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Multisensory Research 37 (2024) 275–297



Glassware Influences the Perception of Orange Juice in Simulated Naturalistic *versus* Urban Conditions

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Received 23 March 2023; accepted 28 May 2024; published online 18 June 2024;
published in print 22 August 2024

Abstract

The latest research demonstrates that people's perception of orange juice can be influenced by the shape/type of receptacle in which it happens to be served. Two studies are reported that were designed to investigate the impact, if any, that the shape/type of glass might exert over the perception of the contents, the emotions induced on tasting the juice and the consumer's intention to purchase orange juice. The same quantity of orange juice (100 ml) was presented and evaluated in three different glasses: a straight-sided, a curved and a tapered glass. Questionnaires were used to assess taste (aroma, flavour intensity, sweetness, freshness and fruitiness), pleasantness and intention to buy orange juice. Study 2 assessed the impact of the same three glasses in two digitally rendered atmospheric conditions (nature *vs* urban). In Study 1, the perceived sweetness and pleasantness of the orange juice was significantly influenced by the shape/type of the glass in which it was presented. Study 2 reported significant interactions between condition (nature *vs* urban) and glass shape (tapered, straight-sided and curved). Perceived aroma, flavour intensity and pleasantness were all significantly affected by the simulated audiovisual context or atmosphere. Compared to the urban condition, perceived aroma, freshness, fruitiness and pleasantness were rated significantly higher in the nature condition. On the other hand, flavour intensity and sweetness were rated significantly higher in the urban condition than in the natural condition. These results are likely to be relevant for those interested in providing food services, or company managers offering beverages to their customers.

Keywords

glass shape, multisensory, nature condition, orange juice, urban condition

1. Introduction

The glasses in which conventional beverages are typically served come in a wide range of different sizes and shapes. Importantly, glass shape has been shown to influence the perception and behaviour of consumers in a variety of everyday contexts (e.g., Clicerì *et al.*, 2018). As such, it is relevant to explore whether and if so, how, glassware may affect people's drinking experiences and their evaluation of a beverage's quality (Wang *et al.*, 2020). Consumers' perception of the quality of a drink is undoubtedly an important factor in their product-related decision-making (Mehta *et al.*, 2022). Many drinks, such as, for example, beer, cola, coffee and other alcoholic drinks are more or less strongly associated with specific drinking receptacles (e.g., Carvalho and Spence, 2018; Cavazzana *et al.*, 2017; Mirabito *et al.*, 2017). The quality and shape of the receptacle has been found to exert a significant influence over consumers' perception and judgement of the contents (Hirson *et al.*, 2012; Spence and Deroy, 2012, 2013; Velasco *et al.*, 2016) and this, in turn, may affect their purchase behaviour (Clicerì *et al.*, 2018). When a drink is congruent with the vessel in which it is presented (e.g., a mug for a cup of filter coffee), people tend to enjoy the experience more and hence may drink more than when drinking from glassware that is somehow incongruent with the beverage being consumed (Schifferstein, 2009; Wan *et al.*, 2015).

Furthermore, the shapes and textures of containers have also been shown to affect people's consumption behaviour, their emotions, and the perceived qualities and their evaluations of a wide range of drinks (Greenfield *et al.*, 1984; Guéguen and Jacob, 2014; Li *et al.*, 2022; Spence, 2018; Spence and Van Doorn, 2017; Westerman *et al.*, 2012; Yang *et al.*, 2019). The research that has been published to date suggests that the shape of the container can exert a significant influence over consumers' preferences. For example, consumers who drank bottled orange juice, ranked both an anthropomorphic-shaped and a square-shaped bottle higher in terms of their preference than the rounded containers (Chitturi *et al.*, 2019). Langfield *et al.* (2018) reported a study in which 162 participants were given 330 ml of apple juice in a glass that sloped inwards towards the top, in a straight-sided glass, or in an outward-sloping glass. The participants drank the apple juice more rapidly from the outward-sloping glass than from the straight-sided glass. Meanwhile, research conducted by Casales-García *et al.* (2023) suggested that the type of beer glass (e.g., Pilsner) and the colour of beer both influence participants' expectations, their hedonic ratings

and their willingness to pay. Beers served in a Pilsner glass were rated as tasting sweeter than when the same beers were served in a mug instead.

In order to investigate whether it is possible to enhance consumers' positive emotion and increase their purchase intent in relation to orange juice, two studies were conducted to evaluate the effects of glass shape (Pilsner, Collins and Weizen) on people's perception, pleasantness ratings and willingness to pay for orange juice. Study 1 tested the effect of glass shape on consumers' perception of aroma, flavour intensity, sweetness, freshness, fruitiness, pleasantness and willingness to pay. Previously it has been demonstrated that consumers' perception, emotion and purchase intentions may be affected by the context in which they find themselves. Thus, Study 2 focussed on assessing the impact of digitally presented nature vs urban conditions on the influence of glass shapes over the tasting experience.

