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Short communication

Perception of Alcohol Strength Impaired by Low and High Volume Distraction

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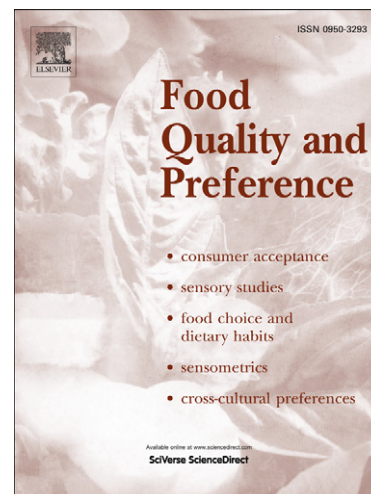
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7 2 **Perception Of Alcohol Strength Impaired By Low And High**  
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10 3 **Volume Distraction**  
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## Abstract

Recent research demonstrated impaired discrimination of alcohol strength under distracting conditions. The present study aimed to extend this by examining the effects of distraction volume on alcohol perception. In the study here (between subjects design, 34 females/20 males), participants completed standardized taste and olfactory tests, followed by a taste test of alcoholic beverages (0, 1.9, 3.9, 5.6, 7.5pct abv) in a randomly allocated distractive or control condition [Control, Shadow Music-Low Volume (SM-L), Shadow Music-High Volume (SM-H)]. Alcohol strength discrimination was significantly impaired in both SM-L and SM-H compared to control, but did not differ from each other. We also found that those individuals with habitually poorer taste acuity were particularly vulnerable to the impairing effects of distraction on alcohol discrimination. This study demonstrates congruent effects of volume on alcohol perception and how this can be modulated by individual taste sensitivity.

## Keywords

Alcohol, Alcohol Strength, Distraction, Taste, Cognitive Load

## 1. Introduction

It may seem obvious to state that human perception is rarely (if ever) unisensory but instead a combination of the senses. Recent research has shown that the connotation of background music can alter the taste of wine; where mellow/soft music led to the wine being perceived as more mellow/soft compared to when the same wine was accompanied by powerful/heavy music (North, 2011). In addition to style of music, the level of sound volume has also been shown to influence more fundamental measures of taste. Hence altering the sounds of munching potato crisps can make the same crisps appear more fresher/staler (Zampini & Spence, 2004), with similar effects on the perceived fizziness of carbonated water (Zampini & Spence, 2005). Work has also provided evidence that sound unconnected to the food itself can influence taste perception (Woods et al., 2011). In that study, participants rated a selection of foods whilst listening to low and high volumes of white noise via headphones. Findings revealed that the food was perceived as less sweet and salty in the high volume condition and in a subsequent study more crunchy. This suggests that sound can influence taste even when the sound does not emanate from the food itself. However, background noise also has the capability to disrupt gustatory processes, demonstrated by poorer discrimination of alcohol strength in the context of a distracting task (shadowing a news story and listening to music) compared to simply shadowing or a control condition (Stafford, Fernandes, & Agobiani, 2012). This effect was also accompanied by increases in negative mood in the shadow-music condition which could be instrumental in impairing alcohol strength discrimination. Such a result is consistent with the finding that olfactory sensitivity was lower following a negative mood induction (Pollatos et al., 2007). It is uncertain however, whether increasing the volume of the distracting task might lead to even poorer discrimination of alcohol strength.

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4 1 Given that alcohol strength has been shown to be influential in both the discrimination of alcohol  
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6 2 from placebo (Jackson, Stephens, & Duka, 2001) and the rate at which alcohol is consumed  
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9 3 (Higgs, Stafford, Attwood, Walker, & Terry, 2008), it would seem important to examine this  
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11 4 issue.

