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Is the Perception of Odor Pleasantness Shared Across Cultures and Ecological Conditions? Evidence from East Africa, Amazonia, New Guinea, Poland and Malaysia.

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Abstract

What makes an odour pleasant or unpleasant? The inherent properties of the constituent chemical compounds, or the nose of the beholder, driven by idiosyncratic differences and culture-specific learning? Here we present data from 582 individuals, including Tanzanian Hadza hunter-gatherers, Amazonian Tsimane' horticulturalists, Yali from the Papuan highlands, and two industrialized populations (Poles, Malaysians). We find similarities in odour preferences across cultures, but our data do not fully support a previous claim regarding universality of smell preferences. Despite cross-cultural similarities in olfactory assessments, likely driven by odour properties, we suggest that odour availability in ecological and cultural niches bears an undeniable effect on human odour preferences.

Keywords: sense of smell; odour pleasantness; smell perception; ecological niche

Pleasantness is a fundamental aspect of odour perception [1]. Most odours evoke positive or negative emotional responses which influence behaviour in numerous ways. Despite this, surprisingly little is known about cultural universality or specificity of odour pleasantness. On the one hand, associative learning or repeated exposure to olfactory stimuli, differing across cultures, may affect odour valence [2]. On the other, pleasantness of certain odours appears independent of experience, evidenced by studies on new-borns [3], or by consistent links between pleasantness and physico-chemical properties of odorant molecules [4]. The extent to which odour valence is engraved within its physico-chemical structure or shaped by the smeller's/perceiver's experience remains critically important but poorly understood. Several studies have tackled this problem by exploring odour preferences in different countries [5-10]. Some studies report cultural differences in fragrance preferences, while others do not. In the largest cross-cultural study to date, conducted in collaboration with the National Geographic Society, responses were received from over a million people in approximately 80 countries [11]. Subjects were asked to rate each of the six microcapsules on various scales, including pleasure. This study revealed differences in pleasure ratings across regions of the world [7]., Furthermore, Oleszkowicz and colleagues, presented data from more than 500 children across 18 countries, finding that hedonic perception of odours in children aged between 5 and 8 years was rather consistent across all countries.

Because almost all the above-mentioned studies (but see: [9]) involved mostly industrialized societies with access to the global marketplace, it may be that they tend to overestimate shared preferences. A better estimate might be obtained by studying people isolated from exposure to olfactory influences from other cultures and who are immersed exclusively in odours pertaining to their ecological niches. Arshamian and colleagues [12] used this approach to record pleasantness ranking of ten odorants by individuals from nine non-industrialized societies. They concluded that 41% of the variance in odour valence was explained by the odorant's properties, while only 6% was explained by culture. Arshamian and colleagues concluded that there might be cultural universality in odour evaluation.

Here we present data of a similar type. Our study was not designed to be a direct replication of Asharmian and colleagues [12], as our data had already been collected before their paper was published. However, because our samples come from diametrically different ecological and cultural backgrounds, including African Hadza, Amazonian Tsimane', Papuan Yali, and two industrialized but distinct and geographically distant populations (Poland and Maleysia), our data presents an opportunity to explore the extent of odour preference universality and to facilitate understanding of the mechanisms that mighty be behind possible cultural differences in the perception of smells.

Method

Participants

The participants (N = 582) were volunteers from five distinctive ecological and cultural backgrounds: African Hadza – hunter-gatherers form Tanzanian savannah (general overview: [13]), Amazonian Tsimane' Amerindians – forager-horticulturalists inhabiting lowland forests (general overview: [14], olfaction studies among Tsimane: [15-16]), Papuan Yali – horticulturalists from New Guinea highlands (general overview: [17]), and two distinct and geographically distant populations (Poles and Malaysians, about which information is common and can be found everywhere). The samples comprised 86 Hadza (47 men and 39 women,*M* age = 33.32, Tanzania – Lake Eyasi Basin), 96 Malaysians (39 men, 57 women, *M* age = 21.70, city of Sintok), 200 Poles (100 men, 100 women, *M* age = 32.62, city of Wrocław), 144 Tsimane' (71 men, 73 women, *M* age = 31.97, Bolivia – banks of the Maniqui River) and 56 Yali (35 men, 21 women, *M* age = 41.29, Indonesia – highland around Baliem Valley). Both Polish and Malaysian populations can be regarded as industrialized. Hadza, Tsimane', and Yali base their lifestyle on a subsistence economy with little market integration (e.g., they still hunt to ensure their food, Tsimane and Yali are gardeners for their own needs, while Hadza and to a lesser extent Tsimane and Yali collect fruits and plants). Individuals from these indigenous societies who have taken part in our research do not have electricity or other modern amenities, and live in the natural environment. All the participants gave their informed consent to be included in this research. The study procedure complied with the Declaration of Helsinki and received the approval of the authors' institutional ethics committee as well as ethical approvals from the head of the local Yali community in West Papua, from the Tanzania Commission for Science and Technology (COSTECH), and from the Great Tsimane' Council (the governing body of the Tsimane'). Approval for the research in Poland and Malaysia was given by local universities.