1.1. Multisensory Perception Influenced by the Shape of the Container

The shapes of foods and of the containers in which they are presented have been shown to affect consumers' preference, perception, affective states, judgements and decisions (for reviews, see Sample *et al.*, 2020; Simmonds *et al.*, 2019). For example, people's judgements of a drink's aroma have been shown to be affected by visual cues under certain conditions (Motoki *et al.*, 2023). Specific shape features give rise to crossmodal associations and may help to prime specific taste expectations and/or feelings (e.g., associated with roundness, angularity). For instance, a round (angular) shape has been shown to be associated with softness (hardness) and sweetness (bitter), when participants tasted a sugar solution (Liang *et al.*, 2013).

The taste of coffee has also been shown to be influenced by the shape of the container in which it is served. For example, coffee served in a mug with a wider diameter tends to be associated with a sweeter-tasting beverage, whereas a mug having a narrow diameter tends to be associated with a more aromatic drink instead (Van Doorn *et al.*, 2017). Carvalho and Spence (2018) reported that the sweetness and acidity of coffee were more intense in a cup shaped like two half spheres (one upright, another other inverted) than in the open cup. The aroma of coffee was rated as smelling more intense in the tulip cup than the split cup and the open cup (Carvalho and Spence, 2018). Note that glass shape also influences people's perception of the flavour and aroma of wine, at least if the drinker happens to be aware of the shape and size of the glass that they are drinking from (see Spence, 2011, for a review). The aroma intensity in the case of wine has been shown to be directly affected by the opening diameter of the glass in which it is served (Spence, 2011).

1.2. Contextual Effects on the Evaluation of Beverages

The relationship between the influence of product-intrinsic and product-extrinsic factors on people's perception of, and preference for, drinks is undoubtedly complex (Mielby *et al.*, 2018). The visual and auditory attributes of the environment have been shown to affect perception and direct attention (Betancur *et al.*, 2020; Cantu *et al.*, 2022; Connors and Sobell, 1986; Franco *et al.*, 2017; Gómez-Corona *et al.*, 2017; Istiani *et al.*, 2023a; Spence, 2015; Stenfors *et al.*, 2019; Yoshimura *et al.*, 2011). People's emotional responses can be affected by environmental factors including the sonic attributes of the environment and background colour and lighting (Franco *et al.*, 2017; Istiani *et al.*, 2023a; Mehrabian and Russell, 1974; Spence *et al.*, 2014). For instance, male beer drinkers reported enjoying their drinks more when background music was played in a bar setting than when they drank in silence instead (Guéguen *et al.*, 2008). Istiani *et al.* (2024) found that both music tempo and pitch influence consumers' evaluation of orange juice on aroma, sweetness, sourness, bitterness and freshness. They reported that high-pitch music enhanced the perceived freshness and sweetness of orange juice. Furthermore, listening to certain types of music has been shown to enhance consumers' positive emotions as well as their willingness to pay for beer (Reinoso-Carvalho *et al.*, 2019, 2020).

Petit and Sieffermann (2007) performed a series of experiments to assess people's liking for, and freshness ratings of, an iced coffee in two natural drinking situations, a classic laboratory test and a situational laboratory environment. Participants' liking and consumption of iced coffee were found to depend on both the surroundings and the situation. Meanwhile, Motoki *et al.* (2021) recently demonstrated that participants associated greenish and darker-coloured coffee shop images with the expectation of a bitter-tasting coffee, while lighter-coloured interiors were associated with a sweeter-tasting coffee instead. Similar effects related to sweetness perception have also been reported in other studies. Istiani *et al.* (2023b) conducted a study with 30 participants showing that when they listened to the natural sound of an urban park environment, orange juice was perceived as tasting sweeter. For instance, Istiani *et al.* (2023a) investigated the effects of environmental cues on judgements of the sweetness of orange juice by showing the participants within indoor environments (i.e., red, green). They found that when participants experienced the environment with a high-frequency tone, a red background and warm lighting, the perceived sweetness of the drink increased (Spence, 2020).

2. Theoretical Framework

Assimilation–contrast theory indicates that if people's perception of a product and their prior expectations differ by only a small amount, the evaluation of the

product is usually in line with their prior expectations (Hovland *et al.*, 1957; Piqueras-Fiszman and Spence, 2015; Reinoso-Carvalho *et al.*, 2019). However, if the discrepancy between expectation and experience is too great then a negatively valenced disconfirmation of expectation response is often observed. A number of studies have demonstrated that the shape of the glass can influence people's feelings and experiences and intensify their product evaluations and pleasantness ratings (Cavazzana *et al.*, 2017; Clicerì *et al.*, 2018; Li *et al.*, 2022; Mirabito *et al.*, 2017). For instance, people rated a drink that is served in the typical glass (with curved sides) as being more pleasant than in a water glass (straight sides) or plastic bottle that is congruent to the drinking of Coca-Cola (Cavazzana *et al.*, 2017). In two studies, researchers found that Chinese participants' ratings of the pleasantness of tea samples were affected by the visual appearance of the teaware (Li *et al.*, 2020). In China, people mainly use a beer mug to drink beer, with only a few bars (whose main consumers are foreigners) serving beer in glasses. It is important to note that when orange juice is served in a beer mug, consumers might therefore initially assume it to be beer. Thus, the present study was developed in order to explore which glass shape might influence the perception of orange juice.