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16 6 The present study therefore aimed to see whether estimating the alcohol strength of a range of  
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18 7 beverages was affected by volume level. We expect elevated negative mood in the two shadow-  
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21 8 music conditions based on the earlier study (Stafford, et al., 2012). We also made a number of  
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23 9 refinements from that study that included testing participants baseline blood alcohol levels to  
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26 10 ensure no alcohol had been consumed prior to testing, and using only non smoking participants to  
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29 11 avoid any differences in taste sensitivity. Additionally, rather than test actual taste and olfactory  
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31 12 thresholds, which did not show any relation to alcohol strength estimation, we used sensory  
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33 13 ratings of the test odor and of bitter and sweet tastants.

## 34 35 36 14 37 15 38 16 **2. Method**

### 39 17 40 18 **2.1 Participants**

41 19  
42 20 Fifty-four university staff and students (34 females/ 20 males) participated in the study and were  
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45 21 aged between 19 and 34 years of age ( $M = 22.6$ ,  $SD = 3.9$ ). Participants were recruited using an  
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48 22 online system where the study was advertised as examining what factors influence our sense of  
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51 23 alcohol perception. Participants were invited to volunteer if they were aged between 18 and 30,  
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53 24 were regular consumers of alcohol, consuming at least 8 units of alcohol per week, consistent  
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55 25 with previous research (Higgs et al., 2008). We further stipulated that participants were non-  
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58 26 smokers and that English was their first language.

1 The rationale for this latter requirement was that since the shadowing tasks required listening and  
2 repeating of information, this could result in differing cognitive demands for non-native English  
3 speakers which might affect the judgement of the test drinks. The study protocol was given  
4 ethical approval from the department's ethics committee (BPS guidelines).

## 6 **2.2 Design**

7 The study used a mixed design where participants were randomly allocated to one of 3 groups:  
8 Control, Shadow and Music-Low volume (SM-L), Shadow and Music-High volume (SM-H)  
9 (Table 1) and made sensory ratings of five different drinks presented in a counterbalanced order.  
10 Group was therefore studied between-subjects and Drink was within-subjects. The main  
11 dependent variable were their sensory ratings of the five drinks.

## 13 **2.3 Materials**

### 15 *2.3.1 Alcohol Usage Questionnaire (AUQ)*

17 Patterns of habitual alcohol consumption were measured using a questionnaire (based on  
18 (Mehrabian & Russell, 1978). Participants were accepted into the study only if their total weekly  
19 alcohol consumption was over 8 units of alcohol.

### 21 *2.3.2 Olfactory & Taste Tests*

22 The olfactory and Taste tests were part of a larger test from the 'Sniffin sticks' battery (Burghart  
23 Instruments, West Germany) and have been used widely in research (Hummel, Kobal, Gudziol,  
24 & Mackay-Sim, 2007; Seo & Hummel, 2009). For the former, participants were asked to sniff  
25 (unblinded) the odor of a single pen (highest concentration of the odor, 4% n-butanol diluted in  
26 aqua conservans) and complete VAS ratings (intensity, bitterness, sweetness, pleasantness).

1 For the taste test, two bottles were used with spray attachments: one bottle containing a sweet  
2 solution (1g sucrose in 10g water) and the other containing a bitter solution (0.005g quinine  
3 hydrochloride in 10g water). Participants were presented with each tastant (counterbalanced  
4 order) which was sprayed directly onto the tongue by the experimenter. After each taste, they  
5 completed the same VAS ratings and sipped some water before the next taste.

### 6 7 *2.3.3 Arousal, Thirst & Hunger*

8 Arousal and hunger were measured using 100 mm Visual Analogue Scales (VAS) unmarked  
9 lines anchored with “Not at all” and “Extremely”. The adjectives were centred above each line in  
10 the following order; “alert”, “thirsty”, “drowsy”, “hungry”. These measures were taken mainly to  
11 check for any differences between groups which might affect taste perception.

### 12 13 *2.3.4 Positive and Negative Mood*

14 The Positive and Negative Affect Schedule (PANAS) from (Watson, Clark, & Tellegen, 1988)  
15 was used to measure mood during the experiment. The PANAS consists of 5-point Likert scales  
16 ranging from 1 (very slightly or not at all) to 5 (extremely) on which participants rated their  
17 feelings and indicated the extent to which they currently experienced 10 positive and 10 negative  
18 emotions.

