Language does not explain the wine-specific memory advantage of wine experts

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Abstract

Although people are poor at naming odors, naming a smell helps to remember that odor. Previous studies show wine experts have better memory for smells, and they also name wine and wine-related smells differently than novices. This leads us to ask whether wine experts' odor memory is verbally mediated? In addition, does the odor memory advantage that experts have over novices generalize to all odors, or is it restricted to odors in their domain of expertise? Twenty-four wine experts and 24 novices smelled wines, wine-related odors and common odors, and were asked to remember these. Critically, half of the participants were asked to name the smells in addition to memorizing them, while the other half just remembered the smells. Wine experts had better memory for wines, but not for wine-related or common odors, indicating their memory is restricted to odors from their domain of expertise. Wine experts were also found to be more consistent and accurate than novices in their descriptions. But there was no relationship between experts' ability to name odors and their memory for odors. This suggests experts' odor memory advantage is not linguistically mediated, but may be the result of differential perceptual learning.

Keywords: expertise, wine experts, olfaction, language, memory, language and thought

Introduction

People from the West are poor at describing smells (Majid, 2015; Olofsson & Gottfried, 2015; Yeshurun & Sobel, 2010). When asked to name smells, they rarely exceed naming more than 50% of them correctly (Cain, 1979; Engen, 1987; Yeshurun & Sobel, 2010; Olofsson & Gottfried, 2015). In contrast, a large body of literature shows remembering smells is relatively easy, as demonstrated by an almost flat forgetting curve. Even after a month, people still recognize around 75% of previously smelled odors correctly (Cain, 1979; Engen, 1987; Herz & Engen, 1996; Schab, 1991).

Given the discrepancy between odor naming and odor memory, surprisingly having the correct label for a smell can increase memory for it. Herz and Engen (1996) concluded "the jury was still out" (p. 303) on whether odor memory is verbally mediated. However, many studies since their review have found language can improve memory for odors and flavors. A number of studies have tested participants' odor memory while providing them with a label generated by the experimenter during the initial presentation of the smell (i.e., during encoding). These studies have shown access to a meaningful label improves memory, and having access to a "veridical" label improves odor memory the most (Cessna & Frank, 2013; Jehl, Royet, & Holley, 1997; Olsson, Lundgren, Soares, & Johansson, 2009; Russell & Boakes, 2011). When participants self-generate a label for odors during encoding, this also leads to improved memory for those odors (Frank, Rybalsky, Brearton, & Mannea, 2011; Lehrner, Glück, & Laska, 1999; Lesschaeve & Issanchou, 1996). This holds true even when people describe complex flavor stimuli such as wines (Fiore et al., 2012; Hughson & Boakes, 2009). There is also some suggestive evidence for a causal role for language in odor memory. When an odor memory task is paired with a verbal interference task, subsequent odor recognition is poorer than when it is paired with a visual interference task (Annett, Cook, & Leslie, 1995; Annett & Leslie, 1996; Perkins & Cook, 1990). Taken together, these studies suggest language plays a critical role in how odors are remembered.

Through years of training and practice, experts acquire theoretical knowledge, perceptual experience, and train their verbal capacities in the domain of their expertise. Becoming an expert has effects on cognition, including memory and language. For example, chess experts have better memory for chess game layouts than novices (e.g., Chase & Simon, 1973; Gobet, 1998), while expert musicians are better able to judge the grammaticality of sentences than novices (Patston & Tippett, 2011).

To become an acknowledged wine expert, a person must study wine for many years. Even after becoming a professional in the field of wine, training and practice continues. An important part of what a wine expert does in their job is to recognize specific aromas and flavors in wine. Wine experts are better than novices at remembering the "flavors" of wine (i.e., a combination of mouth sensation and smell; Melcher & Schooler, 1996), as well as the (orthonasal) smells (i.e., "sniffing") of wines (Zucco, Carassai, Baroni, & Stevenson, 2011) and wine-related odors (Parr, Heatherbell, & White, 2002; Parr, White, & Heatherbell, 2004). So, it seems wine experts have better memory for stimuli salient in their domain of expertise.

