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Article

Assessing the Influence of the Multisensory Atmosphere on the Taste of Vodka

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Abstract: A preliminary study designed to assess the impact of the multisensory atmosphere (involving variations in lighting and music) on people's rating of unflavoured and flavoured (citron and raspberry) vodkas is reported. The auditory and visual attributes of the environment were changed as people tasted, and then rated, four unlabelled glasses of vodka (two unflavoured samples, one sample of citron-flavoured and one sample of raspberry-flavoured vodka). Due to the public nature of the event, all participants experienced the same order of auditory and visual changes at the same time. For flavoured vodkas, we saw significant correlations between atmosphere-vodka matching and both liking and fruitiness, and this was reinforced by results showing that those participants who tasted the vodkas in congruent atmospheric conditions (raspberry vodka in red lighting and sweet music, citron vodka in green lighting and sour music) gave significantly higher ratings of liking and fruitiness than did those participants who tasted the vodkas in atmospheric conditions that were incongruent. Specifically, the participants liked the raspberry-flavoured vodka significantly more, and rated it as tasting significantly fruitier, under red lighting while listening to sweet music as compared to under green lighting and listening to sour music. Meanwhile, the unflavoured vodka was liked less under green lighting while listening to the putatively sour music than under white lighting and no music. These results demonstrate how the multisensory attributes of the environment impact on people's experience of both unflavoured and flavoured vodkas, even when they are not given any information about what they are tasting. Some of the real-world implications for bars (*i.e.*, the "on trade"), experiential events, and other beverage businesses are discussed.

Keywords: multisensory atmospherics; lighting; music; taste; crossmodal correspondences

1. Introduction

Several recent studies have demonstrated that the multisensory atmosphere in which people taste (and rate) a variety of alcoholic drinks can influence their experience of taste/flavour, and how much they enjoy the overall drinking experience (e.g., Sester *et al.*, 2013 [1]; Spence *et al.*, 2013 [2]; Spence *et al.*, 2014 [3]; Stafford *et al.*, 2012 [4], 2013 [5]; Velasco *et al.*, 2013 [6]; see Spence and Piqueras-Fiszman, 2014 [7], for a review).

For instance, in a whisky tasting experiment conducted by Velasco *et al.* (2013) [6], almost 500 participants were given a glass of whisky to rate under three different multisensory atmospheres designed to invoke grassiness, sweetness, and woodiness. Each room comprised specific visual stimuli, a distinctive fragrance, and a purpose-designed soundscape in order to enhance a particular sensory attribute. Intriguingly, the same whisky was rated by participants as tasting significantly more "grassy" in the grassy room, significantly sweeter in the putatively sweet room, and was rated as significantly more woody in the woody room. The changes in participants' ratings were in the region of 10%–20%.

In another study of the role of the multisensory atmosphere, Sester *et al.* (2013) [1] demonstrated in an immersive bar-like setting that the ambience of a bar (which varied in terms of the background music and video that was playing silently in the background) could significantly affect participants' choice of drink order, with the perceived warmth and colour of the room being the two most important factors (less important factors included furniture style and semantic associations between the videos, music and the names of the drinks).

Meanwhile, in a study that focused on the real-life scenarios involving alcohol consumption, Stafford *et al.* (2012 [4], 2013 [5]) assessed the effect of auditory distraction on the perception of alcohol. The distraction conditions consisted of music, shadowing (listening to, and repeating, news stories), and music plus shadowing; the participants in these studies were asked to taste a series of vodka-juice mixtures of different concentrations. The results revealed that the music plus shadowing condition gave rise to impaired discrimination of the strength of an alcoholic drink. Intriguingly, however, the loudness of the auditory distraction (80 dB for the low volume condition and 100 dB for the high volume condition) did not significantly change the degree of impairment (Stafford *et al.*, 2013 [5]; see also Spence, 2014 [8]).

Meanwhile, in a large-scale wine tasting experiential event held recently in London, almost 3000 participants were given a glass of red wine to taste under different combinations of lighting and music (Spence *et al.*, 2014 [3]). In particular, the participants had to rate a red wine (served in a black tasting grass) while in a windowless room with regular white lighting, and then in a subset of conditions involving red lighting, green lighting, red light and sweet music, and green lighting with sour music (the sweet and sour music was taken from a recent study by Knoeferle *et al.*, 2015 [9]). Overall, the wine was rated as tasting fresher and less intense under green ambient lighting than in any of the other conditions. By contrast, the red lighting brought out the fruity notes in the wine (*cf.* Oberfeld *et al.*, 2009 [10]). On average, the participants liked the wine more while drinking under red lighting and listening to sweet music. These results, demonstrating the impact of lighting and music/soundscapes on people's (social drinkers) ratings of a variety of different alcoholic drinks (whisky and wine), mirror the findings reported with various different foods/meal settings (see Wansink and van Ittersum, 2012 [11]; and see Spence and Piqueras-Fiszman, 2014 [7], for a review).

