Research Article

Effects of Food Environments and Eating Environments on Consumers' Food Consumption Volume

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Even though the influences of eating environments and the food environments on consumption have been discussed, little has been done to examine whether the food environments would be influenced by the eating environments. For example, the size of plate has been proved to have impact on consumers' consumption volume; it is still unknown whether the eating environment would interact with the food environment and in turn influences consumers' consumption volume. This research explores the underlying mechanisms how consumers are influenced by the size of bowl when they consume food. In addition, eating environments are also incorporated to discuss their effects on the relationship between bowl size and consumers' consumption volume. The results indicate people who receive a large bowl with large chopsticks exhibit greater food consumption than those who receive a small bowl with small chopsticks. However, when people use tableware inconsistently, they exhibit similar food consumption. Under bright illumination, people given large bowls with large chopsticks exhibit greater food consumption than those given small bowls with small chopsticks; however, when people use inconsistently sized tableware, they exhibit similar food consumption. Under dim illumination, no significant differences in food consumption amount are evident in association with bowl and chopstick sizes.

1. Introduction

Food choice decisions determine what we eat (e.g., noodles or rice), and food consumption refers to how much we eat (e.g., half a bowl or a whole bowl). Food choice decisions and food consumption play crucial roles in health management. An individual consumes more than 71% of their calories using serving aids such as plates, bowls, cups, and saucers [1]. The size of dinnerware has been revealed to be an influential factor in how much people serve and consume during a single sitting [2, 3]. Therefore, numerous organizations and dieting programs recommend using smaller plates to control portion sizes [4, 5], and the sensory experience of eating is an important determinant of food intake control, often attributed to the positive hedonic response associated with certain sensory cues [6]. A seemingly

obvious initial explanation for the aforementioned effect of dinnerware size is that small items of dinnerware simply hold a smaller volume of food [7].

Wansink et al. [3] reported that when plates and bowls are exaggeratedly large and serving capacity is unlimited, the average consumer consistently serves themselves more food compared with the amount they serve when dinnerware is smaller. A visual illusion widely used to explain how the size of dinnerware influences consumers' food intake is the Ebbinghaus-Titchener size-contrast illusion. The illusion demonstrates how a circle surrounded by small circles appears to be larger than a circle surrounded by large circles [8].

Food consumption environments can be divided into eating environments and food environments. For example, when people eat a meal in a restaurant, the environment encompasses both eating and food environments. Eating

environment refers to the ambient factors associated with the eating of food, such as the social interactions that occur, the effort of obtaining food, the atmospherics, and distractions that may occur. By contrast, food environment refers to factors that directly relate to the manner in which food is provided or presented, such as its package or portion size, salience, structure, and how it is served [9].

Researchers have discussed the influences of eating and food environments on consumption; the relevant studies have indicated that tableware (i.e., forks, spoons, dishes, bowls, and chopsticks) influence food consumption. Thus, the use of appropriate tableware during meals is crucial for controlling weight and establishing concepts such as health management. In daily life, using only a single item of tableware (such as a bowl, chopsticks, or fork) when having a meal is impossible; usually, a combination of items is required, such as a bowl and chopsticks, and a dish and a fork. For example, when people eat soup noodles, they may use a bowl, chopsticks, and spoon simultaneously. This leads to the question: how do different sizes of bowls, chopsticks, and spoons influence people's food consumption? Furthermore, how does the consistency of tableware size affect people's food consumption? For example, eating soup noodles from a large bowl with large chopsticks (consistent) or from a large bowl with small chopsticks (inconsistent) may exhibit different effects on people's food consumption. Thus, the interaction of tableware with various sizes should be investigated.

Few studies have examined the extent to which food environments are influenced (e.g., moderately) by eating environments. For example, plate size has been determined to affect food consumption; however, whether factors of the eating environment (e.g., temperature, lighting, odor, and noise) interact with the food environment and in turn influence of food consumption remains unknown. Therefore, the present study investigated whether bowl size and chopsticks size influence consumers' food consumption as well as whether factors of the eating environment (e.g., illumination) and food environments moderate individuals' food consumption.