Wan *et al.*'s (2015) findings, which extend previous research on the shapes of containers and beverage perception, suggested that the shape of glassware in which orange juice is presented could affect consumers' perception, their emotions and their willingness to pay for beverages (Cavazzana *et al.*, 2017; Clicerì *et al.*, 2018; Lefebvre and Orłowski, 2019; Mirabito *et al.*, 2017; Spence and Van Doorn, 2017; Spence and Wan, 2016; Zhou *et al.*, 2021). Note that these taste/flavour expectations often serve to anchor the subsequent tasting experience (see Piqueras-Fiszman and Spence, 2015, for a review). Furthermore, people have been reported to be willing to pay more for drinks that are presented in curved glasses as compared to those presented in the straight glasses instead (Troy *et al.*, 2015). When participants rate drinks as being congruent with the glassware then they are willing to pay significantly more for it (Wan *et al.*, 2015).

Thus, the following hypotheses can be proposed:

Hypothesis 1a–g. Glass shapes (tapering-sided, straight-sided, curved-sided) will exert a significant effect on the perception of aroma (a), flavour intensity (b), sweetness (c), freshness (d), fruitiness (e), pleasantness (f) and people's willingness to pay (g).

Following the stated H1, the shape of the glass might be evaluated differently in two different conditions. The experience of drinking can be influenced by the contextual conditions (Istiani *et al.*, 2023a; Motoki *et al.*, 2021; Reinoso-Carvalho *et al.*, 2019; Spence, 2020). Xu *et al.* (2019) reported that people's emotions and perceptions can be influenced differently by the eating

context, such as a laboratory, university study area, café and a city bus stop. For instance, when bittersweet chocolate ice-cream was consumed at a city bus stop (actual environment), the food was associated with negative emotions and a bitter taste. Bangcuyo *et al.* (2015) found that there were significant differences in their participants' liking for coffee in two environments (e.g., virtual coffeehouse, traditional sensory booths) for those who regularly consumed coffee in a coffeehouse. Comparing three environments (a traditional sensory booth, an immersive wine bar and an actual wine bar), Hannum *et al.* (2019) reported that participants were more willing to buy the wines at a wine bar than at a traditional booth.

Supported by three written scenarios detailing specific consumption contexts (e.g., breakfast, movie, refreshing), Hein *et al.* (2012) reported that hedonic ratings were higher in the breakfast and refreshing context (consuming some kind of refreshing beverage) than in the movie context. In another study, Lipperman-Kreda *et al.* (2017) conducted a survey and measured four different contexts to explore the alcohol-related drinking behaviour of adolescents. They found that compared to when at bars/nightclubs, participants would drink less frequently at home. James *et al.* (2022) showed that video content significantly influenced people's taste sensations and emotions. Compared to the video-only condition, when people watched a mukbang video (white rice with spicy chicken curry) with sound, they perceived the taste of spiciness. Thus, the consumption context should also be considered in the context of marketing as it may influence consumers' drinking behaviour.

Thus, the following hypotheses were proposed:

Hypothesis 2a–g. When the three glass (tapered, straight-sided and curved) of orange juice are presented in the 'nature' and 'urban' conditions to participants, the shape/type of glass will have a significant effects on aroma (a), flavour intensity (b), sweetness (c), freshness (d), fruitiness (e), pleasantness (f) and purchase intention (g).

Hypothesis 3a–g. When the three glass (tapered, straight-sided, curved) of orange juice are presented in the 'nature' and 'urban' audiovisual conditions to the same group of participants, the two types of background will exert a significant effect on aroma (a), flavour intensity (b), sweetness (c), freshness (d), fruitiness (e), pleasantness (f) and purchase intent (g).

Hypothesis 4a–g. When the three glass (tapered, straight-sided, curved) of orange juice are presented in the 'nature' and 'urban' conditions to the same group of participants, the three shapes of glasses and two conditions will exert significant interaction effects on aroma (a), flavour intensity (b), sweetness (c), freshness (d), fruitiness (e), pleasantness (f) and purchase intention (g).

3. Study 1

The primary goal of Study 1 was to provide evidence relevant to assessing Hypothesis 1a–g that the shape of the glass in which a sample of orange juice is served may affect consumers' perception, pleasantness and willingness to pay for the beverage.

3.1. *Methods and Materials*

Seventy-eight participants took part in Study 1 (mean age = 23.1 years, SD = 1.39, ranging from 20 to 26 years; females = 48). In the first period of this experiment, there were 30 participants (mean age = 22.5 years, SD = 1.36, ranging from 20 to 24 years; females = 18) who took part in this study. In order to test the reliability of the experiment, we collected another 48 participants (mean age = 23.4 years, SD = 1.32, ranging from 20 to 26 years; females = 30). The participants received a bottle of juice in return for taking part in the study. The experiment was approved by the ethics committee of the University (ethics number: EST2023019). The procedures used in this study adhere to the tenets of the Declaration of Helsinki. Testing was conducted in a clean and quiet room in a relaxed environment. Before the experiment, participants who were not allergic or uncomfortable (e.g., because they were suffering from a canker sore, toothache, etc.) with the smell and taste of juice and drinking, would be invited to take part in the experiment. All of the participants were naive as to the purpose of the study and signed the consent form prior to taking part.

