ORIGINAL CONTRIBUTION

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Smell training increases cognitive smell skills of wine tasters compared to the general healthy population. The WINECAT Study*

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SUMMARY

Background: *Wine experts show higher accuracy than novices in selecting a wine that matches a sample. Only one study has compared wine experts with non-trained healthy controls on smell. The aim of this study was to compare the smell characteristics, both sensorial and cognitive, of wine tasters with Spanish healthy population using the Barcelona Smell Test-24.*
Methods: *Wine tasters were tested for smell and compared with a control group of healthy volunteers, by tasting 20 odours and scoring smell detection, identification, intensity, irritability, freshness, pleasure and forced choice.*
Results: *Wine tasters performed significantly better on identification and forced choice than healthy controls. In addition, wine tasters perceived more odours as intense, but fewer as irritating than controls.*
Conclusions: *Probably linked to smell education, wine tasters show better cognitive but not sensorial smell skills than a non-trained healthy population.*

Key words: wine tasters, controls, Barcelona Smell Test 24 (BAST-24), olfaction, smell identification test

INTRODUCTION

The olfactory system is very important in determining food flavours. In the process of chewing and swallowing, odour-laden air is forced from the rear of the oral cavity to the olfactory receptors, evoking many flavour sensations that people usually associate with taste but that are almost completely dependent on the sense of retronasal smell [(1)]. The volatile component of a wine is typically nasally perceived before tasting and could play a fundamental role in determining its type, age, condition and overall quality.

Although humans can rarely identify an individual odour being present in a mixture of components, the performance is slightly better in laboratory trained non-experts and in odour experts (perfumers and flavourists) than in untrained subjects [(2)].
Wine experts show higher accuracy than novices in discriminating the wine that matches a given sample from a set of alternatives [(3)]. To our knowledge, only one study has compared wine experts with controls on smell detection of an element in a compound stimulus using common as opposed to wine-specific odours. Professional wine tasters require a lower concentration of a given odour for discrimination on a mixture of wine relevant odorants, and this skill increases with experience [(4)].

There is a need for well-controlled experiments to investigate the perceptual abilities of wine tasters. Odour-identification tests for clinical use have been developed in different countries and cultures. However, the nature of odour identification, closely related to familiar and cultural aromatic items, usually limits the use of olfactory tests to the country or region where they have been developed and validated. The Barcelona Smell Test-24 (BAST-24) is an olfactory subjective instrument which has been tested for reproducibility and validation in a healthy Spanish population [(5)] but has not been used thus far to evaluate the smell capabilities of wine tasters.

The aim of this study was to compare the sensorial and cognitive olfactory functions as well as the perception of smell char-

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acteristics between professional wine tasters and a healthy Spanish population using the BAST-24.

MATERIALS AND METHODS

Study population

Wine taster students from the Oenology School of the Universitat Rovira i Virgili de Tarragona with at least one year of smell and taste training. Eleven males and 10 females with a mean age of 29 ± 4.4 years (ranging from 24 to 41 years). From a potential control group of 120 healthy volunteers without subjective olfactory disturbances, 40 subjects – 20 females and 20 males (ranging from 21 to 40 years) – were selected to match characteristics of the study group.

Approval for this study was obtained from the Ethics Committee of our institution and a signed informed consent was obtained from all subjects.

Inclusion and exclusion criteria

Wine tasters were all students or young staff from the Oenology School who tasted and smelled wine regularly and had at least one year of smell and taste training. All subjects were healthy, and in both groups, individuals with neurodegenerative disorders such as Alzheimer and Parkinson diseases, and nasal disorders such as nasal polyps, chronic rhinosinusitis, or allergic rhinitis were excluded from the study.

Study design

Anterior rhinoscopy, nasal endoscopy and smell test were performed individually by the same otolaryngologist on the same day. There was no significant difference between the groups in terms of age, gender or smoking habits.

Odour-identification test (BAST-24)

Twenty chemical odorants were selected to assess the 1st cranial nerve: banana, gasoline, lemon, rose, onion, smoke, aniseed, coconut, vanilla, melon, orange, bitter almond, pineapple, cheese, strawberry, mushroom, eucalyptol, clove, turpentine, and peach.

