The Influence of Distractors on Odor Identification

Volker Gudziol, MD; Thomas Hummel, MD

**Objective:** To investigate the impact of the use of more contrasted distractors on correct odor identification in patients with olfactory loss.

**Design:** Randomized, cross-over study.

**Setting:** University clinic.

**Patients:** Thirty patients with olfactory deficits.

**Interventions:** The olfactory function of the patients was evaluated by means of the “Sniffin’ Sticks” test battery.

**Main Outcome Measures:** The distractors of the Sniffin’ Sticks odor identification test (classic test) were modified, and more contrasted distractors were used (contrasted test), while the applied odorants were the same. All patients performed both the classic and the contrasted odor identification tests in a randomized sequence.

**Results:** Eighteen patients were hyposmic, and 12 were functionally anosmic. Odor identification was significantly better in the hyposmic patients than in the anosmic patients (P < .01). As predicted, hyposmic patients demonstrated a significant increase in correct odor identification in the contrasted test, while anosmic patients did not.

**Conclusion:** The use of more contrasted distractors in cued odor identification tasks can contribute to better discrimination of anosmic and hyposmic patients, which is highly valuable in a clinical context.


Several psychophysical tests have been validated for the assessment of olfactory loss, including the University of Pennsylvania Smell Identification Test, the test of the Connecticut Clinical Chemosensory Research Center, and the “Sniffin’ Sticks” test. All these tests include, or are even solely based on, cued odor identification tasks. While an odor is presented, the patients choose an item from a list of distractors that best characterizes the smell. The distractors listed for each odor in the odor identification task of the Sniffin’ Sticks test are typically similar; eg, the list presented together with an “orange” odor contains the descriptors orange, blackberry, strawberry, and pineapple. It is apparent that the identification rate of an odor depends on the similarity between descriptors that are presented together. For example, the use of the descriptors garlic and onion in 1 list reduces the rates of correct identification for the odor of garlic to 46% in the “Sniffin’ Sticks” odor identification test, although garlic is an odor that is extremely common and familiar to the population studied.

The idea behind the present study was that when more contrasted distractors are used, it should be easier for patients with olfactory loss to select the correct item, while functionally anosmic patients would demonstrate no change in correct odor identification. It was hypothesized that such modulation of an odor identification task would lead to better discrimination of patients with smell dysfunction in relation to their olfactory deficit. Therefore, the aim of the present study was to investigate the impact of more contrasted distractors on correct odor identification in patients with olfactory loss. It was expected that such manipulations should have a pronounced sex-related effect, as men are typically outperformed by women in terms of verbal abilities.

**METHODS**

The study was performed according to the Declaration of Helsinki on Biomedical Research Involving Human Subjects. Thirty patients with smell deficits were included in the study. All patients exhibited olfactory loss according to the threshold, discrimination, and identification measures (TDI score) obtained with the Sniffin’ Sticks test. Twelve patients (6 women and 6 men; mean [SD] age, 55 [17] years) were functionally anosmic (TDI score ≤15.0), and another 18 patients (10 women and 8 men; age, 63 [8] years) were hyposmic (TDI score >15.0-30.5 points).

Olfactory function was obtained in all patients by means of the Sniffin’ Sticks test kit, which comprises 3 tests of olfactory function: odor threshold, odor discrimination, and odor identification. Odor thresholds were determined for phenylethyl alcohol using a 3-alter-
Contrasted Odor Identification Test