Huiyuan Orange Juice contains 100% orange juice (Huiyuan Juice Group Cooperation), no preservatives, colouring or artificial flavouring. The juice was stored in a fridge at a temperature of 3–6°C before being served to participants who were given no information concerning what it was that they might be tasting.

Three differently shaped glasses were chosen for use in this study (see Figure 1). The Pilsner glass (a) had tapered sides (height: 17.0 cm; diameter of opening: 7.5 cm; 315 ml). The Collins glass (b) had straight sides (height: 15.8 cm; diameter of opening: 6.3 cm; 315 ml). The Weizen glass (c) had curved sides (height: 17.0 cm; diameter of opening: 6.3 cm; 285 ml). The juices were clearly visible through the transparent glass.

3.2. *Design and Procedure*

Perception was assessed in terms of the 'intensity of aroma', 'flavour intensity', 'sweetness', 'freshness' and 'fruitiness'. The consumption experience was also measured in terms of the 'pleasantness' of the experience and participants' 'willingness to pay' (e.g., "How much would you be willing to pay for two-thirds of a glass of orange juice similar to the one you tasted from?").

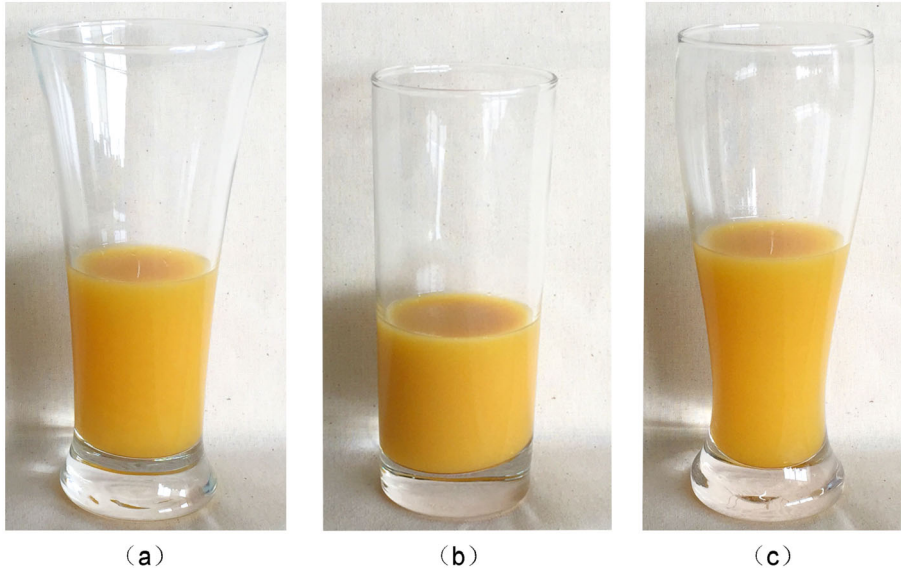


Figure 1. The three different glasses filled with 100 ml orange juice: (a) Pilsner; (b) Collins; and (c) Weizen.

The three glasses were presented to participants in a random order. The participants were asked to taste the juice from each glass and rate its aroma (a), flavour intensity (b), sweetness (c), freshness (d), fruitiness (e), pleasantness (f) and their willingness to pay (g). The variables (from ‘a’ to ‘f’) were measured with possible responses ranging from ‘1 = not at all’ to ‘7 = extremely’. Prior to the study, the participants were not informed that the same orange juice would be served in all three glasses.

The experiment was conducted at Donghua University. Before the experiment, the participants were asked if they were allergic or uncomfortable with drinking a juice or beverage. Those who confirmed that they were not then proceeded on to the main experiment. The participants were told to come to the lab ten minutes early so that they could relax and feel comfortable in the experimental setting. They were informed to smell the beverage, then taste and rate it. Each participant completed the experiment individually. During the study, a cup of water was provided for participants to cleanse their palate.

The study was conducted with the participants seated in a quiet room at 20°C. Each glass was filled with 100 ml of orange juice. The orange juice had been kept in the refrigerator for more than 24 h. The glasses were kept in the room with a temperature of 20°C. The glass and questionnaire were provided to the participant by the experimenter. Once one condition had been completed, the next glass of orange juice and questionnaire were provided. The

Table 1.

Results of the repeated-measures ANOVAs conducted on each of the seven dependent variables assessed in Experiment 1

Variable	Mean			SE			F	Partial eta squared	Sig.
	Pilsner	Collins	Weizen	Pilsner	Collins	Weizen			
Aroma	3.60	3.64	3.88	0.16	0.14	0.13	1.12	0.01	0.33
Flavour intensity	4.36	4.06	4.31	0.15	0.16	0.15	1.10	0.01	0.34
Sweetness	3.15	3.77	4.10	0.14	0.16	0.17	9.46	0.08	<0.001*
Freshness	4.03	3.97	4.45	0.15	0.15	0.14	3.10	0.03	0.05
Fruitiness	4.54	4.24	4.58	0.14	0.13	0.15	1.63	0.01	0.20
Pleasantness	3.78	3.96	4.54	0.16	0.16	0.16	6.23	0.05	0.002*
Willingness to pay	8.56	7.92	9.22	0.70	0.49	0.58	1.20	0.01	0.30

Note. *, $p < 0.007$.

participants were asked to drink some water to cleanse their palate after tasting the glass of orange juice provided. After the experiment, the three glasses were rinsed in hot water, disinfected with 70% alcohol and paper-dried. They were then kept in the refrigerator ready for the next participant. The experiment took less than 15 min to complete.