2. Literature Review

2.1. Effect of Bowl Size on Food Consumption. Wansink [9] indicated that a bowl's size can act as a perceptual cue that may influence how much individuals serve and subsequently consume. Most relevant studies have indicated that dinnerware size positively influences serving and consumption behavior [9, 10] as well as that people are strongly influenced by visual cues when they choose and consume food [1, 10–12]. However, evidence from other researchers has contradicted these findings. For example, Rolls et al. [13] demonstrated that participants' food intake across three occasions did not differ significantly when they used a differently sized plate on each occasion. Findings appear to be ambiguous, indicating a complex relationship between dinnerware size and consumption volume. Hence, the present study explored whether and under what conditions bowl size influences serving and consumption behavior.

According to the Ebbinghaus–Titchener size-contrast illusion, visual bias may influence consumers' food intake. In the illusion, two circles of identical size are placed near each other: one is encircled by large circles and the other by small circles. As a result of this juxtaposition, the central circle that is encircled by large circles appears smaller than the central circle encircled by small circles. Accordingly, a portion on a large plate is perceived as smaller than it actually is, thereby promoting overserving. The size of the bowl acts as a contextual stimulus that may influence how much an individual serves and subsequently eats when he or she decides to eat half a bowl of cereal. Estimating size involves relative judgment [14]; individuals cannot help but perceive some items as smaller (or larger) when viewed in comparison with larger (or smaller) neighboring items [15].

A study on an ice cream illusion demonstrated consistent results with the aforementioned size-contrast illusion [3]. People were randomly given 24- or 16-ounce bowls, and on average, those given the larger bowls served and consumed 31% more ice cream. Thus, it can be predicted that people who receive a larger bowl will serve more than those who receive a smaller bowl. The same amount in a larger bowl may appear insufficient, and individuals may thus eat more, because they are not likely to be aware of the relevant bias. In addition, the prior studies have also indicated that external influences on food intake have been well evidenced; for example, the influence that other people have on food consumption has been well documented, whereby dining with others consuming a small or large amount of food typically decreases or increases food consumption, respectively [16–18]. Shimpo and Akamatsu [19] addressed that portion sizes and bowl sizes may be related to food intake and perceived fullness and also found that large rice bowl leads to higher food intake and perceived fullness.

2.2. Effects of Bowl and Chopstick Sizes on Food Consumption. Most studies on chopsticks have discussed the influences of exterior parameters (such as shape, length, and materials) or method of use on food-serving performance [20–25]. For example, Lin et al. [25] investigated the influence of chopstick size on taste evaluation and found that long chopsticks led people to extend the time they spent eating as well as to enjoy the ambiance more compared with when short chopsticks were used. In addition, studies have indicated that larger portion sizes lead to greater consumption [26–29]. In daily life, people usually use bowls and chopsticks simultaneously. More than one-fifth of the world's population use chopsticks daily to consume food across China, Japan, Korea, and Vietnam [30]. However, little research has focused on the interaction between bowls and chopsticks in terms of eating behavior and consumer psychology. Therefore, the present study examined how bowl and chopstick sizes affect food consumption.

Other studies have further assessed the effect of chopstick size on people's food consumption in combination with various bowl sizes. Hsu and Wu [23] investigated the optimal length of chopsticks and found that 240 mm and 180 mm were optimal for adults and pupils, respectively. They argued

that shorter chopsticks are not ergonomically suitable compared with longer or more appropriately sized chopsticks. When people use longer or more appropriately sized chopsticks, they are likely to consume more. Furthermore, they argued that using large bowls with large chopsticks or small bowls with small chopsticks is consistent behavior; however, using large bowls with small chopsticks or small bowls with large chopsticks is inconsistent behavior. Therefore, the size consistency and ergonomics of dinnerware may be associated with food consumption. In addition, the findings regarding the size-contrast illusion indicated that people who receive larger bowls serve more and thus consume more food than those who receive smaller bowls. In sum, a large bowl with large chopsticks leads to greater food consumption than a small bowl with small chopsticks. Additionally, use of a large bowl with small chopsticks or small bowl with large chopsticks is inconsistent, and therefore exhibits lower fitness; thus, differences in food consumption between use of a large bowl with small chopsticks or of a small bowl with large chopsticks are nonsignificant. Accordingly, we proposed the following hypothesis:

Hypothesis H1. The effects of bowl and chopsticks sizes interact when people consume food. People who receive a large bowl with large chopsticks exhibit greater food consumption than those who receive a small bowl with small chopsticks. However, when people use tableware inconsistently, they exhibit similar food consumption.