Materials

The research was conducted over several years, among very diverse populations with very different experiences not only with researchers but with contact with people from outside their communities, therefore the methods as well as the number of respondents in individual places differ slightly. However, because of the unique diversity of the societies we studied, we wanted to present data from all of them.

In each region of the world, the study was conducted by two (or one of) the same trained investigators (XX and YY). In Malaysia and Poland, researchers spoke the language of a given community. In other countries, we used expert translators experienced in previous scientific research. Independently, we checked whether our subjects understood the questions and the purpose of the study in various ways, for example by randomly checking whether they responded coherently to the smells previously presented to them. We presented participants with 15 odour samples. Of these, butanol, banana, coffee, cinnamon, eucalyptus, clove, rose, leather, turpentine, grass, and onion were from the Sniffin' Sticks identification subtests [18] manufactured by Burghart Messtechnik GmbH, Wedel, Germany. In addition, we used butter (#P0620830), peach (#P0606040), strawberry (#P0603875) and thyme odours (#P0123774) from the Frey und Lau company, Henstedt-Ulzburg, Germany, manually injected into empty Sniffin' Sticks containers. When choosing fragrances, we tried to choose scents that seem attractive (e.g. strawberry, cinnamon) or repulsive (e.g. onion, butter) (some reference) in Western culture and avoid completely artificial scents that could be completely alien to non-Western culture. The subjects rated whether they were familiar with the smell and how pleasant it was. The order of questions about pleasantness and familiarity was randomized. The Hadza and the Yali used 3-point scales to rate odour pleasantness (1 – "I do not like it at all", 2 – "I do not know", 3 – I like it a lot") and their ratings were scaled up to 5- point scales (1=1, 2=3, and 3=5) to reflect the scales used by Malaysians, Poles, and Tsimane' (1 – "I do not like it at all", 2 – "I do not like it"; 3 – "I do not know whether I like it", 4 – "I like it", 5 – "I like it a lot"). Correspondingly, we scaled up the 2-point familiarity ratings of Hadza and Tsimane' (1 – "I do not know this odour", 2 – "I know this odour") to reflect the 5-point scale used by other participants (1 – "I do not know this odour", 2 – "I suppose I do not know this odour", 3 – "I do not know whether I know this odour", 4 – "I suppose I know this odour", 5 – "I know this odour"). The Yali (as the first studied population) did not assess odor familiarity (in subsequent populations we decided that this variable should be taken into account).

Results

In the first step, we addressed the issue of differences in response scale ranges between Malaysians, Poles, and Tsimane', who rated odours' properties on a 5-point scale, and Hadza and Yali, who rated odours' properties on a 3-point scale. We followed a recommended practice, that is, we converted scales using the percent of maximum possible score (POMP; Cohen et al., 1999). POMP is a linear transformation of the original scores that accounts for the differences in the scale ranges, yet, preserves the underlying differences in responses (Mellenbergh, 2019). We used the following equation: New Score = (New Scale Maximum - New Scale Minimum) * (Old Score - Old Scale Minimum) / (Old Scale Maximum - Old Scale Minimum) + New Scale.