The patients were blindfolded to prevent visual detection of the odor-containing pens. They were allowed to sample each odor only once. The interval between presentations of odor triplets was at least 30 seconds. The interval between presentations of individual odor pens was approximately 30 seconds. For odor identification, 16 odors were presented in a randomized sequence. The patient’s task was to identify the pen that smelled different; therefore, a 3-alternative forced-choice task design was reapplied. The patients were again blindfolded to prevent visual identification of the odor-containing pens. Correct identification of the pen that contained the odorant in 2 successive trials triggered a reversal of the staircase to the next lower odorant concentration, whereas a single incorrect identification triggered the reversal of the staircase to the next higher concentration. From a total of 7 reversals, the mean of the last 4 successive trials triggered a reversal of the staircase to the next higher odorant concentration. From a total of 7 reversals, the mean of the last 4 consecutive trials was used as threshold estimate. The test of odor discrimination was performed using 16 triplets of odorants. The patients were presented with 3 pens: two containing the same odorant, and one containing a different odorant. Each patient’s task was to identify the pen that smelled different; therefore, a 3-alternative forced-choice task design was reapplied. The patients were again blindfolded to prevent visual detection of the target odor pens. They were allowed to sample each odor only once. The interval between presentations of odor triplets was at least 30 seconds. The interval between presentations of individual odor pens was approximately 3 seconds. For odor identification, 16 odors were presented in a randomized sequence. The patients were free to sample the odors as often as necessary in order to identify them from a list of 4 distractors. The experimenters presented odor pens separated by an interval of at least 30 seconds to avoid olfactory desensitization. The patients were blindfolded to prevent visual identification of the odor-containing pens.

Correct identification of the pen that contained the odorant in 2 successive trials triggered a reversal of the staircase to the next lower odorant concentration, whereas a single incorrect identification triggered the reversal of the staircase to the next higher concentration. From a total of 7 reversals, the mean of the last 4 consecutive trials triggered a reversal of the staircase to the next higher odorant concentration. From a total of 7 reversals, the mean of the last 4 consecutive trials was used as threshold estimate. The test of odor discrimination was performed using 16 triplets of odorants. The patients were presented with 3 pens: two containing the same odorant, and one containing a different odorant. Each patient’s task was to identify the pen that smelled different; therefore, a 3-alternative forced-choice task design was reapplied. The patients were again blindfolded to prevent visual detection of the target odor pens. They were allowed to sample each odor only once. The interval between presentations of odor triplets was at least 30 seconds. The interval between presentations of individual odor pens was approximately 3 seconds. For odor identification, 16 odors were presented in a randomized sequence. The patients were free to sample the odors as often as necessary in order to identify them from a list of 4 distractors. The experimenters presented odor pens separated by an interval of at least 30 seconds to avoid olfactory desensitization. Hereafter, this odor identification test will be called the classic odor identification test. Results from the 3 tests were added together to obtain a single score, the so-called TDI score. In an additional trial, 16 odors of the classic odor identification test were used, while more contrasted distractors were available (Table). An attempt was made to ensure that dissimilarity of the selected distractors corresponded with the classification of odors described by Saito et al.10 All applied distractors have been confirmed to be familiar to the population studied. Hereafter, this test will be called the contrasted odor identification test. The test interval between the classic odor identification test and the contrasted identification test was at minimum 30 minutes. Whether the classic or the contrasted odor identification test was performed first was randomly determined.

Data were analyzed using SPSS 12.0 for Windows (SPSS Inc, Chicago, Illinois) and repeated-measures analysis of variance (within-subject factors classic/contrasted; between-subject factors anosmia/hyposmia and sex). Patient age was used as a covariate to account for age-related differences between groups. The α level was set at 0.05.

## RESULTS

Hyposmic patients demonstrated better odor identification than anosmic patients ($F_{1,25} = 15.0; P = .001$). The hyposmic patients scored 3.2 (3.1) mean (SD) points higher in the contrasted odor identification test than in the classic odor identification test. Functionally anosmic patients exhibited only a minimal increase (0.2 [2.6] points) (Figure). The significance of this observation was emphasized by the interaction between factors classic/contrasted and anosmia/hyposmia ($F_{1,25} = 7.93; P = .009$). The factor sex had no significant effect ($F_{1,25} < 0.01; P = .99$).