2.3. Effects of Bowl Size, Chopstick Size, and Lighting on Food Consumption. Wansink [9] indicated that dim or soft lighting appears to affect consumption by increasing eating duration and by increasing comfort and disinhibition. Harsh or bright illumination in restaurants is associated with shorter dining periods [31], whereas soft or warm lighting generally causes people to stay longer and enjoy an unplanned dessert or an extra drink [32, 33]. When the lights are dim, people are less inhibited and self-conscious and are likely to consume more than they otherwise would [34]. The effect of lighting may be particularly strong when two or more individuals are eating together. Cho et al. [35] investigated that the influence of lighting color was also compared between men and women, and the results found that blue lighting decreased the hedonic impression of the food's appearance, but not the willingness to eat, compared to yellow and white lighting conditions, and the blue lighting significantly decreased the amount consumed in men, but not in women, compared to yellow and white lighting conditions. In addition, prior studies have found the influence of lighting illuminance on food consumption, and it is generally understood that soft or dim lighting condition leads patrons not only to spend more time in their eating places but also to order additional foods [2, 9, 35]. Seo [36] found that lighting's color affects many aspects of our lives, and one area of particular interest in recent years has been the role of color cues in the perception of food and drink. These reasons showed that illumination of lighting could influence consumer's food consumption.

Other studies have further investigated the effects of chopstick size and illumination on food consumption for people using bowls of various sizes. When people are under bright illumination, they remain in a restaurant for a shorter period and are more self-conscious; in this case, their focus is on satiating their hunger. In addition, as previously mentioned, when people use tableware consistently based on ergonomics and fitness, the associated effects on food consumption are substantial. As described, use of a large bowl with large chopsticks results in greater food consumption than a small bowl with small chopsticks, in accordance with the effects of the size-contrast illusion. However, when people are in a restaurant with dim illumination, they prolong their stay and are less self-conscious; moreover, their goal of hunger satiation decreases. In this case, no goal progress is required because people are less inhibited and self-conscious. The use of large or small bowls may not result in substantial differences in terms of food consumption in this case. Therefore, we proposed the following hypothesis.

Hypothesis H2. Interactions among bowl size, illumination, and chopstick size are evident when people engage in food consumption. Specifically, under bright illumination, people given large bowls with large chopsticks exhibit greater food consumption than those given small bowls with small chopsticks; however, when people use inconsistently sized tableware, they exhibit similar food consumption. Under dim illumination, no significant differences in food consumption amount are evident in association with bowl and chopstick sizes.

3. Study 1

Study 1 examined the influences of bowl and chopstick size on consumption. The independent variable was bowl size (large or small); the moderator was chopstick size (large or small); and the dependent variable was consumption.

3.1. Method

3.1.1. Participants and Experimental Design. The participants were 40 undergraduates recruited at a college campus; 36 of the participants were female with an average age of 22.5 years. A 2 (bowl size: large vs. small) $\times$ 2 (chopstick size: large vs. small) experimental design was employed. All factors were between-subject factors. Participants were randomly assigned to one of the four experimental conditions.

3.1.2. Manipulations of Bowl and Chopstick Size, Experimental Procedure, and Dependent Variable. The study was conducted in a laboratory. The manipulations of bowl size followed the method of Wansink et al. [37]. Two sets of bowls were used: the larger bowls were 16 oz (diameter = approximately 17.5 cm), and the smaller bowls were 8 oz (diameter = approximately 15 cm). Bowls of these sizes are commonly used in homes. Additionally, the large chopsticks

were 15 cm long, and the smaller chopsticks were 12 cm. In the experimental processes, three research assistants served as waitstaff. For each meal, participants sat at either “large bowl” or “small bowl” tables, and bowl assignments were rotated after every meal.

Study 1 employed soup noodles as the experimental material. Each bowl of noodles held 150 g of noodles and 155 g of soup. After participants entered the laboratory and sat down, the soup noodles were prepared and placed on the laboratory counter, at which point the full bowls were weighed (separate weights of empty bowls were also recorded) on a sensitive food scale. Participants were told that when they had finished eating the noodle soup, if they were not satisfied, they could ask for more food. If they were unable to finish the whole portion, they were allowed to leave it. If the subjects asked for more, another 150 g of noodles and 155 g of soup were provided.