In the present study, we wanted to investigate the effect of various combinations of ambient lighting and music on people's liking and taste ratings of both unflavoured and flavoured vodkas. Crucially, in contrast to the previous large-scale participatory studies (e.g., Spence *et al.*, 2014 [3]; Velasco *et al.* 2013 [6]) in which the participants in the main experiments knew all along that they were actually rating the same drink in different environments during the course of the study, here the participants were given four separate glasses of vodka to taste. Unbeknownst to the participants, three different vodkas were presented during the course of the study. For each sample, participants rated the drink in terms of how well it matched the multisensory environment, as well as rating it on response scales anchored with dislike-like, fresh-fruity, and angular and rounded shapes (*cf.* Velasco *et al.*, 2015 [12]). The liking scale was chosen because we were interested in improving the overall drinking experience by means of the design of targeted multisensory atmospherics. The fresh-fruity scale was chosen because the study involved fruit-flavoured vodkas, and it has been shown that fresh/fruity captures two distinct features in wine (Spence *et al.*, 2014 [3]). The shape symbolism scale, shown as shapes, was included in order to assess whether environmental conditions would influence participants' higher-level evaluation of the drinks provided.

Spence and Gallace (2011) [13] examined the connection between shape symbolism and food by having their participants rate the tastes of a variety of foods on scales anchored by pairs of pseudo-words and by pairs of rounded and angular shapes (see Figure 1 for an example). Spence and Gallace's participants consistently associated certain foods (for example, a ripe brie cheese and still water) with rounded shapes and soft-sounding words, and other items (for example, cranberry juice and sparkling water) with angular shapes and sharp-sounding words instead. Interestingly, these associations were not simply driven by the usual shapes that the tasted food items might take. In a study involving cheese tasting, Spence *et al.* (2013) [14] found that taste had the most impact on the overall shape association of the food item, compared to smell and texture. Recently, Velasco *et al.* (2015) [12] reported that when participants were asked to rate actual tastants on a shape symbolism scale, there was a significant correlation between taste liking and the roundness/angularity of the shape that was chosen (specifically, higher liking was correlated with more rounded shapes). Therefore, the possibility should be borne in mind that the shape symbolism scale may, at least in part, act as a non-verbal liking scale.

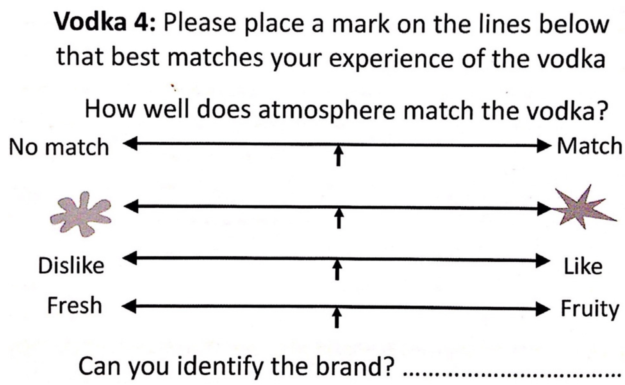


Figure 1. A sample questionnaire given to the participants in the present study.

In the present study, the atmospheric conditions were quite similar to those used by Spence *et al.* (2014) [3]. The unflavoured vodka was tasted initially under a baseline white light condition, and was tasted again at the end under a green light, sour music, and lime picture condition (without the participants being informed that it was the same vodka). The expectation was that the unflavoured vodka would be rated differently in the green light and sour music condition, as compared to the baseline white light condition. In-between, the participants tasted two fruit-flavoured vodkas under red lighting plus sweet music followed by green lighting plus sour music. The participants were divided into two groups such that we could collect data about both fruit flavours under both atmospheric conditions. We hypothesised that the red light and sweet music condition would be liked more than the green light and sour music condition, and that participants would associate the red lighting with more fruitiness and the green lighting with more freshness.

2. Methods

2.1. Participants

Sixty seven participants (19 women, 40 men, 8 who failed to specify) aged between 23 and 70 years (M = 38.25, SD = 9.18) took part in the study. The experiment was conducted as part of a talk on multisensory flavour perception given by the second author at the Spirits Summit event held in Shoreditch, London in November, 2014. Because the experiment was conducted at a public event, the participants did not sign a standard consent form; however, the purpose of the experiment and procedure was clearly explained. The participants were also informed that they did not need to complete the questionnaire should they not want to, and that they could stop responding at any stage. The theme of the day was enhancing the drinks experience. The experiment was approved by the Central University Research Ethics Committee of Oxford University and complied with the Helsinki Declaration.

2.2. Beverage Stimuli

Four 10 mL samples of vodka were prepared for each participant. Unflavoured Absolut vodka was used in Conditions 1 and 4, whereas Absolut raspberry and citron vodkas were used for Conditions 2 and 3. The order in which the participants received the raspberry and citron-flavoured vodkas was counterbalanced across participants. All of the participants sitting on the left side of the auditorium were given raspberry vodka for Condition 2 and citron vodka for Condition 3. All of the participants sitting on the right side of the auditorium experienced the reverse pairing. They were given no information about whether they would be given the same vodka to taste or not. The participants were not informed that flavoured vodkas might be provided either. Note that, given the public nature of the talk in which the study was performed, and given the fact that the study was limited to one room, all of the participants experienced the four multisensory atmospheric Conditions in the same order.

