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Odor Naming Methodology: Correct Identification with Multiple-choice versus Repeatable Identification in a Free Task

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Abstract

Since there is rarely a social labeling consensus in the identification of odors, it would be better to assess whether participants identify an odor by the same name upon repeated presentation rather than by the name designated as 'correct' by the experimenter (veridical label) in identification tasks. To examine the relevance of this proposition, participants were asked to identify familiar odors both in a free and a multiple-choice task. The free task was replicated in order to determine the percentage of repeatable identification. Results showed that the difference between the percentage of correct identification in the multiple-choice task and the percentage of repeatable identification in the free task was small, and that participants often used a repeatable name which differed from the veridical label. Thus, it was suggested that allowing participants to give their own name to an odor when it is not present on a pre-developed list, and measuring whether participants repeat the same name in independent measurements, might improve the relevance of multiple-choice tasks.

Key words: free identification, multiple-choice identification, odor, repeatability, veridical label

Introduction

Although humans detect odors quite well and can discriminate between hundreds of odors, their ability to identify an odor is extremely limited. In an unaided identification task, a person with a normal sense of smell is seldom able to identify familiar odors in >50% of the cases (Cain, 1979; Engen, 1987; Jönsson and Olsson, 2003). In fact, when asked to name an odor, one often experiences the 'tip-of-the-nose' phenomenon. One recognizes an odor as familiar and belonging to a general category, but is unable to recall its specific name. When given the name of the odor, it is recognized immediately and one is puzzled why one could not retrieve it before (Lawless and Engen, 1977). Despite the obvious difficulty for humans to identify odors, under certain circumstances it could be useful to assess human odor identification ability. To avoid the 'tip-of-the-nose' phenomenon and to facilitate the recall of odor names, several authors have designed multiple-choice procedures, such as the UPSIT (Doty *et al.*, 1984), the CCCRC olfactory test (Cain *et al.*, 1996) and the Sniffin' Sticks (Kobal *et al.*, 1996). In these tests, participants are asked to select the name of the odor from a list of labels provided by the experimenter. The use of such a paradigm improves participants' identification performance (Cain, 1982; Engen, 1987; Cain *et al.*, 1998); however, it is not free of potential problems.

First, almost all authors use a method in which only a very limited number of alternatives is offered per stimulus. This makes it possible for participants to find the right answer by elimination of irrelevant alternatives rather than by correct identification of the odor itself. Although presenting a large list of possible odor names is more difficult and time-consuming, it minimizes this problem. Secondly, giving a fixed list of labels and verifying only whether participants choose the 'correct' one presupposes that everybody agrees on the same name for a given odor. In the case of odors, this assumption is not warranted. Indeed, while there is a strong social pressure early in childhood to identify objects, colors or even sounds by consensual names, learning odor names occurs haphazardly in the course of olfactory experience (Rouby and Sicard, 1997). Consequently, the language used to name odors is often idiosyncratic and lacks social agreement. Thus, French people identify the odor of eugenol either by 'odor of cloves' or by 'odor of dentist', depending on the extent of their experience in either cooking or dental care (eugenol is often used in dental preparations). Since the name eugenol is not an established word in the French language, those two names are equally valid (Rouby and Sicard, 1997). Multiple-choice paradigms may thus lead to a disadvantage in test performance for those who use another name for an odor than the one designated by the experimenter as the 'correct' one. In line with this point of view, Lehrner *et al.* (1999) showed that the percentage of repeatable identification was a better predictor of recognition performance than the percentage of correct identification. In fact, the percentage of repeatable identification, i.e. the percentage of odors identified by the same name upon repeated presentations, was measured by several authors in free identification paradigms (Rabin and Cain, 1984; Murphy and Cain, 1986; Cain and Potts, 1996; Lehrner, 1993; Lesschaeve and Issanchou, 1996). Some of these authors reported a correlation between repeatable identifications and correct identifications (Rabin and Cain, 1984; Cain and Potts, 1996; Lehrner *et al.*, 1999). However, they did not give any clear information regarding whether the number of repeatable identifications was lower or greater than the number of correct identifications and whether or not repeatable names were identical to correct names. To address these issues, a comparison of the repeatable names obtained in a free identification task versus the correct names ('veridical labels') obtained in a multiple-choice identification task using a large list of alternatives was performed.