The smell test was performed in a quiet, noise isolated, well ventilated room, with controlled humidity and temperature (21-23°C). All the odorants were located in hermetic glass jars. Neither the examiner nor the wine tasters or healthy controls were allowed to wear perfumes, lotions or creams on the day of testing. The odorant jar was positioned at 1 cm below the nose and without contact to the researcher's finger or the volunteer's face. After being exposed for 5 seconds to each odorant, volunteers were asked by the investigator to answer a number of questions to test: 1) smell detection: "did you smell something?"; 2) smell identification: "did you recognize this odour?"; 3) smell intensity: "was this odour intense?"; 4) smell irritability: "was this odour irritating?"; 5) smell freshness: "was this odour fresh?"; 6) smell pleasure: "was this odour pleasant?"; 7) smell forced choice: "which of this four odours did you smell?". The first six questions had two possible answers: yes (1) or no (0), while the seventh question had four forced multiple choice answers, and only one was correct. The test was repeated for each of the 20 odours. For all smell characteristics, the total score was 0 to 20 (0 -100%).

Statistical analysis

Data analysis was performed with the statistical package SPSS 15.0 for Windows (SPSS Inc, Chicago, IL, USA). The Mann–Whitney U test was used to compare smell characteristics between the wine tasters and the healthy control population. A p-value of less than 0.05 was considered statistically significant. The data was presented as mean ± SD (standard deviation).

RESULTS

Wine tasters and healthy controls scored similarly in smell detection (100% versus 99 ± 1%, respectively) but the wine tasters performed significantly better on identification (72 ± 17%; $p < 0.05$) and forced choice (85 ± 11%; $p < 0.05$) compared to healthy controls (63 ± 20% and 74 ± 11%, respectively). In addition, wine tasters reported more odours as intense (80 ± 13%; $p < 0.05$), but fewer odours as irritating (18 ± 12%; $p < 0.05$) than controls (57 ± 17% and 37 ± 12%, respectively). Wine tasters showed no significant differences in perception of freshness (45 ± 16%) or pleasure (63 ± 12%) when compared to healthy volunteers (42 ± 19% and 58 ± 16%, respectively) (Figure 1).

DISCUSSION

The WINECAT study is the first investigation to compare olfactory perceptions of wine tasters with those of non-trained healthy controls using a smell test that has been validated for this population. The most important findings of the study were: 1) wine tasters have an increased ability to correctly identify odours than a non-trained healthy population; 2) wine tasters perceive odours as more intense and less irritating with a superior frequency than non-trained subjects.

It is well known that olfactory discrimination of unfamiliar odours improves rapidly with odour exposure [6]. One study

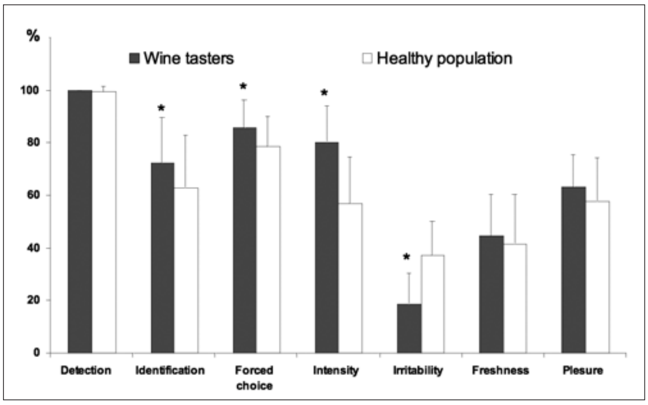

Figure 1. Smell characteristics of odours: comparison between wine tasters and controls. *$p < 0.05$.

has reported improvement in odour discrimination after subjects were trained for one hour, but failed to show an improved discrimination for non-trained odours [7].

Repeated assessment of smell detection has been found to consistently decrease the smell threshold for four odorants [8]. Nevertheless, some researchers have indicated that sensitivity to odours rapidly decreases with repeated exposure to either orthonasal or retronasal odours, and it takes an appreciable time for full sensitivity to recover when the odour is removed [9-12].

In a recent study, Hummel et al. [13] evaluated the impact of exposure to high concentrations of environmental odours on general olfactory function, comparing 58 subjects employed in perfume retail outlets with controls, matched for age and gender, who worked in less odorous environments. They found no differences between groups in odour identification or odour thresholds, although subjects working in perfume retail outlets were better than controls in supra-threshold odour discrimination. These findings would suggest that exposure to odours produces an increase in the ability of discriminating odours [13].

It was recently reported that training with odorants increases olfactory function in subjects with hyposmia. This is a very important clinical finding because one quarter of the patients who consult to a smell clinic, think their disorder has not been well managed [14], but also because it suggests that the sense of smell may have the ability to change and recover.