For olfaction experts, smells and flavors are said to be more important in their daily life than for the average person (Royet, Plailly, Saive, Veyrac, & Delon-Martin, 2013). However, what consequences expertise has for the language

used to describe smells remains unclear. For example, Lawless (1984) found little agreement in the descriptions of wine from wine experts versus novices, and wine experts are apparently not more consistent than novices in their descriptions of wine-related smells (Parr et al., 2002).

On the other hand, in a recent study Croijmans and Majid (2016) found wine experts were more consistent than novices when describing the smell and flavor of real wines. Wine experts have also been found to be able to select the correct label for odors more often than novices (Bende & Nordin, 1997; Marino-Sanchez et al., 2010; Tempere, Hamtat, de Revel, & Sicard, 2015), and they seem to be more precise in their descriptions for wines and wine-related odors (Chollet & Valentin, 2000; Lehrer, 1983; Melcher & Schooler, 1996; Solomon, 1990, 1997; Zucco et al., 2011). Overall, then, wine experts appear to describe smells from their domain of expertise with more consistency and exactness than novices.

Brown and Lenneberg (1954) pioneered the idea that when a percept is expressed more consistently and concisely in language (i.e., when it is "codable"), it is remembered better. Can wine experts' aptitude for describing smells help their memory for odors? Previous studies do not give a satisfying answer. Melcher and Schooler (1996) found no difference when experts gave a verbal description of wines compared to a non-verbal condition, although experts were better than novices and intermediates in remembering the wines they tasted. Similarly, Parr and colleagues (Parr et al., 2002, 2004) found no significant relationship between the ability to label wine-related odors and their subsequent memory for those odors, although wine experts were again much better at remembering odors than novices. However, when inspecting the results more closely (Parr et al., 2004, Table 2, p. 416), a significant recognition memory difference between experts and novices was only found in the condition where participants labeled the stimuli (instead of rating the pleasantness of odors), leaving open the possibility that wine experts' memory is perhaps verbally mediated.

If language is used by experts to remember wines, we might predict wine experts would only be better at remembering the smells of wines, or perhaps wine-related odors, but not other odors (e.g., common household odors). This is because wine experts appear to be better at naming smells and flavors only when these came from their specific area of expertise (Croijmans & Majid, 2016). If language is used to remember wines, then wine experts should only show a memory advantage for wine (and, perhaps, wine-related odors), but not common odors. They should also be better at naming those odors, and there should be a clear relationship between naming and memory. To test these hypotheses, we asked wine experts and novices to remember odors from real wines, wine-related odors, and common household odors unrelated to wine. One group of participants was asked to name the stimuli (verbal condition), while another group smelled the odors without verbalization (baseline condition).

Methods

Participants

Forty-eight people participated in the experiment. Twenty-four were experts (6 women, M_{age} = 49, SD = 9, age range 29 – 60), and worked as qualified vinologists, sommeliers or wine producers. The other 24 people were novices (6 women, M_{age} = 47, SD = 13, age range 26 – 71). All participants were native speakers of Dutch, and were paid with a €15 voucher.

To confirm expertise, all participants completed a questionnaire assessing their knowledge of wine (following Hughson & Boakes, 2001; Lehrer, 1983; Melcher & Schooler, 1996). A non-parametric Mann-Whitney U test confirmed all wine experts had significantly higher scores than novices, $U = 0.0$, $p < 0.001$, $r = 0.86$.

Half the participants from each group were randomly allocated to the verbal condition, and half to the baseline condition.

Materials

Forty-eight stimuli were used in this study. There were 16 different red and white wines, selected for their distinctiveness. There were 16 wine-related smells from the "*Le nez du vin*" kit (Lenoir, 1995), i.e., aromas that can be found in wine, including wine faults. A further 16 were common household smells, using real objects, ranging from cleaning and beauty products, herbs and spices, to food. All smells were presented in small 30 ml brown screwtop jars. A small tuft of scentless polyester hollow fiber in each jar obscured the object inside so the participant could not see it.

Procedure

Twenty-four of the 48 stimuli (four white and four red wines, eight wine-related smells, and eight common smells; all chosen at random) were presented to the participant in random order during the encoding phase. Participants were informed there were three types of smells (i.e. wines, wine-related smells and common smells). In the verbal condition, participants were instructed to smell the odors and name them as quickly and precisely as they could. In the baseline condition, participants were just asked to remember the odors as best as they could. All participants were told they would be tested for their odor memory later.

