, instead, should find a social stability point in the interaction between human and non-human actors through human interaction. Producers, designers, users, earth's clay, energy, and environmental protection are intertwined to form a heterogeneous network in the ceramic industry. The interaction entangles the complex relationship between consumption, production, and environmental protection, especially between consumers and the environment.

When most studies are concerned with sustainable design issues, they tend to focus on product design to change user behavior, increase product lifespan, and reduce energy waste [58], or use the user experience to influence the behavior of other users [59]. Although our knowledge of how design changes behavior is rapidly expanding, we rarely discuss how to design products that meet the real needs of users and reduce design waste and excessive consumption. For example, under the pressure of environmental protection and sustainable development, teaware designers and producers focus more on resource reuse, product sustainability, or zero environmental pollution. Although ceramic teacups are consistent with sustainability and a long product life cycle, less environmental pollution and the non-reusability and excessive production and consumption of clay, coupled with the unique beauty of traditional firewood potters and consumers, have created an enormous carbon footprint in recent years. Thus, sustainable design appears to be empty talk. Unless manufacturers have the advantage of market interest, it is difficult to persuade them to accept sustainable design and reduce production. Tromp and Hekkert [60] discussed that the designer's social responsibility for the influence of design should emphasize the realization of desired consequences rather than the prevention of undesired ones. As a designer and one of the actors in the network, one should understand the social problems and dilemmas resulting from conflicts between personal interests and public interests brought about by the design of tea utensils. This research found that a teacup shape's visual and tactile sense impacts tastes and smell, which can provide teaware designers or ceramicists with a basis for innovative, creative production, solve user problems, and meet user needs. Consumers would have a reduced opportunity to choose inappropriate teacups and waste resources. Manufacturers can reduce the hoarding of improperly designed products and causes of environmental resources and profit depletion. In other words, if producers and designers design products based on the feelings and needs of consumers, users can use products that meet their needs, reduce the waste of clay in the ground, and protect the environment. Through this research, practical teaware design thinking fulfills the designer's social responsibility. Echoing the Actor-Network Theory, in the interaction between humans and non-humans, nature and society, the rearrangement of "people, circumstances, and things" seeks the organic balance of nature, society, culture, people, etc.

Limitation and Suggestions for Future Research

This study is an experimental study. The experimental group focuses on qualitative research by experts. However, compared to general consumers in the control group, qualified participants are few and older. Therefore, considering the complex relationship between factors, this study selected fs/QCA for small-sample analysis. Although empirical data in qualitative research function as a catalyst for constructing theoretical discussions [41], it is recommended that future research expand the experimental research sample and adopt quantitative analysis methods to increase its representativeness. In addition, we suggest redefining the tea test as being in line with the perception of general consumers and expanding the sample for general consumer quantitative survey methods to explore a broader evidence base and different opinions. This study has some limitations regarding the issues of the teacup's shape factors, the teacup's ceramic material, and the firing method. The chemicals used in glazing the teacup may all affect the taste and fragrance of the tea. As an experimental study, this study restricts the materials and colors of teacups as control items. Future research can explore the correlation between the same shape but different materials and colors and tea taste. The relationship between the research and firing methods of ceramic materials and the performance of tea soup is another issue of environmental sustainability. The social responsibility of tea set designers and researchers could be studied to promote the achievement of this goal.

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