## COMMENT

Our findings showed that (1) odor identification was influenced by the distractors that were provided, and (2) the use of contrasted distractors resulted in a significant increase in correct odor identification in hyposmic patients but not in anosmic patients, both in absolute terms. Odor identification has been shown to be influenced whether it is performed as a cued or a free identification task.11 Even the color of the odorant has an impact on the verbal identification of the odor.12 Whether an odor is presented together with a verbal identifier or a photograph/pictogram that would show a graphical representation of the odor source,13 also appears to make a difference. Therefore, it seems to be obvious that the choice of distractors in cued odor identification tasks may make correct odor identification more or less difficult. However, to our knowledge, none of the studies we reviewed involved patients with olfactory loss, and none

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### Table. Odors and Distractors in the Classic and the Contrasted Odor Identification Tests

<table>
<thead>
<tr>
<th>Odor</th>
<th>Classic Odor Identification Test</th>
<th>Contrast Odor Identification Test</th>
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<tbody>
<tr>
<td>Orange</td>
<td>Blackberry</td>
<td>Smoke</td>
</tr>
<tr>
<td>Leather</td>
<td>Strawberry</td>
<td>Garlic</td>
</tr>
<tr>
<td>Cinnamon</td>
<td>Strawberry</td>
<td>Rum</td>
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<td>Peppermint</td>
<td>Strawberry</td>
<td>Apple</td>
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<tr>
<td>Banana</td>
<td>Peanut</td>
<td>Rose</td>
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<tr>
<td>Lemon</td>
<td>Apple</td>
<td>Strawberry</td>
</tr>
<tr>
<td>Licorice</td>
<td>Apple</td>
<td>Rum</td>
</tr>
<tr>
<td>Turpentine</td>
<td>Rubber</td>
<td>Strawberry</td>
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<tr>
<td>Garlic</td>
<td>Sauerkrut</td>
<td>Cartoon</td>
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<td>Clove</td>
<td>Sauerkrut</td>
<td>Shirt</td>
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<td>Pineapple</td>
<td>Plum</td>
<td>Grapefruit</td>
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<td>Rose</td>
<td>Raspberry</td>
<td>Tobacco</td>
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<td>Anise</td>
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of them systematically tried to exploit these effects for the improvement of olfactory diagnostics.

The use of more contrasted distractors led to an increase in correct odor identification. As hypothesized, this effect was significant in hyposmic patients but negligible in functionally anosmic patients. This result is apparent because the use of more contrasted distractors makes it easier for patients with incomplete olfactory loss to select the correct item. In contrast, odor identification in anosmic subjects does not seem to benefit from the use of contrasted distractors. In fact, odor identification scores in anosmic patients did not change in relation to the difficulty of the task. Therefore, the use of more contrasted odor identification tests could help to differentiate between hyposmic and functionally anosmic patients. This distinction seems to be of great clinical value, as patients with some olfactory function have a higher chance for recovery than patients with complete anosmia.19

In cued odor identification tasks, women usually outperform men,1 which is partly because women typically have better verbal abilities than men.6 In the present study, however, no such relationship between sex and odor identification performance was found. Even among the hyposmic patients, the increase of correctly identified odors in the contrasted test was not sex related. Therefore, although the sample size was relatively small, it could be hypothesized that the verbal tasks were too simple, so no sex-related differences were apparent.

In conclusion, the selection of distractors in cued odor identification tasks influences the results of the tests. This effect can be used to better differentiate between hyposmic and anosmic patients.

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Author Contributions: Dr Gudziol had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Gudziol and Hummel. Acquisition of data: Gudziol. Analysis and interpretation of data: Gudziol and Hummel. Drafting of the manuscript: Gudziol and Hummel. Critical revision of the manuscript for important intellectual content: Hummel. Statistical analysis: Gudziol and Hummel. Obtained funding: Hummel. Administrative, technical, and material support: Hummel. Study supervision: Hummel.

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REFERENCES