3.3. Analysis and Results

One-way Analysis of Variance (ANOVA) was performed on each of the seven dependent variables for each of the three glasses (see Table 1). The seven hypotheses were tested. Bonferroni correction was adopted so as to reduce the likelihood of Type I error. The new alpha value was 0.007. Thus, the results should be regarded as significant when $p < 0.007$. Meanwhile, a *post-hoc* test was adopted to analyse the differences in mean values between the glass shapes (see Table 2). Analysis of the results revealed that glass shape exerted a significant effect on ‘sweetness’ ratings ($F = 9.46, p < 0.001, \eta_p^2 = 0.08$), thus corroborating H1c. In particular, the orange juice tasted from the Weizen glass ($M = 4.10$) was rated as tasting sweeter than the same juice sampled from either the Collins ($M = 3.97$) or Pilsner glasses ($M = 3.77$). There was also a significant effect of glass shape on ‘pleasantness’ ratings ($F = 6.23, p = 0.002, \eta_p^2 = 0.05$), thus providing limited empirical support for H1f. The juice served in the curved Weizen glass ($M = 4.54$) was rated as tasting more pleasant than when the same juice was served in either the straight-sided Collins glass ($M = 3.96$) or tapered-sided Pilsner glass ($M = 3.78$). None of the other ratings was significantly affected by the shape/type of glass.

Table 2.Results of *post-hoc* test in Experiment 1

Variable	Glass shape (I)	Glass shape (J)	Mean (I – J)	Sig.
Sweetness	Pilsner	Collins	–0.6154*	0.018
		Weizen	–0.9487***	<0.001
	Collins	Pilsner	0.6154*	0.018
		Weizen	–0.3333	0.400
	Weizen	Pilsner	0.9487***	<0.001
		Collins	0.3333	0.400
Pleasantness	Pilsner	Collins	–0.1795	1.000
		Weizen	–0.7564***	0.003
	Collins	Pilsner	0.1795	1.000
		Weizen	–0.5769*	0.032
	Weizen	Pilsner	0.7564***	0.003
		Collins	0.5769*	0.032

Note. ***, $p < 0.01$; *, $p < 0.10$.

3.4. Discussion

This study demonstrates a significant effect of glassware on ratings of orange juice under relatively austere laboratory conditions. The results of Experiment 1 provide evidence that the shape/type of glass can significantly affect people's perception of the sweetness of orange juice (thus supporting H1c). This result is consistent with previous findings showing that the shape of the cup can exert a significant influence over people's perception of the taste of coffee (e.g., see Carvalho and Spence, 2018). Elsewhere, Van Rompay *et al.* (2017) reported that the round surface pattern on 3D-printed cups increased the perceived sweetness and reduced the perceived intensity when participants tasted a hot coffee or hot chocolate beverage.

In the present study, the perceived pleasantness of the orange juice was affected by the shape of the glassware (H1f is supported), with the orange juice evaluated in the curved glass being rated as more pleasant than when served in the straight-sided or tapered glass. These results are in line with previous findings from Cavazzana *et al.* (2017). The latter researchers demonstrated sensory interactions between the shape of the glass and ratings of the drink's smell and taste. These researchers also found that the perceived pleasantness of cola was affected by the shape of the glass.

4. Study 2

In Study 2, we went on to examine whether similar results would be obtained under those conditions in which a specific dynamic audiovisual context/atmosphere was introduced to the testing scenario. To that end, the participants once

again tasted orange juice from the same set of three glasses but now under one of two digitally rendered conditions, one designed to capture an urban environment and the other designed to imitate a nature environment.

4.1. *Methods and Materials*

The experiment call (for those participants who were not allergic to any drink or beverage) was announced on a public notice board at the university. The participants were informed of the purpose of the study. The experiment was approved by the university's ethics committee. A convenience sample of 76 participants (mean age = 22.2 years, SD = 1.51, ranging from 19 to 25 years; 58 females) took part in Study 2. First, we collected 56 participants (mean age = 21.93 years, SD = 1.5, ranging from 19 to 25 years; females = 40). Then, another 20 participants were collected (mean age = 23 years, SD = 1.32, ranging from 20 to 25 years; females = 18). Before the experiment, the participants completed a questionnaire to make sure that they did not have any potential visual, haptic, auditory, or gustatory sensory dysfunction by self-report. The participants were instructed not to consume any food or drink for at least an hour prior to taking part in the study. Before the experiment, the participants were informed that they would smell and taste several juice samples, then rate them *via* a questionnaire.