### 19 20 21 *2.3.5 Music & Shadowing Stimuli*

22 The same stimuli were used as in our previous study (Stafford, et al., 2012) for both SM-L and  
23 SM-H. The music was a contemporary piece, typical of club music (Hardcore, 303 Freestyle,  
24 Jamie Ritmen – Scott Brown – Hardcore Heaven 4). For the shadowing task, we used various  
25 news articles selected from the BBC news website (<http://news.bbc.co.uk/>) and different items  
26 for the practice and main task.

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4 1 These articles were recorded by the same male voice (native English speaker) at approximately  
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6 2 120 words per minute. The music and shadowing tasks were compiled in audio format (using  
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9 3 Sound Forge 7.0) presented via stereo headphones (Unitone HD-3030) connected to a PC  
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11 4 (Windows XP professional operating system), with sound volume set to 80dB in the SM-L and  
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14 5 100dB for the SM-H conditions. The latter level was chosen as this is typical of the range  
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16 6 experienced in a nightclub environment (OHS1, 2008) and roughly equivalent to the differences  
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19 7 between the low and high levels in previous observational work (Gueguen, Jacob, Le Guellec,  
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21 8 Morineau, & Lourel, 2008). The ear of presentation (e.g. Shadow-Left, Music-Right) was  
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24 9 counterbalanced across subjects and conditions. Twenty-four minutes of material (i.e. music,  
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26 10 news article) were recorded, being easily sufficient for the task of tasting and rating the drinks.  
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### 31 12 *2.3.6 Drinks and administration*

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33 13 The study used a cranberry (Tesco smooth) and vodka (Tesco Value, 37.5% abv) beverage,  
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35 14 based on a mini-study to select the most appropriate levels of alcohol and mixer. Participants  
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38 15 received five freshly prepared drinks (counterbalanced order), each in 25ml shot glasses  
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40 16 (Arcoroc, Amazon UK): 0pct abv (20ml cranberry); 1.9pct abv (19ml cranberry/1ml vodka);  
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43 17 3.9pct abv (18ml/2ml); 5.6pct (17ml/3ml); 7.5pct abv (16ml/4ml), hence all drinks were the same  
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45 18 volume. For each beverage, participants used 100 mm VAS anchored with “Low” or “Not at all”  
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48 19 followed by the relevant adjective, and “High” or “Very”, again followed by the relevant  
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50 20 adjective. The following descriptors within the context of a sentence verifying the question were  
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52 21 centred above each line in the following order; “cold”, “familiar”, “alcohol strength”, “like”,  
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55 22 “sweet”, “bitter”. These descriptors were the same as those used in previous research (Higgs, et  
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57 23 al., 2008). Cranberry and vodka were refrigerated separately at a temperature of 7°C.  
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## 1 2.4 Procedure

2 All testing took place between 1200 and 1700 and participants were asked to consume lunch  
3 before coming to the laboratory. Upon arrival, participants provided informed consent and had  
4 their Breath Alcohol Level measured using a digital personal breathalyzer (Alcoscan AL7000) to  
5 ensure it was zero (all readings were '0'). They then completed the AUQ. Next, they completed  
6 the olfactory and taste tests. After this, Arousal and hunger ratings were taken, followed by  
7 positive and negative mood. Participants were then taken to a different room, where they were  
8 presented with the five test drinks and instructed to sample each drink by taking one sip only,  
9 then to complete all the VAS ratings for that beverage, take a sip of water and to repeat for the  
10 next drink, working from left to right. Prior to this task, participants in the shadow-music groups  
11 were given practice in shadowing (repeating aloud) the news article which lasted one minute,  
12 having the news article presented to one ear and music to the second ear (same pairing for main  
13 task). For the main task these participants were instructed to sample and rate drinks whilst  
14 simultaneously shadowing the article and listening to music. In both shadowing groups it was  
15 strongly emphasized that participants must attempt to repeat the information as much as possible  
16 throughout the task. When all of the drinks had been sampled, the completed VAS ratings were  
17 removed and if relevant, the distracter task was terminated. Next, final measures of Arousal and  
18 hunger ratings were taken, followed by positive and negative mood. Participants then had their  
19 weight and height recorded and were paid a small amount (£5.00) for participation and given a  
20 full debriefing.