After the meal, the participants were asked a series of questions about how satiated they were, how hungry they were, and what their preference for the food was before starting the study. Responses were measured on a 7-point scale. Example items are as follows: “How hungry are you right now?” (1 = a little; 7 = very); “How full are you right now?” (1 = a little; 7 = very); “How much food do you think you could eat right now?” (1 = a little; 7 = a lot); and “The food was likeable” (1 = strongly disagree; 7 = strongly agree). A small sticky note was attached to the underside of each bowl and noted the weight of the full bowl in grams, bowl size, chopstick size, and number of extra noodle servings. The purpose of the notes was to reduce confusion when the bowls were returned. Each returned bowl, whether empty or containing leftovers to be disposed of, was reweighed, and the weight was recorded on the sticky note. Finally, the sticky note was removed and stored.

3.1.3. Dependent Variable and Manipulation Checks. The dependent variable was consumption. The influences of bowl and chopstick sizes on the weight of soup noodles left in each bowl were measured using a method adopted from Mishra et al. [26]. To further assess the manipulation results of bowl and chopstick size, this study included the following questions: “What do you think about this bowl?” (1 = very small; 7 = very large); “What do you think about these chopsticks?” (1 = very small; 7 = very large); and “How much effort was required to eat the soup noodles?” (1 = none at all; 1 = substantial effort).

3.2. Results

3.2.1. Manipulation Checks. A *t*-test analysis indicated that participants perceived the large bowls ($M = 5.20$) to be larger than the small bowls ($M = 3.25$), $t(1, 38) = 6.091$, $p \leq 0.001$. Additionally, a *t*-test analysis indicated that participants perceived the large chopsticks ($M = 4.30$) to be larger than the small chopsticks ($M = 2.35$), $t(1, 38) = 6.270$, $p \leq 0.001$. Moreover, the analysis showed that participants’ effort ratings between the large and small chopstick conditions were not

significantly different; that is, the effort required was statistically identical for both types of chopsticks ($M_{\text{small}} = 3.45$ vs. $M_{\text{large}} = 4.25$; $t(1, 38) = -1.804$, $p = 0.079 > 0.05$).

3.2.2. Influences of Bowl Size and Chopstick Size on Consumption. A two-way analysis of variance was performed on food consumption to reveal the two-way interaction between bowl size and chopstick size ($F(1, 36) = 5.921$, $p = 0.02 < 0.05$). The main effects of bowl size ($F(1, 36) = 3.696$, $p = 0.062 > 0.05$) and chopstick size ($F(1, 36) = 0.076$, $p = 0.78 > 0.05$) were nonsignificant. As denoted in Figure 1, when using large chopsticks, participants with large bowls ($M = 550.65$) consumed more food than did those with small bowls ($M = 286.02$) ($F(1, 18) = 11.935$, $p = 0.003 < 0.005$). However, when small chopsticks were used, no difference in food consumption was observed between participants with large bowls ($M = 386.06$) and those with small bowls ($M = 417.09$) ($F(1, 18) = 0.108$, $p = 0.746 > 0.005$). Furthermore, this study employed satiety and preference as covariates and found that no significant interactions occurred with any other variables; therefore, satiety and preference were not further discussed.

4. Study 2

Study 2 examined the influences of bowl size, chopstick size, and illumination on consumption. The independent variable was bowl size (large or small); the moderators were chopstick size (large or small) and illumination (bright or dim); and the dependent variable was consumption.

4.1. Method

4.1.1. Participants, Experimental Design, and Procedure. The participants were 91 undergraduates recruited at a college campus; 71 of the participants were female with an average age of 20.64 years. A 2 (bowl size: large vs. small) $\times$ 2 (chopstick size: large vs. small) $\times$ 2 (illumination: bright vs. dim) experimental design was employed. All factors were between-subject factors. Participants were randomly assigned to one of the eight experimental conditions.

4.1.2. Manipulations of Bowl and Chopstick Size and Illumination, Experimental Procedure, and Dependent Variable. The manipulations of bowl and chopsticks, experimental procedure, and dependent variable were identical to those in Study 1. The illumination manipulations for the bright condition followed the method of Wang et al. [38]; a brightness of 600–650 lux was used in the bright room, and 350–400 lux was used in the dim room. The two rooms were identical in size and layout. To ensure thorough investigation of the manipulation, participants were asked “What do you think about this room?” (1 = very dark; 7 = very bright).