In the next step, using the lme4 package in R, we conducted a set of multilevel models with the maximum likelihood estimator and participants as random effects to verify the magnitude of variance explained by each predictor (see Table 1 and Table S1 in the Supplementary Material). Model 1.1 included only an intercept. Model 2.1 included odour identity as a predictor. In Model 3.1 we replaced odour identity with population as a predicting factor. In Model 4.1 we included an interaction between odour identity and population. Next, we repeated the above 4 steps but without data from the Yali sample (as they did not rate familiarity of the odorants), which allowed us to compare the models with odorant identity (Model 2.2), population (Model 3.2), interaction of odorant identity and population (Model 4.2), familiarity (Model 5.2), and all the above predictors (Model 6.2). Models 2.1 and 2.2 (with odorant identity as a fixed effect) had better fit to the data than Models 3.1 and 3.2 (with population as a fixed effect), $\chi^2 = 1345.2$, $p < .001$ and $\chi^2 = 1794.3$, $p < .001$, respectively. The most complex models, including the one with the interaction term of odorant identity and population (Model 4.1) and the interaction term of odorant identity and population and familiarity ratings (Model 6.2) had the best fit (for detailed results of the Likelihood Ratio Test, see Table S2 in the Supplementary Material). We then compared the amount of explained variance between odorant identity and population: odorant identity explained 14% of the variance in the full sample (Model 2.1) and 19% of the variance in the sample without data from the Yali (Model 2.2), while population – 7% in both the full sample and the sample without data from the Yali (Models 2.3 and 3.2). Yet, familiarity was even a stronger predictor of pleasantness ratings, explaining as much as 37% of the variance (Model 5.2), than odorant identity and population, which jointly explained 33% of the variance (Model 4.2).

In the next step, we complemented the above analyses by running ordinal multilevel models, in which we treated pleasantness ratings not as a continuous, but as an ordinal variable. The analyses yielded a similar pattern of results, which can be found in the Supplementary Material (Table S3).

Moreover, we observed population differences in overall preference to odours in different populations (Model 3). The odours were the least pleasant to Hadza (EMM = 28.8, SE = 1.51), then Malaysians (EMM = 36.7, SE = 1.43), then Tsimane' (EMM = 49.1, SE = 1.16), Yali (EMM = 54.2, SE = 1.87, no significant difference to Tsimane') and Poles (EMM = 54.8, SE = 0.99, no significant difference to Yali). However, when familiarity was included in estimating the means of pleasantness (Model 6.2), we observed differences between Malaysians (EMM = 39.3, SE = 1.24), Poles (46.7, SE = 0.88), and Tsimane' (EMM = 51.7, SE = 1.01), but not between Hadza (EMM = 39.6, SE = 1.33) and Malaysians.

We have also rerun the analyses with pleasantness ratings of the three most pleasant smells (Peach, Strawberry and Coffee) and the three least pleasant smells (Butter, Butanol, Grass) as outcome variables. The results revealed that familiarity ratings were more strongly related to pleasantness ratings for the three most pleasant smells ($\beta = 0.55$, SE = 0.02, 95%CI[0.51,0.59], $p < .001$) than the three least pleasant smells ($\beta = 0.46$, SE = 0.02, 95%CI[0.41,0.50], $p < .001$).

Additionally, in Figures 1 and 2, we visually presented odour pleasantness and odour familiarity scores across individuals and cultures. They allow the reader to perceive cross-cultural differences and similarities in olfactory preferences for each of the substances used. Since cross-cultural comparisons of preferences for some fragrances sound much more anecdotal than the abovementioned analyses, we have included them in the discussion.

Table 1

The estimates of multilevel models explaining the scores of odour pleasantness.

	Models with data from the Yali people							Models without data from the Yali people										
	Model 1.1	Model 2.1		Model 3.1		Model 4.1		Model 1.2	Model 2.2		Model 3.2		Model 4.2		Model 5.2		Model 6.2	
	B (SE)	*F*	*p*	*F*	*p*	*F*	*p*	B (SE)	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Fixed coefficients																		
Intercept	46.53 (0.70)							45.72 (0.75)										
Odorant identity		124.02	<.001			156.25	<.001		164.51	<.001			156.25	<.001			95.471	<.001
Population				69.92	<.001	85.54	<.001				85.60	<.001	85.54	<.001			30.023	<.001
Odorant identity * Population						23.83	<.001						23.83	<.001			19.814	<.001
Familiarity															3966.80	<.001	2626.209	<.001
Random parameters								Variance (SD)										
Participant	206.3 (14.36)	219.8 (14.83)		112.9 (10.63)		134.5 (11.60)		221.4 (14.88)	237.8 (15.42)		124.9 (11.17)		148.2 (12.17)		128.3 (11.33)		108.5 (10.42)	
Model fit																		
AIC	87267.9	85722.2		87047.4		84600.7		78074.1	76098.5		77870.8		75040.9		74187.8		72130.7	
BIC	87289.2	85842.4		87096.9		85145.2		78095.0	76217.0		77912.6		75473.1		74215.6		72569.3	
Pseudo-R2[a] (fixed)		0.14		0.07		0.28			0.19		0.07		0.33		0.37		0.51	
Pseudo-R2 (total)	0.14	0.30		0.14		0.38		0.17	0.37		0.17		0.44		0.46		0.59	