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## 1 2.5 Data Analyses

2 One participant rated all drinks with zero alcohol strength, and was therefore excluded. The  
3 remaining data for alcohol strength and other sensory data were analysed using separate repeated  
4 measures ANOVAs, using the within-subjects factor of Drink (0, 1.9, 3.9, 5.6, 7.5pct abv) and  
5 between-subjects factors of Group (Control/SM-L/SM-H). The positive and negative mood and  
6 arousal/thirst/hunger data were analysed by using the change scores from baseline which were  
7 entered into separate Univariate ANOVAs using the between-subjects factor of Group  
8 (Control/SM-L/SM-H).

## 11 3. Results

### 13 3.1 Alcohol Strength

15 Analyses revealed a significant effect of Drink,  $F(4, 200) = 29.19, p < .001, \eta^2 = .37$ , with ratings  
16 increasing in line with alcohol strength (Figure 1). We also found a main effect of Group,  $F(2,$   
17  $50) = 5.37, p < .01, \eta^2 = .18$ , where compared to control, overall alcohol ratings were higher in  
18 both SM groups ( $p < .05$ ), who did not differ from each other. Importantly, as predicted there  
19 was a significant Drink x Group interaction,  $F(8, 200) = 2.65, p = .01, \eta^2 = .10$ . Since we wished  
20 to understand how the perception of drinks varied within each distraction condition, we  
21 calculated a discrimination index (per our previous study, Stafford et al., 2012) score by  
22 measuring the mean difference between the five drinks, with larger resulting figures indicative of  
23 higher discrimination between beverages. This index was then entered into a Univariate  
24 ANOVA with Group as the between-subjects factor. A Group effect was found,  $F(2, 50) = 4.12,$   
25  $p = .02, \eta^2 = .14$ , with poorer discrimination between both SM groups versus control ( $p < .05$ ).

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4 1 This demonstrates that discrimination of alcohol strength was impaired in both distraction  
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6 2 conditions, who did not differ between themselves (Figure 2).  
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13 5 -Insert Figures 1 and 2 about here-  
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### 17 7 **3.2 Additional Sensory And Mood Ratings**

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19 9 As expected, ratings of sweetness and liking generally declined with alcohol strength, whilst  
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22 10 bitterness increased (Table 2). For sweetness only, there was a marginal effect of Group, where  
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25 11 ratings were lower in the SM-L compared to Control condition ( $p < .05$ ), but neither differing  
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27 12 from the SM-H group.  
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31 14 For negative mood, the Group effect was not significant,  $F(1, 50) = 1.82$ ,  $p = .17$ , though there  
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33 15 was a tendency for increased negative mood in the SM-L group compared to control ( $p = .07$ ).  
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36 16 No other effects were significant.  
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### 39 18 **3.3 Correlations**

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41 19 To further explore the relationship between distraction and alcohol perception, we completed  
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43 20 correlations using the discrimination index for the two distracting conditions with the variables of  
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45 21 alcohol consumption, positive and negative mood, the ratings for the test odor and bitter and  
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48 22 sweet tastants. Results revealed significant negative associations for sweetness,  $r(36) = -.36$ ,  $p =$   
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51 23  $.03$  and pleasantness,  $r(36) = -.35$ ,  $p = .04$  ratings for the bitter test tastant, indicating that  
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54 24 individuals who rated the bitter tastants as less sweet and pleasant had better alcohol  
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57 25 discrimination under distraction conditions.  
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4 1 Additionally, to further explore whether certain individuals are more vulnerable to the distractive  
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6 2 effects on discrimination we repeated the correlation between patterns of alcohol consumption  
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9 3 and discrimination, but controlled for differences in taste acuity using a partial correlation. This  
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11 4 revealed a significant negative association for ‘times drunk in the last 6 months’,  $r(33) = -.38$ ,  $p =$   
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14 5  $.02$ , suggesting irrespective of taste sensitivity, those individuals who are intoxicated more  
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16 6 frequently are particularly affected by the observed distractive effects.  
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#### 21 8 **4. Discussion**