Materials and methods

Participants

One hundred and thirty-six healthy participants (74 females and 62 males; age range 18–89 years) with no previous experience in sensory analysis and no self-reported problems in their sense of smell were recruited. They were paid for their participation.

Stimuli

Thirty-six odorants with a familiar odor, i.e. an odor often smelled in the participants' everyday life, were chosen on the basis of pre-testing (Sulmont *et al.*, 2002). The odorants consisted of essential oils, food flavors, food products, non-food fragrances and monomolecular chemicals (Table 1). They were prepared according to the procedure described in Sulmont *et al.* (2002). In order to reduce olfactory adaptation, an interval of 45 s was imposed after smelling each odorant.

Free identification task

The 36 odorants were divided into two sets (A and B) of 18 odorants each. Half of the participants were presented with set A during the first session and with set B during the second session. The other half of participants proceeded in the reverse order. At the beginning of a session, the participants were presented with the 18 odorants of a set in a first randomized order (first trial). After smelling an odorant, the participants indicated whether they could describe its odor (yes/no). In case of 'yes', they indicated their description. At the end of the session, the participants were presented with the same 18 odorants in a second randomized order and asked to describe them again (second trial). Participants were not informed about the fact that they received the same odorants twice.

The word 'describe' was used instead of the word 'identify' to incite the participants to give an answer even when they only had a general name (e.g. flower). However, the participants were encouraged to find the most precise name to describe odor quality and to avoid hedonic (e.g. 'pleasant', 'disgusting') and quantitative (e.g. 'strong', 'weak') terms.

Multiple-choice identification task

During the third session, the participants were presented with the 36 odorants in a randomized order. After smelling an odorant, the participants were asked to find the name of the odor in a list of 72 labels, which were sorted in alphabetical order. This list contained 36 veridical labels (Table 1) and 36 distractor labels (Table 2). With regard to the chemicals, the veridical labels were the names usually associated with their odor (e.g. mushroom for oct-1-en-3-ol), with regard to the essential oils, the flavors and the fragrances, the veridical labels were the names given by the manufacturer and with regard to the natural products, the veridical labels were the names of the product (bleach, olive oil, etc.).

Experimental conditions

The tests were conducted under red light in a sensory room equipped according to a known standard (AFNOR, 1987). The presentation order of the odorants was the same for all participants to allow between-participant comparison.

Data analysis

During the free task, a response was scored as 'repeatable' when the participant identified the odor by at least one common name during the two trials. For instance, the responses (1 = flower; 2 = flower), (1 = banana; 2 = artificial banana) and (1 = strawberry or raspberry; 2 = strawberry) were scored as 'repeatable'. During the multiple-choice task, a response was scored as 'correct' when the participant identified the odor by its veridical label.

Results and Discussion

Table 1 gives the percentage of repeatable identification obtained in the free task and the percentage of correct identification obtained in the multiple-choice task, for each odor. According to a χ^2 test, the percentage of correct identification is significantly superior to the percentage of repeatable identification for two odorants (4-methylacetophenone, $\chi^2 = 10.08$, $P < 0.001$, and lavender fragrance, $\chi^2 = 3.77$, $P < 0.05$), but the reverse is also true for two odorants (licorice flavor, $\chi^2 = 7.10$, $P < 0.01$, and methyl salicylate, $\chi^2 = 3.71$, $P < 0.05$). The last column of Table 1 presents the repeatable name associated with the highest percentage of citation

Table 1 Presentation of the odorants: results of the free identification versus the multiple-choice identification