Note. Detailed results can be found in Table S1 in the Supplementary Material. [a]–Pseudo r^2 computed following the Nakagawa and Schielzeth (2013).

Figure 1

Odour pleasantness (A) and odour familiarity (B) scores across individuals and cultures. Each column represents a response of a single individual. B section does not contain the results of Yali, as we did not obtain their odour familiarity ratings.

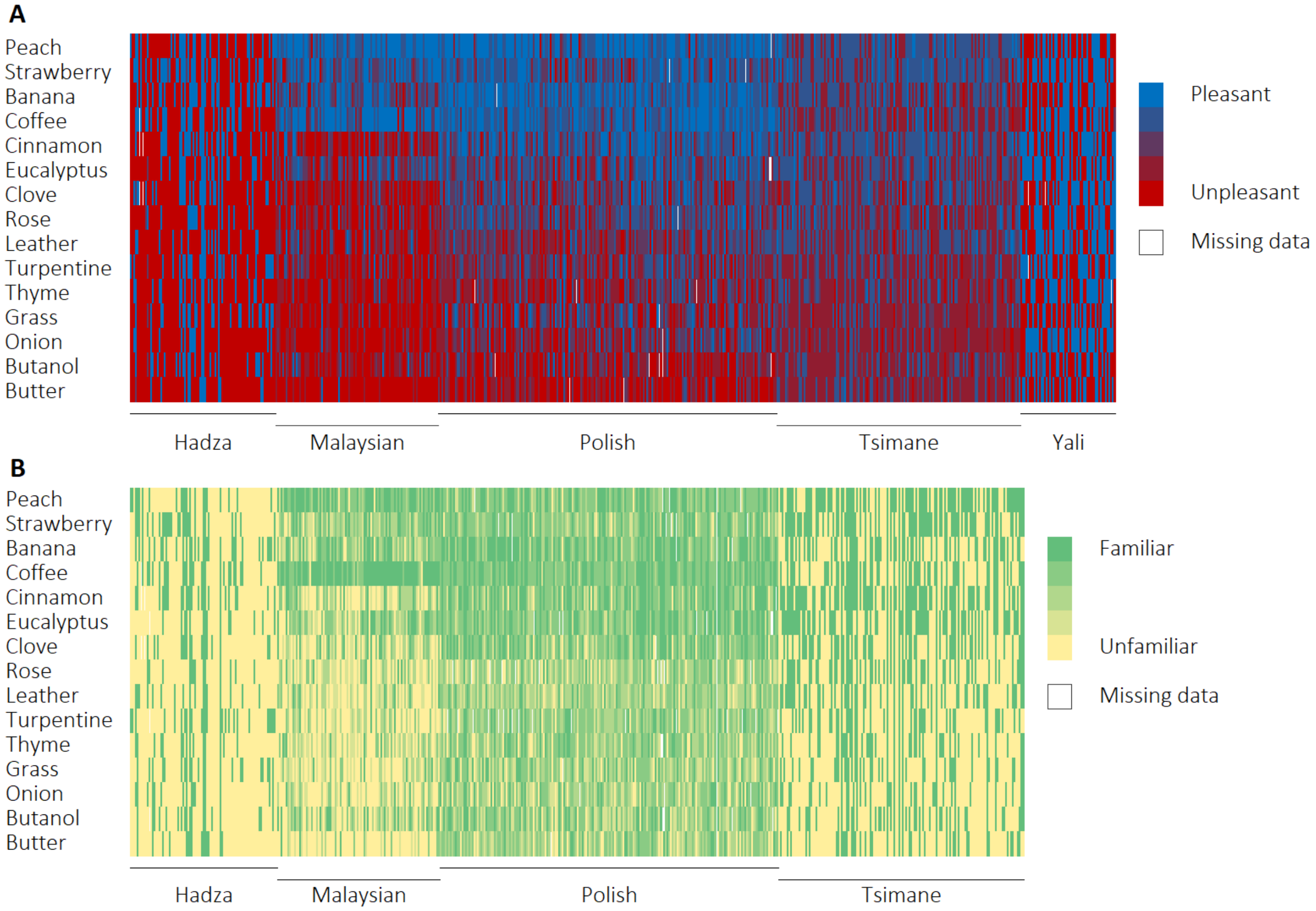
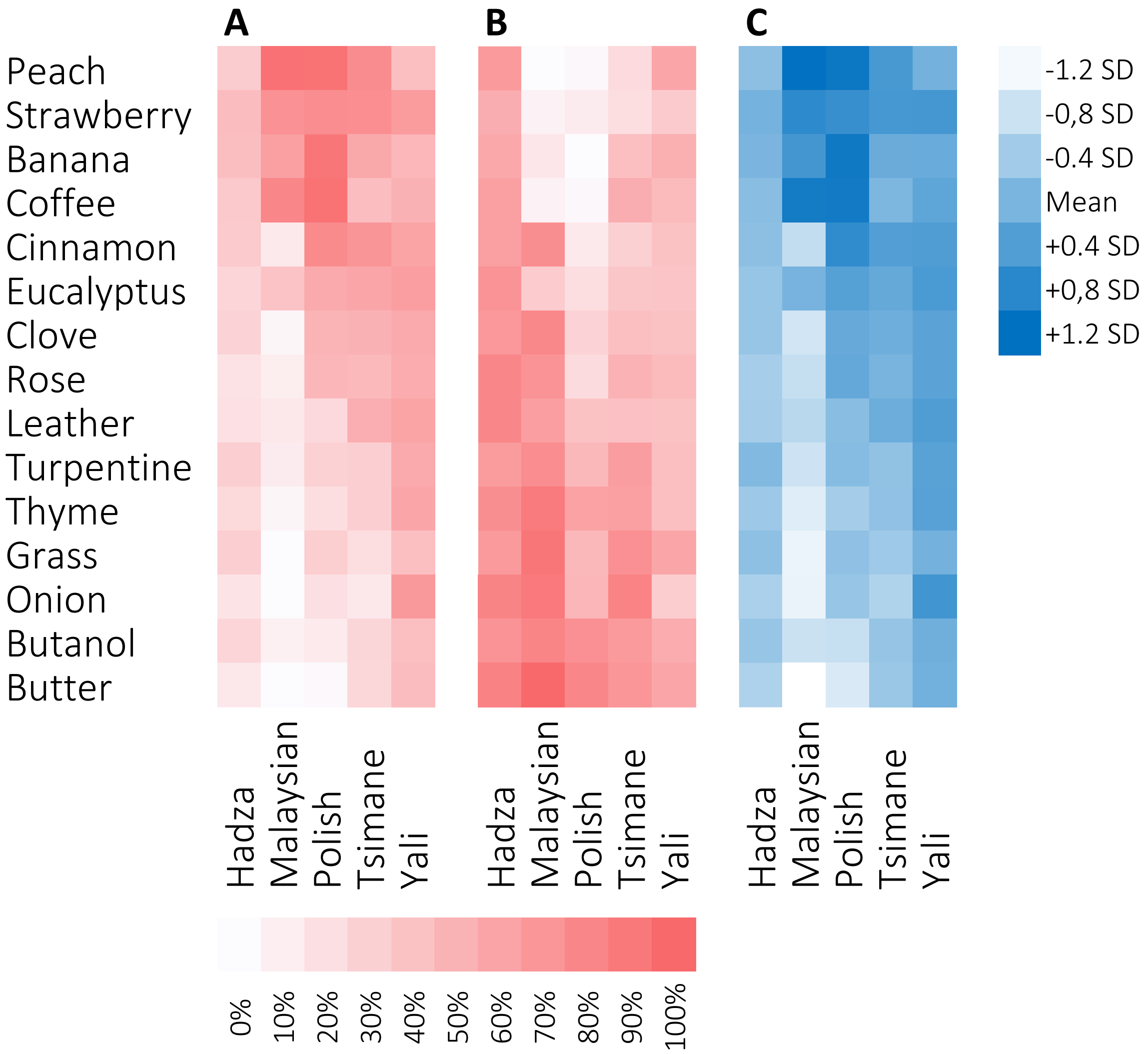


Figure 2

Percentage of participants in each group that rated each odour as the most pleasant (A) and the least pleasant (B). Average pleasantness scores for each odour (C).