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24 10 The study found that alcohol strength discrimination was significantly impaired in both the SM-L  
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26 11 and SM-H groups compared to control, which is in line with prediction and the previous study  
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29 12 (Stafford, et al., 2012). Since there were no differences between the two distraction groups, this  
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31 13 suggests that judgement of alcohol strength does not differ between the volume levels used here.  
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34 14 This was a surprising finding given that sound volume led to differences in the taste of food and  
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36 15 drink, whether originating from its source (Zampini & Spence, 2004, 2005) or not (Woods, et al.,  
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39 16 2011) as in the current study. One possibility could be that the volume levels in the present study  
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41 17 were not sensitive enough to detect any contrasts between the two SM groups. The closest work  
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44 18 to the present study (Woods, et al., 2011), used a low volume of white noise (45-55dB) compared  
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46 19 to high (75-85dB), which is somewhat lower than the 80dB/100dB used here; hence it could be  
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48 20 that utilising similar low and high volume levels as that study might produce differences in  
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51 21 alcohol perception.  
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4 1 The strongest effect in the current study was in terms of both SM groups exhibiting impaired  
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6 2 alcohol strength discrimination. In attempting to explain the possible mechanisms accounting for  
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8 3 this finding, we propose that the cognitive load of the task acted to distract participants from the  
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10 4 complex task of estimating alcohol strength. This is consistent with research demonstrating that  
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12 5 discrimination of odors was disrupted in a verbal noise environment (Seo, Gudziol, Hähner, &  
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14 6 Hummel, 2011). Additionally, work has shown that the influence of an advertising slogan on the  
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16 7 taste of a food snack was diminished in a high cognitive load condition (Elder & Krishna, 2010).  
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18 8 It is clear from the work here and other recent research (Stafford, et al., 2012; Woods, et al.,  
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20 9 2011) that sound has the ability to affect taste even when it does not originate from the food/drink  
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22 10 itself, as shown in other work e.g. (Zampini & Spence, 2004). Multisensory research is now  
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24 11 needed to examine the nature of these differences. In particular, why is it that music can induce  
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26 12 increased perceived alcohol sweetness (Stafford, et al., 2012) and congruency effects with  
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28 13 beverage (North, 2011); but in contrast as shown here, shadowing and music lead to lower  
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30 14 sweetness and poorer discrimination of alcohol strength.  
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41 16 In terms of identifying those more susceptible to the impairing effects of distraction on alcohol  
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43 17 perception, we found those individuals with habitually poorer taste acuity were most at risk.  
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45 18 Of particular interest, we found that increases in pleasantness for the bitter test tastant were  
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47 19 associated with poorer alcohol discrimination, since this relates to previous research where the  
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49 20 main difference between alcohol discriminators and non-discriminators was in terms of initial  
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51 21 dislike of the test beverage (alcohol/tonic and tabasco) (Jackson, et al., 2001). So, in concert with  
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53 22 the study here, it is the dislike of bitter substances that predict better alcohol discrimination.  
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4 1 It is important to note however, that although the present data suggest an association between  