After going through the 24 smells in the encoding phase, there was a 10-minute break in which participants completed the wine knowledge questionnaire, and two other questionnaires.

In the recognition phase, participants smelled all 48 stimuli one by one, and told the experimenter for each of the odors whether they had smelled the odors before. They named all the odors too.

Results

Odor memory

We first analyzed participants' recognition memory. Were experts better at remembering odors than novices? In addition, were they better in the verbal condition than in the

baseline? Following detection theory, hits and false alarms were first coded from participants' responses for each odor type. From these values, *d'* was calculated (Macmillan & Creelman, 1991; Parr et al., 2002). The larger the *d'*, the better the participants were able to distinguish between old and new odors. A three-way mixed ANOVA with expertise (wine expert vs. novice) and condition (verbal vs. baseline) as between-participant factors, and odor type (wine, wine-related, vs. common) as a within-participant factor was conducted, with *d'* as the dependent variable.

Experts were no better at remembering odors overall than novices, F (1, 44) = 0.64, p = .427, η_p^2 = .01, and naming the odors during encoding did not improve memory, F (1, 44) = 0.46, p = .503, η_p^2 = .01. There was, however, a main effect of odor type. Common odors and wine-related odors were remembered better than wines, F (2, 88) = 41.53, p < .001, η_p^2 = .49. There was no significant interaction between expertise and verbal condition, F (1, 44) = 1.40, p = .244, η_p^2 = .03, and no significant three-way interaction between verbal condition, expertise, and odor type F (2, 88) = 0.92, p = .402, η_p^2 = .02. So it appears experts do not benefit any more from verbalizing smells than novices.

There was no overall effect of expertise on odor memory, but we had specifically predicted experts' memory for odors would be restricted to smells in their domain of expertise (i.e., to wines and wine-related odors). The interaction between expertise and odor type was not significant, F (2, 43) = 2.35, p = .108, η_p^2 = .10, but Bonferroni corrected pairwise comparisons (as recommended by Hsu, 1996) demonstrated wine experts were significantly better at remembering the smells of wines (M = 0.23, SD = 0.56) than novices (M = -0.13, SD = 0.57), p = .036, d = .63. This was not true for wine-related smells, for which wine experts did not differ significantly from (M = 1.1, SD = 0.72) novices (M = 1.3, SD = 0.75), p = .394, nor was there a significant difference between experts and novices for common household smells (wine experts, M = 1.2, SD = 0.60, vs. novices, M = 1.0, SD = 0.97), p = .548.

Overall, these analyses show wine odors were particularly hard to remember for both experts and novices. Nevertheless, wine experts were better than novices at remembering whether they had previously smelled a specific wine. The results also suggest naming odors explicitly during encoding did not help improve odor memory, consistent with the suggestion experts' superior memory for wine odors is not verbally mediated. To test this proposal more directly, we conducted additional analyses examining the relationship between naming and memory.

Odor naming

Previous studies with novices suggest remembering an odor successfully depends on the ability to name that odor accurately and consistently (e.g., Cessna & Frank, 2013; Fiore et al., 2012; Frank, Rybalsky, Brearton, & Mannea, 2011). Therefore, we first examined the naming data more closely. Half the participants named odors twice during the experiment (verbal condition); i.e., during encoding and then again during recognition. The answers for those participants were coded for consistency (i.e., did they give the same label during encoding and recognition?). In addition, the labels of all participants during the recognition phase were coded for accuracy. An answer was considered correct if participants gave the same answer as the pre-determined "veridical" label. For wines it was considered correct if participants gave the correct color, grape type, or production country. Coding was done by the experimenter and one independent researcher.