Odorant	Veridical label	Most frequent repeatable name given in the free task (percentage of citations)	Percentage of repeatable identification in the free task	Percentage of correct identification in the multiple-choice task
(−) Carvone	mint	chlorophyll (29%)	53	54
(*E*) Anethole	anise	anise (32%)	49	36
(*E*) Cinnamaldehyde	cinnamon	cinnamon (13%)	22	33
4-Methylacetophenone	bathroom cleaner/bitter almond	cleaner (7%)	16	69
Allyl isothiocyanate	mustard	mustard (33%)	51	59
α-Ionone	violet	violet (14%)	31	28
Apple flavor[a]	apple	strawberry (8%)	34	30
Banana flavor[b]	banana	banana (23%)	51	74
Bacon flavor[f]	smoked	bacon (7%)	33	41
Bitter almond flavor[c]	bitter almond	almond (35%)	56	74
Buccoverte forte base	lily of the valley/rose	lily of the valley (14%)	44	67
Butane-2,3-dione	butter	caramel (13%)	38	25
Cherry flavor[a]	cherry	almond (7%) – candy (7%)	38	45
Coffee flavor[a]	coffee	coffee (21%)	60	71
Eucalyptus (essential oil)[d]	eucalyptus	mint (8%)	28	28
Garlic (essential oil)[e]	garlic	garlic (55%)	68	80
Laurel (essential oil)[g]	laurel	laurel (5%)	22	38
Lavender fragrance[a]	lavender	lavender (33%)	36	63
Leek (essential oil)[g]	leek	garlic (26%)	53	46
Lemon (essential oil)[d]	lemon	lemon (15%)	45	64
Licorice flavor[a]	licorice	anise (37%)	51	20
Lily of the valley fragrance[a]	lily of the valley	lily of the valley (18%)	40	42
Liquid caramel[c]	caramel	caramel (53%)	64	57
Methyl salicylate	mouthwash	camphor (16%)	47	24
Nutmeg (essential oil)[g]	nutmeg	pepper (10%)	30	26
Oct-1-en-3-ol	mushroom	mushroom (36%)	59	78
Olive oil	olive oil	olive oil (14%)	23	34
Orange flavor[a]	grapefruit/orange	orange (13%)	43	54
Peach flavor[h]	peach	peach (18%)	43	52
Petylyn	marshmallow/orange blossom	orange blossom (12%)	32	54
Pine (essential oil)[i]	pine	pine (5%)	27	20
Piperonal	almond/vanilla	vanilla (11%)	27	33
Strawberry flavor[a]	strawberry	strawberry (46%)	57	62
Thyme (essential oil)[d]	thyme	thyme (26%)	49	52
Vanillin	vanilla	vanilla (30%)	44	39
Viandox	meat stock	stock (16%)	34	42

[a]Sentosphère (France); [b]Systems Bio-Industries (France); [c]Malilé (France); [d]Lozano (Spain); [e]Laboratoire CRMN; Toulouse (France); [f]home-made preparation; [g]Sanoflor (France); [h]Givaudan (France); [i]Coopération Pharmaceutique Française, Melun (France).

Table 2 Multiple-choice identification task: list of distractor labels

Alcohol	Linden tea
Black pepper	Melon
Blackcurrant	Moldy, earth, cave
Blue cheese, Roquefort	Pear
Bread	Persil
Burnt paper	Pineapple
Celery	Prune
Cigarette smoke	Raw potato
Coconut	Sweet pepper
Crab, sea food	Rhubarb
Cucumber	Rotten meat
Fried chicken	Rubber
Grape juice	Rum
Grass	Sardine
Green beans	Soap
Hard-boiled egg	Tea
Hazelnut	Tomato
Leather	Vinegar