In each block, the participants tasted the orange juice in two conditions: (a) nature condition: plants with chirping and birdsong; (b) urban condition: skyscrapers with anthropocene traffic noise (see Figure 2). The nature image (size 2560 pixels × 1600 pixels) was retrieved from VCG.com (<https://www.vcg.com/creative/816892313>); the nature soundscape was retrieved from NetEase Cloud Music (<https://music.163.com/#/song?id=1368600695>). The urban image (size 2560 pixels × 1600 pixels) was retrieved from VCG.com (<https://www.vcg.com/creative/1395636772>); the urban soundscape was retrieved from NetEase Cloud Music (<https://music.163.com/#/song?id=1923780649>). The environmental images were shown on the screen of a MacBook Pro with a 13.3-inch (2560 pixels × 1600 pixels) display. The music was presented from the MacBook to the participants at the same volume (70%) and normal speed. Printed questionnaires were presented to the participants in each of the two experimental blocks.

4.2. *Design and Procedure*

The sole change from the first study was that an image was presented on the screen with an accompanying auditory soundscape (to provide context) while the participants tasted the juice samples (cf. Sester *et al.*, 2013). The music was played with the atmospheric context (nature, urban) in the same experiment room. The participants were asked to evaluate the six conditions in one session. A five-minutes rest period was provided between the two sessions.



Figure 2. The nature condition (A), urban condition (B) and testing tool (C) used in Experiment 2.

4.3. Analysis and Results

The three glass shapes were each presented in both the nature and urban conditions. Separate Glass (3 levels; Pilsner, Collins, Weizen) \times Atmospheric Context (2 levels; nature vs urban) MANOVAs were performed on each of the seven rating scales. The interaction effects between three glass shapes and the two conditions were analysed (see Table 3). Data analysis was performed using SPSS Statistics version 23.0. Given that fourteen hypotheses were tested, Bonferroni correction was adopted to adjust the results and reduce the likelihood of Type I error. The new alpha value was 0.004. Thus, the result would be regarded as significant when $p < 0.004$.

Ratings of the aroma ($F = 7.907$, $\eta^2 = 0.034$, $p < 0.001$), flavour intensity ($F = 15.363$, $\eta^2 = 0.064$, $p < 0.001$), sweetness ($F = 19.459$, $\eta^2 = 0.080$, $p < 0.001$), freshness ($F = 24.712$, $\eta^2 = 0.099$, $p < 0.001$), fruitiness ($F = 36.577$, $\eta^2 = 0.140$, $p < 0.001$), pleasantness ($F = 30.608$, $\eta^2 = 0.120$, $p < 0.001$) and purchase intent ($F = 33.589$, $\eta^2 = 0.130$, $p < 0.001$) were all significantly affected by the shape/type of glass in both the nature and urban conditions (see Table 3), thus supporting H2a–f.

Additionally, ratings of the aroma ($F = 16.574$, $\eta^2 = 0.036$, $p < 0.001$), flavour intensity ($F = 21.580$, $\eta^2 = 0.046$, $p < 0.001$), sweetness ($F = 15.082$, $\eta^2 = 0.032$, $p < 0.001$), freshness ($F = 91.750$, $\eta^2 = 0.169$, $p < 0.001$), fruitiness ($F = 35.365$, $\eta^2 = 0.073$, $p < 0.001$) and pleasantness

Table 3.
Interaction effect between condition and glass shape in Experiment 2

Variable	Glass shape			Condition			Glass shape * condition		
	<i>F</i>	Sig.	Partial eta squared	<i>F</i>	Sig.	Partial eta squared	<i>F</i>	Sig.	Partial eta squared
Aroma	7.907	<0.001	0.034	16.574	<0.001	0.036	4.222	0.015*	0.018
Flavour intensity	15.363	<0.001	0.064	21.580	<0.001	0.046	4.178	0.016*	0.018
Sweetness	19.459	<0.001	0.080	15.082	<0.001	0.032	0.138	0.871	0.001
Freshness	24.712	<0.001	0.099	91.750	<0.001	0.169	0.227	0.797	0.001
Fruitiness	36.577	<0.001	0.140	35.365	<0.001	0.073	2.012	0.135	0.009
Pleasantness	30.608	<0.001	0.120	34.514	<0.001	0.071	3.282	0.038*	0.014
Purchase intention	33.589	<0.001	0.130	2.021	0.156	0.004	1.703	0.183	0.008

Note. *, $p < 0.05$.

Table 4.
Effect between condition and glass shape in Experiment 2

Variable	Nature condition			Urban condition			<i>F</i>	η^2	<i>p</i> value
	Pilsner	Collins	Weizen	Pilsner	Collins	Weizen			
Aroma	4.28	4.54	5.28	4.00	4.30	4.24	4.222	0.018	0.015
Flavour intensity	4.03	3.62	4.42	4.11	4.51	5.13	4.178	0.018	0.016
Sweetness	4.68	3.71	4.36	5.09	4.26	4.79	0.138	0.001	0.871
Freshness	5.61	4.92	4.63	4.49	3.95	3.67	0.227	0.001	0.797
Fruitiness	5.07	4.64	5.47	4.38	3.83	5.14	2.012	0.009	0.135
Pleasantness	5.03	4.74	5.70	4.76	3.80	4.95	3.282	0.014	0.038
Purchase intent	4.71	4.13	5.39	4.84	3.88	5.00	1.703	0.008	0.183

($F = 34.514$, $\eta^2 = 0.071$, $p < 0.001$) were all significantly affected by the experimental condition (see Table 3), thus supporting H3a–g. Purchase intent ($p = 0.156$) was not affected significantly in the two conditions. Thus, H3g was not supported. Further, ratings of the three glass shapes in the two conditions were tested (see Table 4). In the nature condition, a Weizen glass was rated significantly higher in terms of perceived aroma ($M = 5.28$), flavour intensity ($M = 4.42$) and pleasantness ($M = 5.70$) than a Pilsner glass and a Collins glass in the nature condition. A Collins glass ($M = 4.30$) was rated significantly higher on perceived aroma than a Pilsner glass ($M = 4.00$) and a Weizen glass ($M = 4.24$) in the urban condition, while orange juice served

Table 5.