2.3. Musical Stimuli

The two musical pieces used in the present study were taken from Knoeferle *et al.* (2015) [9]. In that study, participants ($N = 39$) were asked to adjust six auditory parameters of a short music piece to best match one of the four basic tastes (sweet, sour, bitter, and salty). Based on the results, musical compositions were developed to reflect those tastes. We used the sweet and sour music in the atmospheric settings outlined below.

2.4. Multisensory Atmospherics

Condition 1: The room was illuminated with standard white lighting. There was no music in this baseline condition. All of the participants were given unflavoured vodka to taste.

Condition 2: The room was illuminated by red lighting (the coloured lights were built into the room and the lighting conditions were managed from a control room). Putatively sweet music taken from Knoeferle *et al.* (2015) [9] played in the background at a pleasant listening level. Participants sitting on the left side of the auditorium were given the citron vodka to taste, while the other half were given the raspberry vodka to taste.

Condition 3: The room was illuminated by green lighting. Putatively sour music played in the background (again taken from Knoeferle *et al.*, 2015 [9]). Participants sitting on the left side of the auditorium were given raspberry vodka to taste, while the other half were given citron vodka to taste. Note that, due to this experimental setup, participants on the right side of the auditorium always experienced matching atmosphere-vodka combinations (red lighting and sweet music with raspberry vodka, green lighting and sour music with citron vodka) while the left side of the auditorium always experienced mismatching atmosphere-vodka combinations.

Condition 4: The room was illuminated by green lighting. The image of a lime was projected on the screen in front of the participants. Putatively sour music was once again played in the background. In this condition, the participants were given the same unflavoured vodka (as in Condition 1) to taste. The participants were not made aware that the vodka was the same as in Condition 1.

2.5. Procedure

All of the participants experienced the four conditions in the same order, and at the same time. However, the participants were divided into two groups for Conditions 2 and 3. In each condition, the participants were instructed to taste the vodka and then to fill out a series of rating scales on a pencil and paper questionnaire. The ratings scales included the following questions/response scales: (1) How well does the environment match the vodka? (2) A shape symbolism scale anchored with a round and an angular shape (*cf.* Velasco *et al.*, 2015 [12]); (3) How much do you like the vodka? and (4) A scale anchored with the words fresh and fruity (see Figure 1). The fresh-fruity scale was inspired by Spence *et al.*'s (2014) [3] wine study where fresh and fruity were used as two distinct descriptors for the red wine that the participants tasted (and possibly for alcoholic beverages in general-here it was extended to the case of vodka). The participants were also asked to try and guess the brand of vodka that they were tasting. The participants were instructed to mark their ratings anywhere along the scale; each scale is 100 mm in length, with a midpoint marking in the middle (see Figure 1). The entire study lasted 10 min.

3. Results

Given the public nature of the event (*i.e.*, we could not force the participants to answer all of the questions if they did not want to), certain of the questions were not answered by all of the participants (72 responses out of 67 subjects × 4 vodkas × 4 ratings per vodka, corresponding to approximately 7% of the data incomplete). Missing data were not filled in because there were no repetitions, and no reasonable values could be used as a substitute. Note therefore that the degrees of freedom fluctuate slightly between statistical tests.

Two separate analyses were conducted. First, the participants' ratings of the unflavoured vodka in Conditions 1 and 4 were compared. Separately, the participants' ratings of the flavoured vodkas in Conditions 2 and 3 were compared. Unlike with the unflavoured vodka, where all participants tasted the vodka while experiencing both conditions, none of the participants tasted the same flavoured vodka in both conditions. For each flavoured vodka, half the participants experienced the flavour under one condition, and half experienced it under the other condition.

For Conditions 1 and 4, we compared the ratings of unflavoured vodka with white lights and no music (Condition 1) to the ratings of the same vodka that were obtained under green lighting, while viewing a picture of a lime, and while listening to putatively sour music instead (Condition 4). The correlation between atmosphere-vodka match rating and shape symbolism rating (r (110) = 0.345, $p < 0.01$), between the liking rating and shape symbolism rating (r (110) = 0.374, $p < 0.01$), and between the liking rating and the fruitiness rating (r (131) = 0.175, $p < 0.05$) were all significant (all correlations reported here and henceforth calculated with Pearson's correlation). The correlation between liking and shape symbolism ratings supports the notion that the shape symbolism scale acts in part as a non-verbal liking scale.

The mean ratings for each scale are shown in Figure 2. Because the ratings were moderately correlated, a repeated measures multivariate analysis of variance (MANOVA) was used to test the effect of atmospheric conditions on vodka ratings. Four measures were assessed: atmospheric matching, liking, fruitiness, and shape symbolism. The results showed there were no significant multivariate effects on atmospheric conditions on the measures, F (4,39) = 1.421, p = 0.245, $\eta^2 = 0.127$. Within-subject univariate tests indicated there was an effect of atmospheric conditions on liking, F (1,42) = 5.824, p = 0.020, $\eta^2 = 0.122$, where vodka was liked more in the baseline white light condition than in the green light and sour music condition.