A two-way mixed ANOVA with expertise and odor type as factors, and percentage of consistently named odors as the dependent variable, showed wine experts (M = 47.5, SD = 23.8) gave more consistent labels than novices (M = 29.3, SD = 19.0), F (1, 44) = 12.24, p = .002, η_p^2 = .36. There was also a main effect of odor type, F (2, 44) = 16.37, p < .001, η_p^2 = .42. Bonferroni corrected pairwise comparisons showed common odors (M = 46.2, SD = 23.9) were more consistently named than wine odors (M = 18.2, SD = 21.2), p = .018, d = .8. Wine-related odors (M = 50.9, SD = 24.8) were also more consistently named than wine odors, p = .009, d = 1.0. There was no difference between common odors and wine-related odors, p = .332. There was no interaction between expertise and odor type, F (2, 44) = 0.82, p = .448, η_p^2 = .04, but Bonferroni corrected pairwise comparisons showed wine experts gave more consistent answers for wine odors (M = 28.1, SD = 21.4) than novices (M = 8.3, SD = 16.3), p = .018, d = 1.0. Wine experts also gave more consistent answers for wine-related odors (M = 63.5, SD = 24.1) than novices (M = 38.3, SD = 19.0), p =.009, d = 1.2. But there was no difference between wine experts (M = 51.0, SD = 25.8) and novices (M = 41.4, SD = 21.8), p = .332, for common odors.

This analysis was also repeated with percentage of correctly named odors as the dependent variable. Wine experts (M = 33.0, SD = 17.0) named more odors correctly than novices (M = 24.8, SD = 19.2), F (1, 46) = 4.91, p = .032, η_p^2 = .10, and wines were more often correctly named than wine-related odors or common odors, F (2, 45) = 5.7, p = .006, η_p^2 = .20. There was no interaction between expertise and stimulus type, F (2, 92) = 1.6, p = .217, η_p^2 = .03, but Bonferroni corrected pairwise comparisons showed wine experts (M = 44.8, SD = 25.4) were more accurate in naming wines than novices (M = 29.7, SD = 26.1), p = .048, d = .59. This was not the case for wine-related odors (wine experts M = 26.8, SD = 12.7 vs. novices M = 20.3, SD = 14.4), p = .104, d = .48 or common odors (wine experts M = 27.6, SD = 13.0 vs. novices M = 24.5, SD = 17.1), p = .480, d = .20. In line with the results for consistently named odors, wine experts had a domain-specific advantage for accurately naming wine odors, but not other types of odors.

To summarize, experts were more consistent and accurate than novices when naming wine odors. In addition, experts were also more consistent (but not more accurate) than novices when naming wine-related odors. Odor naming for common odors was comparable across experts and novices.

Relationship between odor memory and odor naming

So, was naming consistency and accuracy related to experts' superior memory for wine odors? To test this, the correlations between *d'* and naming consistency, and *d'* and naming accuracy were calculated for the different stimuli, for wine experts and novices separately (see Table 1).

The correlation analyses replicated the previously established finding (e.g., Cessna & Frank, 2013) that novices have better odor memory for common odors they named correctly, $r = .523$, $p = .004$. They also have better memory for wine-related odors they named correctly, $r = .518$, $p = .005$. No other correlations were significant for this group.

For wine experts, there was a similar trend of better memory for correctly named common odors $r = .309$, $p = .071$, but this was not significant. Similarly, there was a positive correlation between naming accuracy and memory for wine-related odors, $r = .463$, $p = .011$. Critically, memory for wine odors and naming consistency and accuracy were not positively correlated (see Table 1); in fact, if anything, memory for wines and naming accuracy had a small (insignificant) negative relationship. Taken together, these results suggest the superior memory for wine odors displayed by wine experts is not verbally mediated, even though they seem to remember wine-related odors and common odors by their names, just like novices.

Table 1: Correlations between odor memory and naming consistency and accuracy for wine experts and novices (Pearson's correlation coefficients, reported *p*-values are one-tailed)

		Wine experts		Novices	
Naming	Odor type	*r*	*p*	*r*	*p*
Naming consistency	Wines	.041	.449	-.320	.155
	Wine-related odors	.381	.111	.130	.343
	Common odors	.385	.108	.328	.149
Naming accuracy	Wines	-.151	.241	-.036	.433
	Wine-related odors	.463	.011	.523	.004
	Common odors	.309	.071	.518	.005

Discussion

Wine experts were better than novices at remembering the odor of wines. This replicates a number of previous studies (Hughson & Boakes, 2009; Melcher & Schooler, 1996), and corroborates the proposal that wine experts superior memory for odors is restricted to wines (Zucco et al., 2011). Wine experts were no better than novices at remembering common household odors, or even wine-related odors.