The differences in ratings of nature and urban conditions obtained by means of *t* tests, with the comparison of two conditions (nature vs urban) in Experiment 2

Variable	Condition	Mean (SE)	Levene's test for equality of variances		<i>t</i>	Sig. (<i>p</i>)
			<i>F</i>	Sig.		
Aroma	Nature	4.70 (0.093)	0.11	0.736	3.98	<0.001
	Urban	4.18 (0.091)				
Flavour intensity	Nature	4.02 (0.092)	0.11	0.738	−4.48	<0.001
	Urban	4.58 (0.085)				
Sweetness	Nature	4.25 (0.088)	0.00	0.991	−3.74	<0.001
	Urban	4.71 (0.088)				
Freshness	Nature	5.05 (0.076)	1.90	0.168	9.13	<0.001
	Urban	4.04 (0.081)				
Fruitiness	Nature	5.06 (0.080)	0.33	0.567	5.52	<0.001
	Urban	4.45 (0.076)				
Pleasantness	Nature	5.15 (0.080)	3.59	0.059	5.50	<0.001
	Urban	4.50 (0.086)				
Purchase intent	Nature	4.75 (0.096)	2.69	0.102	1.33	0.185
	Urban	4.57 (0.086)				

from a Weizen glass was rated as having a significantly higher flavour intensity ($M = 5.13$) and pleasantness ($M = 4.95$) than when the same juice was served from a Pilsner glass or a Collins glass in the simulated urban condition.

An independent samples *t* test was performed for both conditions (nature, urban) and the results are shown in Table 5. The results of seven Levene's tests were supported ($p > 0.05$), indicating the homogeneity of variance. The results revealed that aroma, freshness, fruitiness and pleasantness were rated significantly higher in the nature condition than in the urban condition. On the other hand, flavour intensity and sweetness were rated significantly higher in the urban condition compared to the nature condition.

The interaction results of glass shapes and two different conditions are presented in Table 3. The results show that there were significant interaction effects between glass shapes and conditions (nature and urban) on aroma ($F = 4.222$, $\eta^2 = 0.018$, $p = 0.015$), flavour intensity ($F = 4.178$, $\eta^2 = 0.018$, $p = 0.016$) and pleasantness ($F = 3.28$, $\eta^2 = 0.014$, $p = 0.038$). Thus, H4a, H4b and H4f were supported. There was no significant interaction effect between glass shapes and the conditions on sweetness ($p = 0.871$), freshness ($p = 0.797$), fruitiness ($p = 0.135$) and purchase intention ($p = 0.183$). H4c, H4d and H4e were not supported.

The results of Experiment 2 demonstrate that providing an audiovisual condition (nature vs urban) to tasting resulted in a significant influence of

glass shapes on participants' ratings of the aroma, flavour intensity, sweetness, freshness, fruitiness and pleasantness of the orange juice samples they were tasting.

4.4. Discussion

The results of the two studies reported here clearly demonstrate that people's ratings of orange juice can be affected by the shape/type of glassware in which it happens to be presented. In particular, under the simulated audiovisual contextual conditions (nature and urban) of Experiment 2, ratings of the aroma, flavour intensity, sweetness, freshness, fruitiness, pleasantness ratings and purchase intent for the orange juice samples were all affected by the shape of the glass in which it was served. It has long been known that ambient stimulation (e.g., soundscape, lighting, background noise) can influence consumers' product selection, purchase behaviour and taste/flavour perception (e.g., Biswas *et al.*, 2019; Bschaden *et al.*, 2020; Ikeda *et al.*, 2023; Istiani *et al.*, 2022; Spence, 2017; Velasco *et al.*, 2016). Ambient sound and music impact people's taste experiences and their mood (Krishna, 2012; Krishna and Elder, 2021; Spence *et al.*, 2019, for a review). Sweetness and pleasantness were the attributes/ratings that were most consistently affected by the shape (and/or type) of glass in Studies 1 and 2.

Additionally, perceived aroma, freshness, fruitiness and pleasantness were rated significantly higher in the nature condition than in the urban condition. Participants' ratings of the aroma, flavour intensity and pleasantness of orange juice in the nature and urban conditions were influenced by the shape of glassware, thus going beyond the findings of Study 1. These gastrophysics findings (cf. Spence, 2017) therefore help to further our growing understanding of the influence of the type and shape properties of drinking receptacles on people's perception of the contents.