Most of the studies about wine tasters compare subjects with different levels of experience or training, confirming that wine experts can perform at a higher level than novices in tasks that require discrimination, recognition, or matching on the basis of wine sample description. In 1990, Solomon suggested that the superiority of experts in correctly matching wines in sample testing may be based on more consistent use of verbal descriptors [15]. However, a later study showed that wine tasters were better at discriminating between wines even in the absence of the linguistic skills associated with formal wine training [16]. These findings were later corroborated by Parr et al. [16] by comparing 11 experts with 11 novice wine judges. Detection thresholds for n-butyl alcohol did not differ between groups, but experts showed superior discrimination of olfactory stimuli when compared with novices for wine relevant odours. However, there was no evidence of superior olfactory identification by experts; nor did expertise affect the consistency of labeling wine relevant odours. Although they found no correlation between odour recognition and the consistency of identification by either experts or novices, they did point to such a trend which may have been significant had the sample size been larger, suggesting that verbal skill may interfere with olfactory performance in expert wine judges [17]. To minimize the advantages of experts and enhance the sensory measurement and performance of non-experts, Zamora et al. [18] used a list of descriptions generated by trained assessors, to compare the performance of wine experts and subjects trained in sensory analysis but with little experience in wine tasting. They found that the trained panel reached a higher level of consensus, while the experts were more discriminative among attributes and were better in replicating terms [18]. In a recent study, it was reported that untutored experience can also improve wine recognition capabilities [19].

To date, only one study has compared the sense of smell between wine experts and non-trained healthy controls on smell detection for a given element in a compound smell stimulus, using common as opposed to wine-specific odours. They used eugenol ("clove") and citral ("lemon") in a task where participants had to discriminate between eugenol and a mixture of eugenol and citral, using a two-choice ascending method of limits in which the concentration of citral was adjusted. Wine tasters required a weaker citral concentration to make this accurate discrimination. When absolute thresholds were measured for 1-butanol, wine tasters produced similar results to a matched group of non-experts. Wine tasters performed significantly better on identification of 16 odour stimuli than controls. However, this overall effect was predominantly due to a few odours (lemon, orange, cinnamon, lilac). They therefore determined to what extent wine tasters had professional experience with each of the 16 sets of test stimuli by calculating an "experience factor", which was found to significantly correlate with the number of correct identifications among wine tasters. It seems logical to expect that, at an elementary level, experts would show greater accuracy in component identification. This hypothesis is confirmed by the finding that, when experts and novices sampled 16 odours and then, after each odour, were asked to identify its source from a list of four alternatives, experts showed greater accuracy in the task. While there was a tendency for the wine tasters with the higher experience factor to outperform the controls for the 8 sets of stimuli, no such tendency was found for the 8 sets with the lowest experience factor. Rather than indicating that professional experience with wine-related compounds reflects generally superior sensory abilities, this suggests professional experience contributes to perceptual learning in odour identification [4].

In the WINECAT study, although olfactory threshold or discrimination tests were not used, a validated smell test [5] with common odorants, was used to compare performance of wine tasters with that of a control group. This study confirms previous evidence that olfactory performance is facilitated by perceptual learning. Although previous studies that compare wine experts with novices have found differences in odour discrimination, they have not found differences in odour identification. However, when comparing wine tasters with controls, Bende et al. [4] did find that wine tasters were better at identifying wine related odours. We also found that wine tasters outperform controls in the identification of odours. These results would suggest that the ability to identify odours is related to perceptual learning, and that wine tasters have an acquired skill in identifying odours related to wine, like those in our set of odours (aniseed, lemon, vanilla, rose, orange, banana, pineapple). Although controls experience these odours during their daily lives, they have not been formally trained in identifying them.

Another interesting finding in our study is that wine tasters described more odours as intense, but fewer odours as irritating when compared to controls. This could be explained by the more consistent use of verbal descriptions associated with formal wine training, or by a higher sensitization and level of tolerance in those subjects trained to detect small changes in odorants, and used to intense odours over prolonged periods. It could be also be explained by functional changes mediated peripherally. Evidence has shown that repeated exposure to an odorant (androstenone) can increase the sensitivity of the olfactory epithelium to that odorant in genetically anosmic rats [20] and of olfactory receptor cells in salmon (phenyl ethyl alcohol) [21].

The non superiority of wine tasters over controls on detection may be explained by the fact that wine tasters have no training in detection per se, implying that odour learning does not transfer from the olfactory task of identification to the detection of odours. An other hypothesis is that detection is purely sensorial and therefore not altered by training, while identification is a cognitively mediated task.

CONCLUSION

In conclusion, our study demonstrates that wine tasters are superior to a non-trained healthy population in their abilities to identify odours by name and to identify a specific odour among 4 possible choices. These cognitive abilities do not extend to sensorial smell detection. In addition, wine tasters perceive odours as intense and not irritating with more frequency than non-trained subjects.

There is an obvious need for well designed prospective, randomized studies, with validated smell tests, to compare olfactory functions in wine tasters with different levels of training, with those in healthy controls to determine the potential influence of perceptual learning and verbal skills in olfaction.

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