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6 2 sweet/pleasantness of a bitter tastant and alcohol strength, it would seem likely that the  
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8 3 perception of a complex attribute such as alcohol strength involves both sensory cues  
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10 4 (bitter/sweet) but also the effects of alcohol itself (e.g. drowsiness, lightheadedness). Additional  
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12 5 work is therefore necessary to investigate how these post ingestive effects of alcohol influence  
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14 6 alcohol strength perception in different distracting conditions.  
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21 8 It was also interesting that even after controlling for differences in habitual taste sensitivity, that  
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23 9 alcohol discrimination was poorer with increases in the frequency of intoxicating episodes in the  
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25 10 last six months. In theorizing the reason for such a relationship, it could be that some form of  
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27 11 tolerance/conditioning may occur in those who become intoxicated more often, such that the  
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29 12 frequent pairing of alcohol, music and intoxication elicits a particular response to alcohol. To  
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31 13 some extent, this connects to addiction work, where it is theorized that the frequent pairing of  
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33 14 drug (e.g. alcohol) and environmental stimuli (e.g. beer glass, pub atmosphere) can later in the  
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35 15 absence of the drug itself, produce attentional bias and craving to just these environmental stimuli  
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37 16 (Robinson & Berridge, 2003; Townshend & Duka, 2001). Future research could therefore  
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39 17 examine whether those who get drunk more frequently have differing responses (including  
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41 18 alcohol strength perception) to alcohol in different environments.  
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50 20 Reflecting on the limitations of the study, it could be argued that using both a shadow and music  
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52 21 task is problematic in disentangling their effects on alcohol perception. The rationale for the  
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54 22 combined task was to simulate a more ecologically valid context (listening to music and  
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56 23 conversational listening & talking) as in earlier observational work (Gueguen et al., 2008).  
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1 We do however see the value in examining the differences in music/sound volume alone as a  
2 purer measure of its effect on alcohol taste. Another related point is that those participants in the  
3 distraction conditions sampled the beverages and completed ratings in the presence of music  
4 while simultaneously doing the shadowing task. We therefore cannot be certain whether music  
5 and shadowing affected actual taste perception per se and/or the participant's ability to complete  
6 the rating task; hence could it be that the cognitive effort of rating the beverages is affected by the  
7 demands of the distraction tasks, but not the purer perception of taste. This is a difficult issue to  
8 resolve, since subjective ratings of taste and perception of taste are generally taken to mean the  
9 same thing. One possibility would be to monitor the performance on the distraction tasks to see  
10 if these relate to taste ratings, which could reveal if more errors in the shadowing task predicted  
11 poorer discrimination of alcohol strength across beverages. However, this would still not show  
12 the influence of distraction on actual taste perception. An alternative approach would be to use a  
13 different, indirect measure of taste perception that does not require the same mental effort, such  
14 as the volume or speed of alcohol consumption (as used previously, Higgs *et al.* 2008). On the  
15 basis of the present findings that alcohol strength discrimination was poorer under distraction, it  
16 could be predicted that such distractions might lead to faster and greater volumes of alcohol  
17 consumption, which would agree with previous naturalistic research (Gueguen, Le Guellec, &  
18 Jacob, 2004). Finally, we accept the limitations of the correlational data reported here (as with  
19 any such data), that in addition to not being able to infer causation, there is also the possibility  
20 that since participants are a common factor between the two sets of measurements (e.g. bitter test  
21 tastant and alcohol strength), it could be that their individual biases act to skew the resulting  
22 correlation.