5. General Discussion

The results of Study 1 revealed that the Weizen glass resulted in higher ratings of the sweetness and perceived pleasantness of the orange juice than either the Pilsner or the Collins glass. This finding is consistent with previous findings from Liang *et al.* (2013). The latter researchers reported that sensitivity to sweetness tends to be strongly associated with rounder forms and higher hedonic scores, whereas bitter tastes tend to be associated with angular shapes instead. In Study 1, no significant effect of glass shape was observed for aroma, flavour intensity, freshness, fruitiness or willingness to pay. Study 1 revealed a borderline-significant trend towards participants rating the orange juice as tasting more pleasant when served in the curved-sided Weizen glass and as less pleasant when served in the Pilsner glass. The higher

pleasantness ratings for the orange juice presented in the curved-sided glass aligns with previous findings suggesting that consumers prefer to drink beverages from rounder containers (Salgado-Montejo *et al.*, 2015). Curved shapes tend to increase perceived sweetness and this can potentially result in the consumer deriving more pleasure from a drinking experience (Machiels, 2018). In another study, researchers found that consumers' emotions were affected by the shape of the drinking vessel (Cavazzana *et al.*, 2017). Such findings indicate that the shape of the glass can influence consumers' ratings of the pleasantness and perception of the taste of a drink.

Study 2 assessed the impact of glass shape on people's perception of orange juice in two audiovisual environments, one associated with nature and the other with an urban setting. Our findings are consistent with previous findings from Petit and Sieffermann (2007), as well as those reported by Xu *et al.* (2019). Both groups of researchers found that background colour impacts food perception, consumers' feelings and also their actual consumption behaviour. The analyses reported here demonstrate that the way in which glass shape affects people's perception and pleasantness is also influenced by the consumption environment. Furthermore, the interaction effect of perceived aroma, flavour intensity and pleasantness of the orange juice were significant in both the nature and urban conditions when it was served in the different shapes/types of glass. Additionally, it is worth noting that the findings from Study 2 revealed that perceived aroma, flavour intensity, sweetness, freshness, fruitiness and pleasantness were all influenced by the glass shapes in the two conditions.

The majority of studies to date on glass shape have been conducted in the setting of the (food) science laboratory (see Spence and Wan, 2015, for a review). The effect of glass shape on the consumers' perception of beverages still needs further research under a range of more ecologically valid multisensory conditions (cf. Sester *et al.*, 2013), given that certain glass shapes may be deemed more appropriate for specific environmental contexts (e.g., service providers could offer orange juice in a Weizen glass for consumers drinking orange juice in a natural environment, such as a beer garden, as this may enhance the pleasantness that the customer experiences; consumers would perceive orange juice as being more aromatic when drinking from a Collins glass in an urban environment, such as one showing skyscrapers). In this study, the impact of three different glass shapes was studied under digitally rendered naturalistic and urban conditions. The findings reported here may be taken to suggest that beverage marketers should consider providing/displaying juice in a Weizen-style glass in order to maximise consumers' pleasure and consumption. Consumers appear to enjoy drinking orange juice in a curved-sided glass more than in a straight or tapered glass.

Taken together, therefore, the findings reported here provide support for the importance of considering the shape of the drinking vessel (or container) in those consumption conditions in which one wants to improve consumers' positive emotion or sell more orange juice. Across both studies, the participants' ratings of the orange juice samples were influenced by the shape of the glass. The type of glassware had significant effects on taste ratings and pleasantness in both the naturalistic and urban conditions (of Study 2). With the multisensory atmospheric/contextual stimuli presented in Study 2, the glass shapes significantly affected consumers' ratings even though they were actually drinking the same orange juice. The results reported here suggest that the ratings on three glass shapes differ significantly as a function of whether one is in (simulated digital) nature or urban conditions. As expected, the digitally rendered multisensory environments influenced participants' ratings of the orange juice. These results also suggest that nature and urban environment can both positively affect consumers' perception and emotions (Istiani *et al.*, 2023b; Juntti and Ozsezer-Kurnuc, 2023; Ulrich, 2002). In particular, the shape (or type) of glass in which orange juice is served can significantly influence the perceived aroma, flavour intensity and pleasantness in different conditions, when people were simultaneously stimulated by dynamic audiovisual stimuli. As such, designers, manufacturers and juice sellers should all consider the shape of the glasses and juices which are provided to consumers.

5.1. Research Contribution, Limitations and Future Directions

The main aim of this study was to explore people's perception, emotion and willingness to buy orange juice served in a small selection of different glass shapes. The results revealed that glass shape influenced the perceived sweetness and pleasantness of orange juice. Additionally, the results also demonstrate that the perceived aroma, flavour intensity and pleasantness were influenced by the glass shape under both naturalistic and urban settings. Therefore, based on the findings of the present study, bar workers and restaurateurs should provide orange juice in glasses with a round shape as it influences perceived sweetness and pleasantness. The drinking environment should be considered by service providers, as the feature of the condition would affect people's perception and pleasantness. It is worth mentioning that this study was focussed on studying the influence of glass shape (type) on people's perception of orange juice under a range of different conditions. The findings suggest that

perception and emotion should be explored in different conditions. In other words, different shapes of containers can provide different stimuli to people.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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