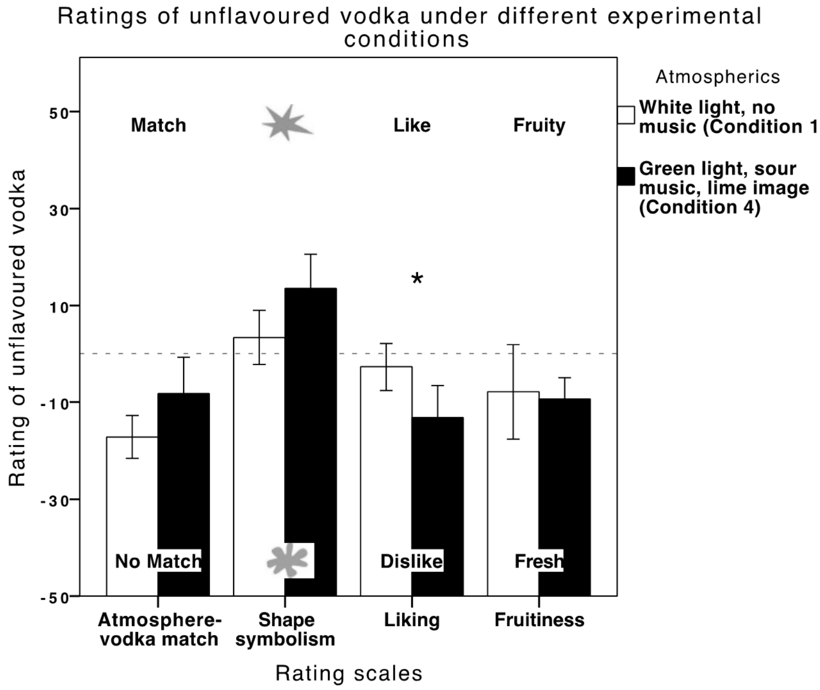
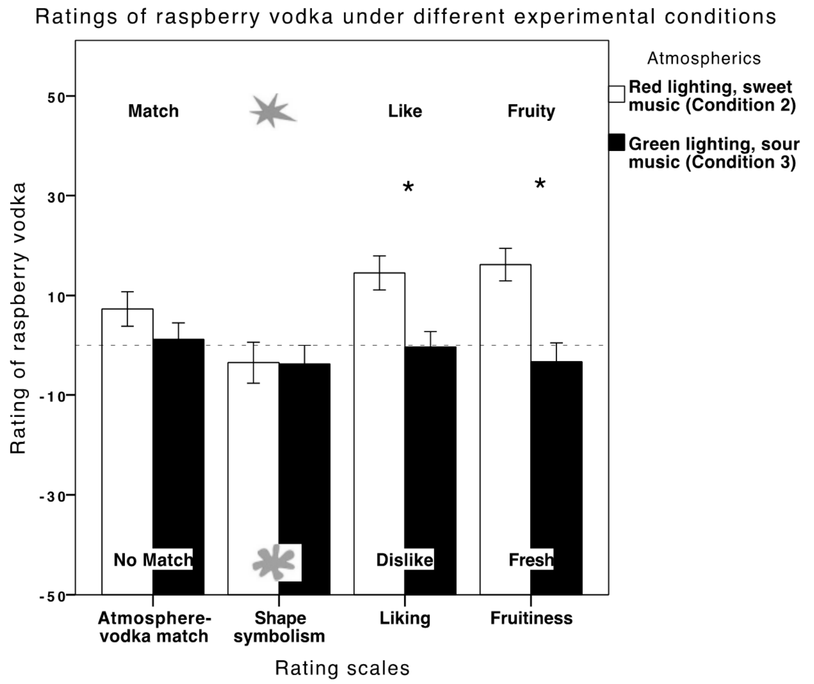