We also found wine experts were more consistent and accurate than novices when naming wines, and this extended to wine-related odors. This is an interesting finding in its own right. Previous studies suggest wine experts' descriptions are highly idiosyncratic (Lawless, 1984), and experts are no more consistent in their descriptions for wine-related smells than novices (Parr et al., 2002, 2004). In this study, experts were more accurate and consistent than novices, but only for the odors from their domain of expertise. This replicates the finding of Croijmans and Majid (2016) that wine experts name wine odors, but not common odors, more consistently than novices. Note, the current study adds a new dimension to the issue. Croijmans and Majid (2016) found wine experts as a group were more consistent with each other in how they talk about wine odors than novices, whereas the current study shows experts are also more consistent with themselves when they name the same wine odors at two different times (cf. Brown & Lenneberg, 1954).

Since language influences odor memory amongst novices (Fiore et al., 2012; Frank et al., 2011; Lehrner et al., 1999; Lesschaeve & Issanchou, 1996), we asked whether it was also the basis of wine experts' superior memory for wine odors. But there was little evidence in support of this proposal. Experts were no better at remembering wine odors in the verbal condition than the baseline (i.e., non-verbal) condition. Moreover, there was no significant correlation between odor memory for wines and odor naming accuracy or naming consistency.

To recap, wine experts were only better at remembering the odors of wines, but they were more consistent and accurate in both their descriptions of wines *and* wine-related odors. During wine experts' training, they are taught to identify and name different aroma components of wines (Herdenstam, Hammarén, Ahlström, & Wiktorsson, 2009; Lehrer, 1983). This is exactly the sort of skill the *Le nez du vin* kit (Lenoir, 1995) is designed to help with. So, the greater consistency for naming wine-related odors probably comes from specific training to identify wine-related odors.

Wines are complex. They can contain up to 800 different volatiles (Ortega-Heras, González-SanJosé, & Beltrán, 2002). When remembering the odors of wines, experts appear to remember the whole gestalt rather than the individual components of a wine. An analogy can be made to memory for faces. Humans are excellent at remembering faces, yet perform poorly when having to recall individual features of faces, such as a nose, eye, or mouth (Tanaka & Farah, 1993). Expert memory for wines, similarly, appears to be holistic instead of featural.

Another analogy can be made to chess experts. Chess experts are better at remembering the layout of chess plays than novices (Frey & Adesman, 1976; Gobet & Simon, 1996). However, these layouts have to be possible configurations that are encountered during real chess games. Experts are no better than novices at remembering randomly assembled layouts (Frey & Adesman, 1976; Gobet, 1998). This suggests chess experts have learned to remember particular configurations of arrays.

These analogies suggest wine experts are perceptually processing wines in a different way to novices (e.g., Hughson and Boakes, 2009). As wine students become experts, it seems a shift occurs which encourages the holistic processing of wines. Aside from the perceptual gestalt, this representation likely includes knowledge about the specific wine from its particular region made from

particular grapes (Solomon, 1997). Wine-related odors, when presented out of context, seem to be processed similarly to common odors. This is exemplified by the relationship between language and memory for wine-related and common odors in both experts and novices; and also the absence of a wine-related odor memory advantage amongst wine experts.

The results from the current study suggest language is not directly involved in remembering wine odors. However, we cannot rule out the possibility that experts and novices recruited language sub-vocally during the baseline task: i.e., they could have been naming the odors silently. A better way to test whether odor memory is verbally mediated would be to test if experts are still better at remembering wine odors when performing a simultaneous verbal interference task. Chess grandmasters are apparently not hindered in their memory for chess board positions if they perform a verbal task at the same time as encoding a chess board layout (Robbins et al., 1996). However, novices' memory for odors is harmed if they have to perform an odor memory task simultaneously with a verbal interference task (e.g. Annett & Leslie, 1996). This raises the interesting question of what would happen with wine experts if they have to remember wine odors under verbal interference. If wine experts' odor memory is truly not verbally-mediated, then experts' odor memory should not be harmed by a verbal interference paradigm. If, on the other hand, they are using language (just like novices with common odors), their advantage for remembering wine odors should disappear.

In conclusion, our results show wine experts are better than novices at remembering wine odors, and at describing wines and wine-related odors. However, the results show little evidence that these two aspects of expert cognition are related. That is, wine experts' better memory for wine odors does not seem to be based on their ability to name wine odors.

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