4.2. Results

4.2.1. Manipulation Checks. A *t*-test analysis indicated that participants perceived the large bowls ($M = 5.02$) to be larger

FIGURE 1: Influences of bowl size and chopstick size on food consumption.

than the small bowls ($M = 3.58$), $t(1, 89) = 7.390$, $p \leq 0.001$. Additionally, a t -test analysis indicated that participants perceived the large chopsticks ($M = 4.53$) to be larger than the small chopsticks ($M = 2.81$), $t(1, 89) = 9.672$, $p \leq 0.001$; the analysis also revealed that participants' effort ratings between the large and small chopstick conditions were not significantly different; that is, the effort required was statistically identical for both types of chopsticks ($M_{\text{small}} = 3.70$ vs. $M_{\text{large}} = 4.06$; $t(1, 89) = -1.183$, $p = 0.240 > 0.05$). Furthermore, participants perceived the bright room ($M = 5.53$) to be brighter than the dim room ($M = 2.07$), $t(1, 89) = 19.207$, $p \leq 0.001$.

4.2.2. Influences of Bowl and Chopstick Size on Consumption under Bright and Dim Conditions. This study separately examined the effects of bright and dim conditions using analyses of variance. For the bright condition, the two-way interaction between bowl size and chopstick size ($F(1, 41) = 4.417$, $p = 0.042 < 0.05$) was significant, but the main effects of bowl size ($F(1, 41) = 0.178$, $p = 0.675 > 0.05$) and chopstick size ($F(1, 41) = 0.017$, $p = 0.898 > 0.05$) were nonsignificant. As denoted in Figure 2, when using large chopsticks, participants with large bowls ($M = 526.818$) consumed more food than did those with small bowls ($M = 352.600$) ($F(1, 19) = 5.571$, $p = 0.0293 < 0.005$). However, when small chopsticks were used, no difference in food consumption was observed between participants with large bowls ($M = 372.800$) and those with small bowls ($M = 488.754$) ($F(1, 22) = 1.077$, $p = 0.211 > 0.005$). Furthermore, this study employed satiety and preference as covariates and discovered that no significant interactions occurred with any other variables; therefore, satiety and preference were not further discussed. For the dim condition, the two-way interaction between bowl and chopstick sizes ($F(1, 42) = 0.562$, $p = 0.458 > 0.05$) and the main effect of bowl size ($F(1, 42) = 1.173$, $p = 0.285 > 0.05$) and chopstick size ($F(1, 42) = 0.904$, $p = 0.347 > 0.05$) were nonsignificant.

5. Discussion

Both studies 1 and 2 demonstrated that use of a large bowl with large chopsticks drove participants to consume more

FIGURE 2: Influences of bowl and chopstick size on food consumption under the bright condition.

food than did use of a small bowl with small chopsticks. Moreover, illumination moderated the effects of bowl and chopstick sizes on food consumption. Under bright illumination, people given a large bowl with large chopsticks consumed more food than those given a small bowl with small chopsticks; however, when people used inconsistently sized tableware, food consumption remained similar. Under dim illumination, no significant differences were observed between bowl and chopstick sizes.

This paper makes two major contributions to the literature. First, most studies on food consumption have used single item of tableware to conduct surveys. Such setups are not representative of the actual experiences of consumers, because people use more than one item of tableware when consuming a meal. The present study showed that size consistency in tableware influences food consumption. During meals, people tend to use tableware of various sizes, and the sizes and size combinations influence food consumption. Second, this study demonstrated that eating environment and food environment moderate individuals' food consumption. These findings and contributions may help people to beneficial control their diets and establish concepts of health management.

Practically, these findings imply that consumers can change their choice of eating utensils to affect their diets. Consumers who wish to reduce food intake should use a small bowl with small chopsticks. For example, if a family orders a large bowl of beef noodles, the parents can provide a small bowl to their children. Individuals who use shorter chopsticks may feel that they have eaten more while actually reducing their food intake. In addition, this study suggests that consumers should choose a dining environment with brighter lighting, because this type of illumination increases their self-awareness and results in less time spent in the dining environment as well as less consumption. Under bright light, the size of tableware is clearly visible, enabling consumers to choose a combination of a small bowl and small chopsticks to reduce their food intake. In sum, choosing appropriately sized cutlery enables consumers to control their diets and to maintain health management.

This study's findings open numerous avenues for future research. First, the environmental factors, including package size, plate shape, lighting, and presence of other people, increase food consumption volume far more than people may realize. Future research can be conducted to ascertain whether other environmental factors (e.g., temperature and music) influence consumers' food consumption. Second, studies have indicated that dinnerware color may influence consumers' food consumption. Future studies may investigate the effects of bowl color, food, and eating environment on individuals' food consumption.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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