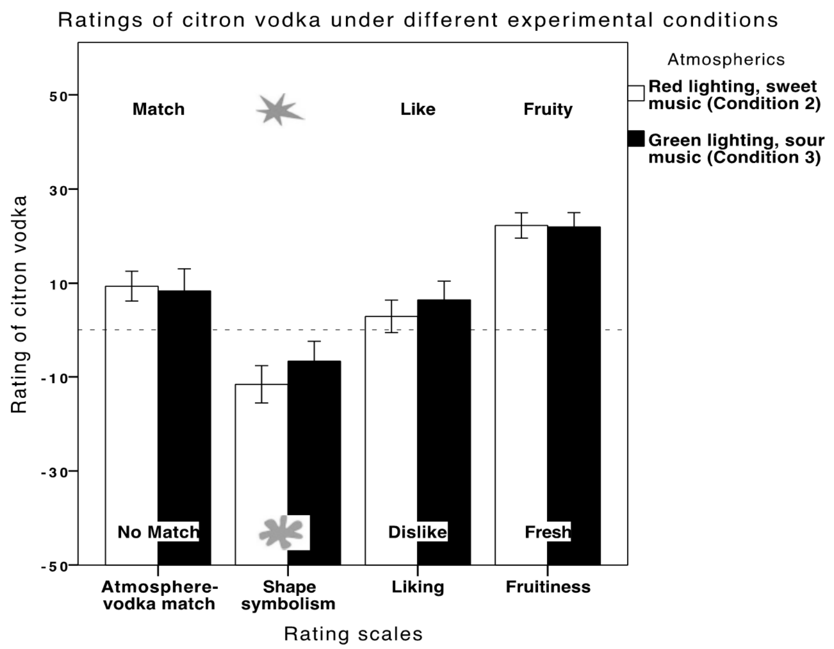
Figure 2. Participants' ratings of the unflavoured vodka under two different conditions. In Condition 1, there was standard white room lighting and no music. By contrast, in Condition 4, the ambient lighting was green, putatively sour music was played (see Knoeferle *et al.*, 2015 [9]), and the picture of a lime was projected on a large screen in front of the participants. Each scale was 100 mm long, with the 0 point corresponding to the midpoint of the scale, shown by the dashed line in the figure. The *y*-axis reflects the distance of participants' responses from the midpoint, from −50 mm to 50 mm. The asterisks highlight a significant difference between the conditions ($p < 0.05$). The error bars represent the standard error of the means.

In Conditions 2 and 3, participants' ratings of flavoured vodkas (raspberry and citron) were compared under red lighting and sweet music (Condition 2) and green lighting and sour music (Condition 3). The mean ratings for each scale are shown in Figure 3.

For the flavoured vodkas, the correlation between atmosphere-vodka match and liking ratings (r (114) = 0.340, $p < 0.0005$), between atmosphere-vodka match and fruitiness (r (114) = 0.227, $p = 0.015$), and between the fruitiness and the shape symbolism scale ratings (r (125) = 0.208, $p = 0.020$) were all significant. Notably, a positive correlation between atmospheric matching and liking was also seen in Spence *et al.*'s (2014) [15] recent study.



A



B

Figure 3. Participants' ratings of the raspberry (**A**) and citron (**B**) vodka under the different experimental conditions. In Condition 2, the ambient lighting was red and putatively sweet music was played, whereas in Condition 3, the ambient lighting was green and sour music was played (see Knoeferle *et al.*, 2015 [9]). Each scale was 100 mm long, with the 0 point corresponding to the midpoint of the scale, shown by the dashed line in the figure. The *y*-axis reflects the distance of participants' responses from the midpoint, from −50 mm to 50 mm. The asterisks highlight a significant difference between the conditions ($p < 0.05$). The error bars represent the standard error of the means.

Because the ratings were moderately correlated, we first conducted data analysis via a two-way mixed measures MANOVA, with atmospheric condition (Condition 2 or 3) as the within-participants factor and congruence (whether the atmospheric conditions matched the vodka or not[1] as the between-participants factor, for the attributes of matching, liking, shape symbolism, and fruitiness. We examined the main effects of atmospheric conditions and atmosphere-vodka congruence as well as any interaction effects between them.

We observed a significant main effect of atmosphere-vodka congruence, F (4,47) = 5.21, $p = 0.001$, $\eta^2 = 0.307$. Follow-up univariate tests revealed that both liking and fruitiness were rated significantly higher in the group who experienced congruent atmosphere-vodka matches (e.g., those who tasted raspberry vodka with red lighting and sweet music and citron vodka with green lighting and sour music) than in the group who experienced incongruent atmosphere-vodka matches (for liking, F (1,50) = 5.82, $p = 0.020$, $\eta^2 = 0.104$; for fruitiness, F (1,50) = 6.61, $p = 0.013$, $\eta^2 = 0.117$). This is in line with our correlation results earlier where atmosphere-vodka congruence was positively associated with both liking and fruitiness ratings.

A significant interaction effect was also observed between atmospheric-vodka congruence and atmospheric conditions, F (4,47) = 5.24, $p = 0.001$, $\eta^2 = 0.308$. Follow-up univariate tests showed that fruitiness was the rating giving rise to the significant interaction effect, F (1,50) = 15.65, $p < 0.0005$, $\eta^2 = 0.238$. Bonferroni-corrected pairwise comparisons indicated that fruitiness ratings in Condition 2 (green lighting and sour music) were significantly lower for the citron vodka than raspberry vodka, $p < 0.0005$.

Next, we used a one-way multivariate analysis of variance (MANOVA) to test the effect of atmospheric conditions on specific flavoured vodkas. The variables assessed were matching, liking, fruitiness, and shape symbolism. For the raspberry vodka, the differences between conditions on the combined dependent variables was statistically significant, F (4,49) = 4.842, $p = 0.002$; $\eta^2 = 0.283$). Follow-up univariate ANOVAs showed that liking (F (1,52) = 7.604, $p = 0.008$; $\eta^2 = 0.128$) and fruitiness (F (1,52) = 10.166, $p = 0.002$; $\eta^2 = 0.164$) were significantly different between atmospheric conditions. Namely, both liking and fruitiness were rated significantly higher in the red light plus sweet music condition than the green light plus sour music condition.