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4 1 In conclusion, the research here found social drinkers exposed to a distracting music and  
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6 2 shadowing task were significantly poorer in their discrimination of alcohol strength. The most  
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9 3 likely explanation for this effect is via a disruption in attentional mechanisms which act to blur  
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11 4 the differences in other sensory dimensions (bitter/sweet) that are used to gauge alcohol strength.  
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14 5 Individuals with habitually poorer taste acuity and separately those with a higher number of  
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16 6 recent intoxicated episodes are particularly at risk from these distracting effects.  
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21  
22 9  
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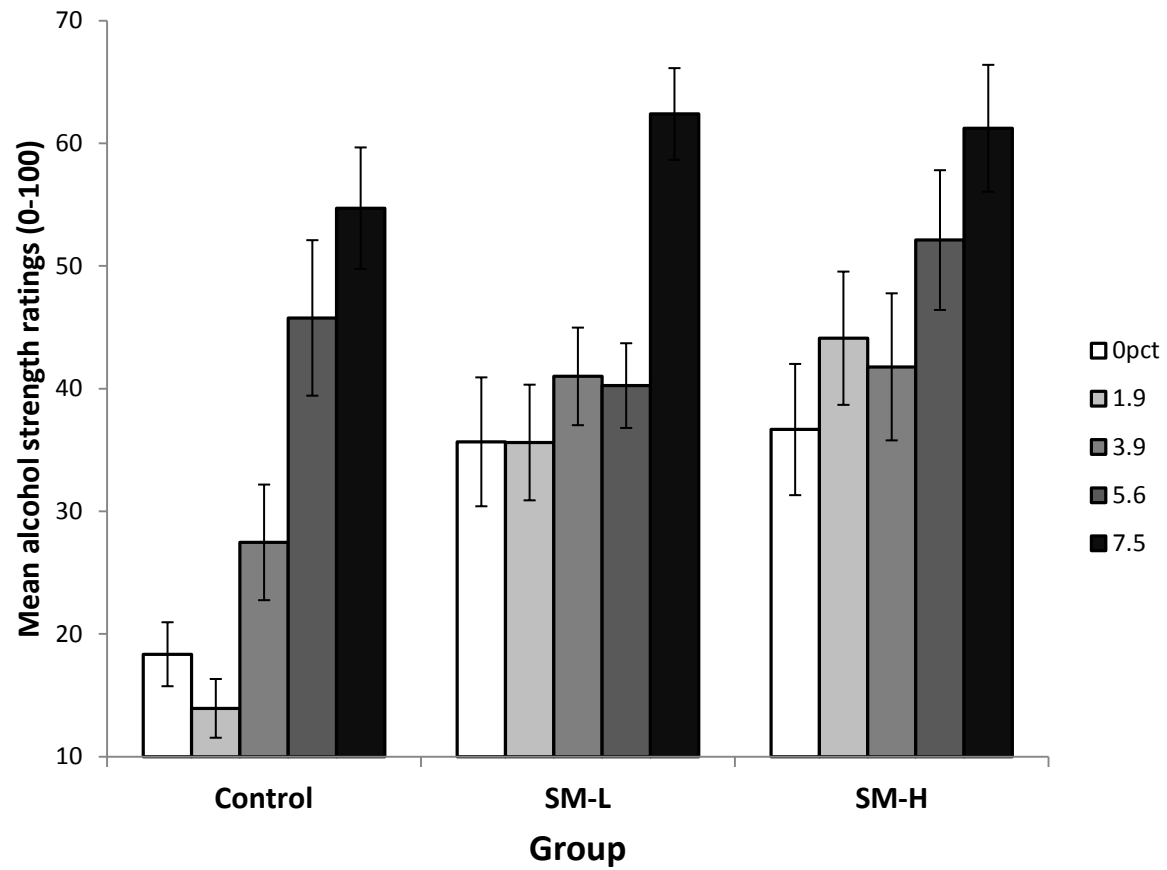
1 **Legends for figures:**