Discussion

Our study was conducted in five populations from different ecological and cultural backgrounds. Similar to several other studies [6,9,12] we showed that odour preferences in our societies are relatively similar. The "Population" factor explained only 7% of variance of our results. However, our data also point to other cross-cultural differences. Our samples differed in general odour liking: Hadza and Malaysians found presented odours less pleasant than Yali and Poles. What is more, Yali's olfactory preferences turned out to be the most different from the rest, as they did not significantly correlate with the preferences of other societies. Examination of pleasantness ratings across odorants (Model 4.1, Figure 2) shows that fruity odours were most preferred (EMMs, Strawberry = 64.3, Peach = 62.8). The most unpleasant odours were Butter (24.1), Butanol (31.9), Grass (32.9), Onion (33.6), and Thyme (35.2). Again, however, preference patterns were far from uniform. For example, Yali liked Onion considerably more than the other populations, and Tsimane' liked leather but disliked coffee, which was pleasant for Poles and Malaysians (Figures 1 and 2).

Our ecologically and culturally distinct dataset complements that of [6, 7, 9, 12, 19] in efforts to understand human olfactory perception. Like theirs, our data suggest that olfactory preferences are probably influenced by physico-chemical properties of odours independent from culture. Our results diverge, however, in the extent to which odour pleasantness is universal. Although there was certainly cross-cultural consistency, like Wysocki [7] we found notable differences, raising interesting research questions.

First, variation in preferences in our study was strongly predicted by odour familiarity. For example, familiarity was the strongest predictor of pleasantness ratings (see Table 1, Figure 1, and Table S1 in the Supplementary Material). Furthermore, we observed that familiarity was more strongly associated with pleasantness of the three most pleasant odours than the three least pleasant odours, what corroborates the results of previous studies (Delplanque et al., 2015; Ferdenzi et al., 2013). Relatedly, familiarity seems especially important in dietary preferences [20-21], making food odours particularly prone to cultural variation. As humans are generalist feeders, innate preferences for cues of edibility seem unlikely – experience and learning enable us to acquire information about local foods. Indeed, odours of certain locally enjoyed foods (e.g., durian fruit in Southeast Asia, Chinese century eggs or French cheese) render them almost inedible by members of different societies. Dietary familiarity may hence be the crucial dimension shaping differences in odour preferences across human cultures. Second, cultural consensus in valence may be expected for odours associated with hazardous or pathogenic stimuli (such as odours of faeces or decomposing foods). In this respect, we agree with authors [9,19] who hypothesize that a universal tendency among populations to dislike bad smells (like butter and butanol in our study) could be adaptive, but agreement on liking smells is less probable. However, even this hypothesis is at odds with the outcome of a study undertaken by the US military to create a universal "stink bomb": it was impossible to find an odour that was unanimously considered repulsive across various ethnic groups [22].

Although our study offers novel insights into how different odorants are perceived across five distinct societies, some limitations are noteworthy. First, participants from two societies, namely Hadza and Yali, rated odorants properties on a 3-point scale, while participants from three societies—Malaysians, Poles, and Tsimane—on a 5-point scale. Additionally, participants from one society, the Yali, did not provide ratings for the familiarity of the odorants. As discussed earlier, pleasantness ratings are strongly related and likely influenced by familiarity ratings. The lower familiarity of Hadza participants with odorants, compared to, for instance, Polish participants, may have introduced some bias. Future studies could investigate pleasantness ratings across various societies, first establishing which odorants are relatively similarly known across the studied populations.

In conclusion, our study contributes to the ongoing discussion on the nature of human olfactory preferences. Our results demonstrate that, despite some cross-cultural consistency, odour preferences are complex and influenced by a combination of factors, which likely include familiarity, cultural background, and individual experience. Our findings emphasise that it remains important to consider cultural diversity in future research on human olfactory perception and suggest that the study of odour preferences has potential to provide insights into how biology and culture interact in shaping human behaviour.

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