during the free task for each odor. The names spontaneously and consistently chosen by the participants in identification of ten odorants during the free task were different from the veridical label. One could argue that our veridical labels did not fit our odors well, because we mainly used artificial odorants. However, during the multiple-choice identification task, the percentages of correct identification of some artificial odorants (80% for essential oil of garlic, 78% for oct-1-en-3-ol, 74% for banana flavor) were far superior to the percentages of correct identification of the few natural odorants that we used (57% for liquid caramel, 34% for olive oil, 42% for Viandox®). Repeatable but incorrect identifications may have resulted from the lack of social consensus in odor naming. During the free identification task, some names were highly personal and referred to autobiographical memories, like 'paste that I used in elementary school, when I was 12 years old' (bitter almond flavor), or 'my mother's strawberry ice cream' (strawberry flavor). Several names were more generic, but still highly dependent on the participant's previous olfactory experiences. One participant consistently identified the odor of olive oil as 'seasoning of canned fish like canned sardines', probably because he encountered and/or noticed this odor only in this context. In the same way, several participants consistently identified the odors of flowers as 'cleaning supply' or 'bathroom freshener', which are often perfumed with such floral fragrances.

During the multiple-choice task, participants replaced their repeatable but non-veridical name, in favor of the veridical label in only 42% of the cases. Obviously, this shift was observed when the list of labels provided in the multiple-choice task did not include those repeatable names: 85% of the participants who identified the odor of (−) carvone as 'chlorophyll' during the free task chose the veridical label 'mint' during the multiple-choice task. This shift was also observed when the list of labels provided in the multiple-choice task included the repeatable names, but was less drastic. Only 33% of the participants who identified the odor of essential oil of leek as 'garlic' during the free task chose the veridical label 'leek' during the multiple-choice task. More remarkable, 84% of the participants who identified the odor of licorice flavor as 'anise' during the free task still chose this name during the multiple-choice task.

One could argue that performance on the multiple-choice task would have been better with a four-alternative choice as used in the standard identification tests than with a 72-alternative choice as used in the present experiment. However, even in a four-alternative choice, the subject could select the veridical label by elimination of the false alternatives without being convinced by this veridical label: "It's not lavender, nor tar, nor mushroom, so it's strawberry. However, I would rather use the label *apple* to identify this odor if I had the choice." As the subjects were asked to 'describe' the odors in the free task, one could also argue that these 'descriptions' were likely to be rather general (e.g. 'flower'), which makes the two identification tasks difficult to compare. However, as mentioned above, the participants were encouraged to provide the most precise name to describe the odor quality in the free task. Moreover, a participant might be unable to provide a precise name for an odor either because he/she had this precise name on the 'tip of the nose', or because he/she did not know (had never learned) a precise name for this odor. In the first case, the list of labels provided in the multiple-choice task probably helped the participant to recall the precise name of the odor, whereas in the second case, this list, which included only precise labels, may have disturbed the participant. In fact, a participant could consistently associate an odor with the general name 'flower' without being able to associate this odor with a precise flower name.

Conclusion

In conclusion, our results demonstrated that an identification index based on the veridical label, which does not take into account personal names, may underestimate the participants' ability to identify odors. Obviously, this bias, which is not very great, has no consequence for the results of clinical tests used to detect serious olfactory impairments such as the ones induced by Alzheimer's disease or head injury. However, this bias may be of importance when the identification test aims at comparing populations with a 'normal' sense of smell, and in particular when populations belong to different cultures. In fact, if odor identification already lacks social agreement within a culture, this lack of agreement may be even stronger between different cultures with different languages and different habits. Moreover, this bias may be of importance when the identification test aims at evaluating an odor's 'identifiability' to further study the impact of verbal encoding on recognition performance.

Thus, it is proposed to use a combination of multiple choice (participants are provided with a large list of labels) and free naming (participants are allowed to give their own name when it is not found in the list), in a design in which the stimuli are presented twice under different codes. Such a design has the advantages of the multiple-choice method, by making the measurement less dependent on word-finding problems (in particular for the elderly). At the same time, it permits the participant to use idiosyncratic terms, provided he or she is able to repeat them in an independent measurement. The use of the percentage of repeatable identification, i.e. the percentage of odors identified by the same name across trials, as the performance criterion will reduce the influence of semantic ambiguity to a minimum.

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