2  
3 Figure 1. Mean Alcohol Strength Ratings Dependent On Drink And Group  
4 Error bars represent standard errors of the mean.  
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7 Figure 2. Mean Alcohol Strength Index Dependent On Group  
8 Error bars represent standard errors of the mean.  
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Figure 1



**Figure 2**

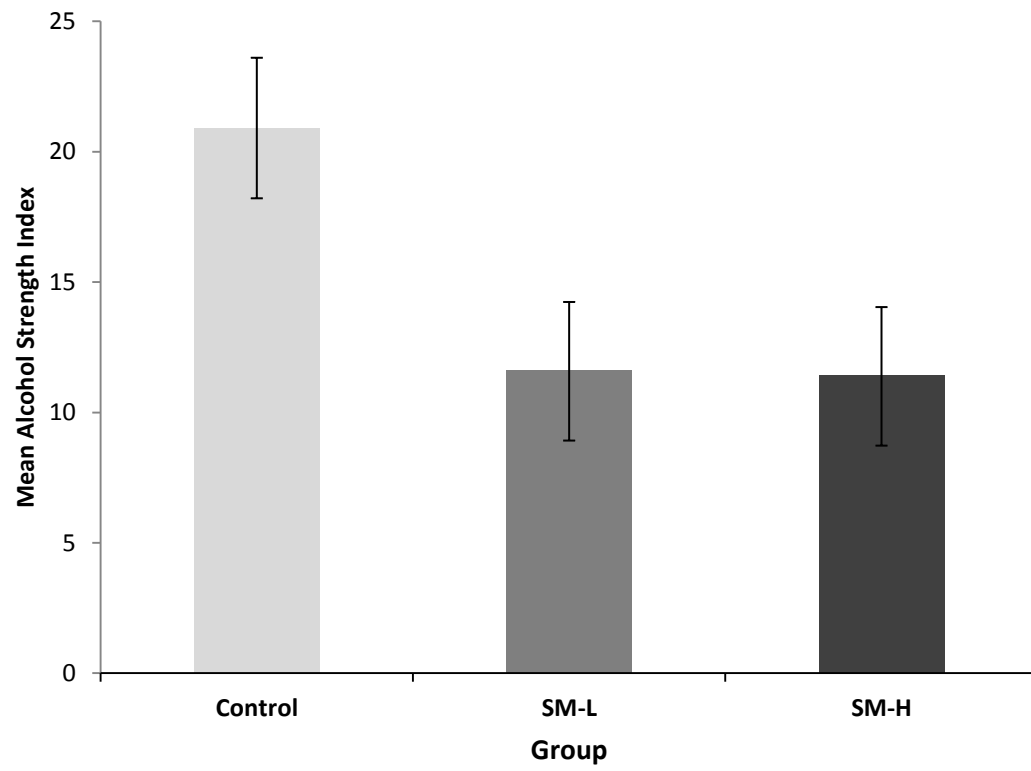


Table 1. Mean (SEM) Participant Characteristics

	Group					
	Control		S-Music Low		S-Music High	
	M	SE	M	SE	M	SE
<b>Age</b>	21.9	0.5	23.0	1.1	22.7	1.1
<b>BMI</b>	24.32	1.17	24.16	1.30	24.19	0.66
<b>UK Alcohol units (p/week)</b>	34.78	3.96	39.02	5.55	34.34	3.66
<b>Gender (M:F)</b>	6:12		6:12		8:10	

Notes: No group differences (all ps > .10)

Table 2. Mean (SEM) Sensory Ratings Dependent On Drink (ABV pct)

	0		1.9		3.9		5.6		7.5				
	M	SE	M	SE	M	SE	M	SE	M	SE	F <sub>Drink</sub>	F <sub>Group</sub>	F <sub>Drink x Group</sub>
<b>Sweet</b>	56.8	3.2	59.0	3.0	55.2	3.2	51.8	3.1	41.9	2.8	F = 7.07***	F = 3.07*	F = 1.10
<b>Bitter</b>	31.0	3.1	27.6	2.5	35.1	3.2	38.5	3.3	47.7	3.3	F = 9.57***	F = 0.46	F = 1.16
<b>Liking</b>	56.6	3.0	56.4	3.4	62.3	2.5	51.1	3.0	39.1	3.2	F = 15.26***	F = 0.79	F = 0.92
<b>Cold</b>	29.4	2.3	31.5	2.8	33.5	2.9	32.9	3.0	28.6	2.8	F = 1.36	F = 0.20	F = 2.71**
<b>Familiar</b>	52.9	3.6	52.1	3.3	54.1	3.2	52.7	3.3	49.8	3.4	F = 0.47	F = 0.16	F = 0.88

\*\*\* p < .001; \*\* p < .01; \* p = .05



**Highlights**

We examined whether volume level of background noise could alter alcohol taste perception. Both low and high volume levels led to diminished alcohol strength discrimination. Additionally, individuals with habitually poorer taste acuity were particularly vulnerable to these effects. This study suggests congruent effects of both low and high volume on alcohol taste perception.

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