A similar MANOVA test was conducted as for the raspberry vodka. The differences between conditions on the combined dependent variables was not statistically significant, F (4,50) = 0.607, $p = 0.660$, $\eta^2 = 0.046$.

4. Discussion

The results of the present study clearly demonstrate that the multisensory attributes of the environment in which people taste vodka can exert a significant influence over their taste ratings. The results reported here extend previous studies (e.g., Spence *et al.*, 2014 [3]; Velasco *et al.*, 2013 [6]) while at the same time lowering the possibility of demand effects in that participants had no idea whether the drinks were the

[1] Recall that, due to this experimental setup, participants on the right side of the auditorium always experienced matching atmosphere-vodka combinations (red lighting and sweet music with raspberry vodka, green lighting and sour music with citron vodka) while the left side of the auditorium always experienced mismatching atmosphere-vodka combinations. Hence atmosphere-vodka congruence is a between-subjects variable. Vodka type is neither a between-subjects variable nor a within-subjects variable since participants only tasted each type of vodka once.

same or different across conditions. The participants in the present study liked the raspberry-flavoured vodka significantly more under the red lighting/sweet music condition than in the green lighting/sour music condition. They also reported liking the unflavoured vodka more under white light than under green light and sour music (and while the picture of a lime was projected on the screen). These results are comparable to those reported recently by Spence *et al.* (2014) [3], in a study in which the participants were introduced to similar environments (white light, red light plus sweet music, green light plus sour music) while tasting a glass of red wine; specifically, liking for the wine was significantly higher under red light and sweet music than for all other conditions, and liking for wine under the white light condition was greater than under the green light and sour music condition.

The participants rated the raspberry vodka as tasting significantly fruitier under the red light/sweet music condition than in the green light/sour music condition. To give an idea of the magnitude of the change that was observed, the average mean difference was −19.58 mm on the 100 mm rating scale, or almost 20% (Cohen's d = 1.62, *i.e.*, a large effect according to Cohen, 1988 [16]). In previous studies, an average change of 10%–15% has typically been observed (Crisinel *et al.*, 2012 [17]; Velasco *et al.*, 2013 [6]). The increased difference in ratings may be attributable to the fact that giving participants different glasses in the present study breaks the so-called "assumption of homogeneity" (Woods *et al.*, 2010 [18]) which may have served to minimise any atmospheric effects in previous whisky and wine studies (Spence *et al.*, 2014 [15], Velasco *et al.*, 2013 [6]).

Intriguingly, the observation that vodka tasted fruitier under red lighting stands in contrast to the results of a study by Oberfeld *et al.* (2009 [10], Experiment 2) in which participants drinking Riesling from opaque black glasses rated the wines to be fruitier while drinking under green light, compared to drinking under red or blue light[2]. One possible explanation (and a drawback of the present experimental design) was that participants consumed the vodkas from sequentially-presented clear plastic cups, thus different lighting conditions could possibly also have changed the apparent colour of the drinks/stimuli. For instance, red lighting might have made the drink appear a little redder; since red colouring has been shown to significantly increase the perceived sweetness of the drink (see Spence, 2015 [19]; Spence *et al.*, 2010 [20], for reviews), the participants could have increased their ratings of the drink's fruitiness as a result of perceiving the drink to be sweeter (Spence *et al.*, 2010 [20]). Another drawback of the present design (*i.e.*, a public tasting event) was that we were not able to control for the luminance of different lighting conditions because the auditorium in which the present study took place had externally controlled, pre-programmed coloured lighting. Therefore, discrepancies from the results by Oberfeld *et al.* (2009) [10] could also be attributed to differences in luminosity levels. More realistically, however, participants from Oberfeld's study could have rated Riesling, a wine often described with flavours of lime or green apples (Fielden, 2009 [21]), as more fruity under green lighting because the flavours of the wine were of green fruits. In contrast, in the present study, we found that vodka with raspberry flavouring, a red fruit, tasted more "fruity" under red lights. Therefore, it is probable that the ratings of "fruitiness" depends on the colour of the lighting and the colour of the fruits in question.

Analysis of the correlations between rating scales revealed that our participants' liking for the vodka was correlated with how well the drink matched the environment, at least for the flavoured vodkas.

[2] To be fair, Oberfeld *et al.*'s (2009) [14] Experiment 3 revealed that while there was no overall effect of lighting conditions on ratings, pairwise comparisons between red, blue, and white lighting conditions showed that Riesling tasted under red lighting was rated as more fruity than under white or blue lighting.

This result is in line with the findings reported by Spence *et al.* (2014) [15] showing that people rated wines as more enjoyable when drinking while listening to music that the participants rated as matching the wine (when compared to when tasting the wine under conditions where no music was playing). One possible explanation for the link between how well the atmosphere matches the vodka and how much people like the vodka is due to processing fluency; when the vodka matches the atmosphere, participants can more easily evaluate the sensory stimuli (the vodka in this case) and hence like it more as a result (see Labroo *et al.*, 2008 [22]; Winkielman *et al.*, 2003 [23]).

In addition, the correlation data revealed that the rounder shape was associated with the descriptor "fruity" and the more angular shape associated with the descriptor "fresh". This finding agrees with the findings from other researchers (e.g., Deroy and Valentin, 2011 [24]; Gallace *et al.*, 2011 [25]; Spence and Deroy, 2011 [26]; Velasco *et al.*, 2015 [12]) about how people tend to assign rounded shapes to foods with sweet tastes and angular shapes to foods with sour tastes (see also Spence and Deroy, 2013 [26], for a review).

One important limitation with the current study is the potential confounding effect of the order in which the various conditions were presented. For instance, reduced liking for the unflavoured vodka between Conditions 1 and 4 could simply have been attributed to repeated consumption. Similarly, the red lighting and sweet music condition could have been liked more due to novelty factors (since it was the first multisensory condition encountered by the participants).

Another limitation of the current study relates to the use of the fresh-fruity scale. The idea was taken from a study by Spence *et al.* (2014) [3], which involved red wines. For red wines, with mostly red and black fruit flavours, it is conceivable that fresh and fruity may lay on opposite ends of the spectrum. However, the current study uses vodkas (especially citron) with green fruit flavours, which could be considered to be both fresh and fruity at once! This potential ambiguity may, then, perhaps explain why we did not see significant differences in citron vodkas on the fresh-fruity scale.

One key question to emerge at this stage is whether results like those presented here are in any way relevant to real life situations? Studies that try to reproduce bar conditions (Sester *et al.*, 2013 [1]; Stafford *et al.*, 2012 [4], 2013 [5]) have already demonstrated that atmospherics can significantly impact the drinking experience. In combination with results from the current study, one can plausibly conceive of restaurant designers using lighting and music to improve the customer experience and to bring out different characteristics of the food and drink. Colourful and colour-changing backdrops is certainly a signature feature of a number of recent high-end modernist dining experiences (see Bergman, 2012 [27]; Driver, 2014 [28]; [29,30]), not to mention artistic performances (see Miller, 2015 [31]), and experiential events. And extending beyond atmospheric lighting, one could imagine how similar results might be obtained with coloured glassware (Spence and Wan, 2015 [32]) or even tablecloths. Finally, results from this study emphasises the importance of crossmodal correspondence between lighting/music and food/drinks in order to create matching atmospherics that enhance the eating/drinking experience; most importantly, the key takeaway from the current study was how participants' evaluation of congruity between the atmospheric conditions and vodkas was correlated with higher liking and fruitiness ratings (at least for flavoured vodkas, but one could argue that most drinks served at bar/restaurants are flavoured). Of particular interest for beverage establishments (and the "on trade"), increased liking often translates to greater willingness to pay (*cf.* Zeithaml, 1988 [33]).

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Author Contributions

C.S. developed the study concept and ran the study. Q. J. W. conducted data analysis. Both authors contributed to the writing of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Sester, C.; Deroy, O.; Sutan, A.; Galia, F.; Desmarchelier, J.F.; Valentin, D.; Dacremont, C. "Having a drink in a bar": An immersive approach to explore the effects of context on beverage choice. *Food Qual. Prefer.* **2013**, *28*, 23–31.
2. Spence, C.; Richards, L.; Kjellin, E.; Huhnt, A.M.; Daskal, V. Looking for crossmodal correspondences between classical music and fine wine. *Flavour **2013***, *2*, 29, doi:10.1186/2044-7248-2-29.
3. Spence, C.; Velasco, C.; Knoeferle, K. A large sample study on the influence of the multisensory environment on the wine drinking experience. *Flavour* **2014**, *3*, 8, doi:10.1186/2044-7248-3-8.
4. Stafford, L.D.; Fernandes, M.; Agobiani, E. Effects of noise and distraction on alcohol perception. *Food Qual. Prefer.* **2012**, *24*, 218–224.
5. Stafford, L.D.; Agobiani, E.; Fernandes, M. Perception of alcohol strength impaired by low and high volume distraction. *Food Qual. Prefer.* **2013**, *28*, 470–474.
6. Velasco, C.; Jones, R.; King, S.; Spence, C. Assessing the influence of the multisensory environment on the whisky drinking experience. *Flavour* **2013**, *2*, 23, doi:10.1186/2044-7248-2-23.
7. Spence, C.; Piqueras-Fiszman, B. *The Perfect Meal: The Multisensory Science of Food and Dining*; Wiley-Blackwell: Oxford, UK, 2014.
8. Spence, C. Noise and its impact on the perception of food and drink. *Flavour* **2014**, *3*, 9, doi:10.1186/2044-7248-3-9.
9. Knoeferle, K.M.; Woods, A.; Käppler, F.; Spence, C. That sounds sweet: Using crossmodal correspondences to communicate gustatory attributes. *Psychol. Mark.* **2015**, *32*, 107–120.
10. Oberfeld, D.; Hecht, H.; Allendorf, U.; Wickelmaier, F. Ambient lighting modifies the flavor of wine. *J. Sens. Stud.* **2009**, *24*, 797–832.
11. Wansink, B.; van Ittersum, K.; Fast food restaurant lighting and music can reduce calorie intake and increase satisfaction. *Psychol. Rep. Hum. Resour. Mark.* **2012**, *111*, 228–232.
12. Velasco, C.; Woods, A.; Deroy, O.; Spence, C.; Hedonic mediation of the crossmodal correspondence between taste and shape. *Food Qual. Prefer.* **2015**, *41*, 151–158.
13. Spence, C.; Gallace, A. Tasting shapes and words. *Food Qual. Prefer.* **2011**, *22*, 290–295.

14. Spence, C.; Ngo, M.; Percival, B.; Smith, B. Crossmodal correspondences: Assessing the shape symbolism for cheese. *Food Qual. Prefer.* **2013**, 28, 206–212.
15. Spence, C. Wine and Music: A Scientific Exploration. Available online: https://apps.utu.fi/media/nakoislehdet/5d-cookbook/en/desktop/index.html?article=74&page=1 (accessed on 6 January 2015).
16. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed.; Lawrence Erlbaum Associates: Hillsdale, NJ, USA, 1988.
17. Crisinel, A.S.; Cosser, S.; King, S.; Jones, R.; Petrie, J.; Spence, C. A bittersweet symphony: Systematically modulating the taste of food by changing the sonic properties of the soundtrack playing in the background. *Food Qual. Prefer.* **2012**, *24*, 201–204.
18. Woods, A.T.; Poliakoff, E.; Lloyd, D.M.; Dijksterhuis, G.B.; Thomas, A. Flavor expectation: The effects of assuming homogeneity on drink perception. *Chemosens. Percept.* **2010**, *3*, 174–181.
19. Spence, C. On the psychological impact of food colour. *Flavour* **2015**, *4*, 21, dio:10.1186/s13411-015-0031-3.
20. Spence, C.; Levitan, C.A.; Shankar, M.U.; Zampini, M. Does food color influence taste and flavor perception in humans? *Chemosens. Percept.* **2010**, *3*, 68–84.
21. Fielden, C. *Exploring the World of Wines and Spirits*; Wine & Spirit Education Trust: London, UK, 2009.
22. Labroo, A.A.; Dhar, R.; Schwartz, N. Of frog wines and frowning watches: Semantic priming, perceptual fluency, and brand evaluation. *J. Consum. Res.* **2008**, *34*, 819–831.
23. Winkielman, P.; Schwarz, N.; Fazendeiro, T.; Reber, R. The hedonic marking of processing fluency: Implications for evaluative judgment. In *The Psychology of Evaluation: Affective Processes in Cognition and Emotion*, Musch, J., Klauer, K.C., Eds.; Lawrence Erlbaum: Mahwah, NJ, USA, 2003; pp. 189–217.
24. Deroy, O.; Valentin, D. Tasting shapes: Investigating the sensory basis of cross-modal correspondences. *Chemosens. Percept.* **2011**, *4*, 80–90.
25. Gallace, A.; Boschin, E.; Spence, C. On the taste of "Bouba" and "Kiki": An exploration of word-food associations in neurologically normal participants. *Cogn. Neurosci.* **2011**, *2*, 34–46.
26. Spence, C.; Deroy, O. Tasting shapes: A review of four hypotheses. *Theor. Hist. Sci.* **2013**, *10*, 207–238.
27. Bergman, J. Restaurant Report: Ultraviolet in Shanghai. The New York Times, 2012. Available online: http://www.nytimes.com/2012/10/07/travel/restaurant-report-ultraviolet-in-shanghai.html (accessed on 22 February 2015).
28. Driver, C. Don't Forget to Tip! New Hard Rock Hotel in Ibiza to Open the Most Expensive Restaurant in the World-at £1235 a HEAD, 2014. Available online: http://www.dailymail.co.uk/travel/article-2609619/New-Hard-Rock-Hotel-Ibiza-open-Sublimotion-expensive-restaurant-world.html#ixzz3IamRVLM7 (accessed on 6 January 2015).
29. Ultraviolet by Paul Pairet. Available online: http://uvbypp.cc/ (accessed on 6 January 2015).
30. Sublimotion by Paco Roncero. Available online: http://www.sublimotionibiza.com/en/ (accessed on 6 January 2015).
31. Miller, B. Artist Invites Public to Taste Colour in Ten-Day Event with Dancers and Wine at the Oval, 2015. Available online: http://www.culture24.org.uk/art/art516019-artist-invites-public-to-taste-colour-in-ten-day-event%20with-dancers-and-wine-at-the-oval (accessed on 6 January 2015).

32. Spence, C.; Wan, I. Beverage perception & consumption: The influence of the container on the perception of the contents. *Food Qual. Preference.* **2015**, *39*, 131–140.
33. Zeithaml, V.A. Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *J. Mark.* **1988**, *52*, 2–22.