

# Smell diskettes as screening test of olfaction\*

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## SUMMARY

*A screening test of olfaction was developed with reusable diskettes as applicators of 8 different odorants. Using a questionnaire with illustrations, the test was designed as a triple forced multiple choice test resulting in a score of 0 to 8 correct answers. To validate the test, 102 volunteers with normal olfaction, as well as 22 patients with subjective hyposmia or anosmia, were tested. To compare the developed test with an already validated method, the same persons also performed the sniffin' sticks screening test. The results indicate that the screening test with smell diskettes recognizes patients with normal olfaction and consistently distinguishes them from patients with hyposmia or anosmia.*

*Key words: screening test of olfaction, smell diskettes*

## INTRODUCTION

The assessment of olfactory function plays an important role in rhinology; especially in the preoperative evaluation and documentation for endonasal surgery. Clinically, screening tests are used as a first step in the assessment of the sense of smell (Delank, 1998). A screening test must recognize patients with normal olfactory function and distinguish them from patients with hyposmia or anosmia.

A widely used method for screening the sense of smell is to present odorants in small bottles and to ask the patient to identify the odor. Recently, more sophisticated screening tests were developed and standardized (Mösges et al., 1990; Nieschalk et al., 1995; Davidson and Murphy, 1997). A well-known example is the University of Pennsylvania Smell Identification Test (UPSIT) (Doty and Kobal, 1995). In this test, the odorants are liberated by scratching micro-encapsulated odor labels mounted on paper. Another method of odor application is used in the sniffin' sticks test (Kobal et al., 1996; Hummel et al., 1997). Here, the odorants are liberated through the tip of a pen.

The aim of this study was the development and validation of a new screening test of olfaction with reusable diskettes as odor applicators.

## MATERIALS AND METHODS

A screening test of olfaction was designed using 8 diskettes containing different odorants. These diskettes are widely used in the perfume and flavour industry as applicators for odorants. They are made of polyester and measure 5 cm × 6 cm. The diskettes can be opened to release the odors and are closed after testing (Figure 1). The odorants were used in a high suprathreshold concentration (Table 1). The test was designed as a triple

Table 1. Odorants used in the screening test of olfaction with smell diskettes.

Odor	Odorant
coffee	COFFEE 79736-33
vanilla	ETHYL VANILLINE 10% PE (Diethylphthalat)
smoke	CADE ESS 1% PE
peach	PECHE D40110/727417
pineapple	ANANAS COEUR D 50214
rose	ROSE CENTIFOLIA KAISER
coconut	PRUNOLIDE 10% PE
vinegar	ACETIC ACID 10%



Figure 1. Smell diskette as applicator of odorants.

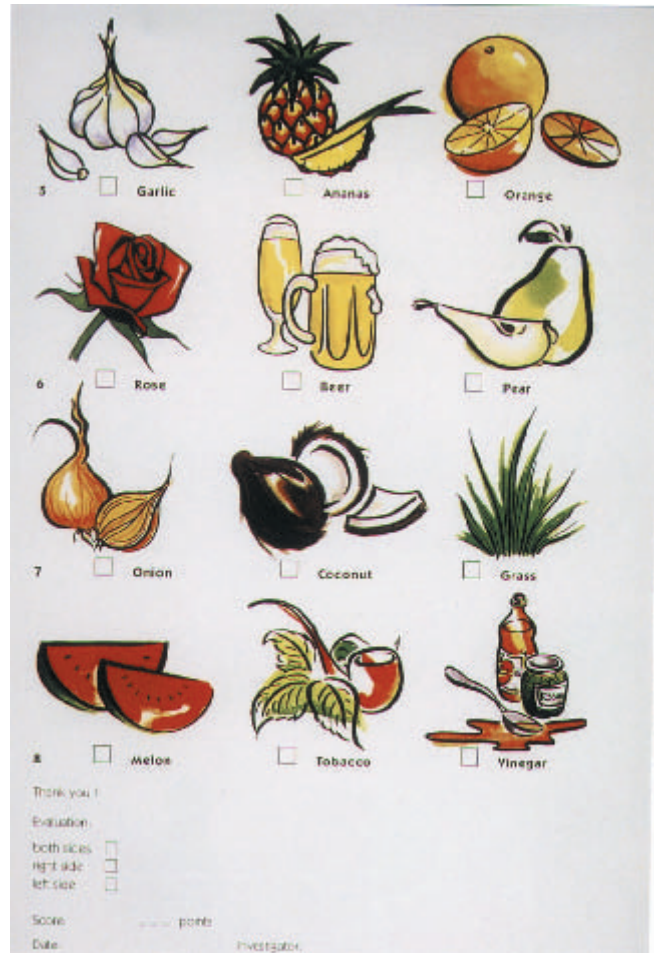
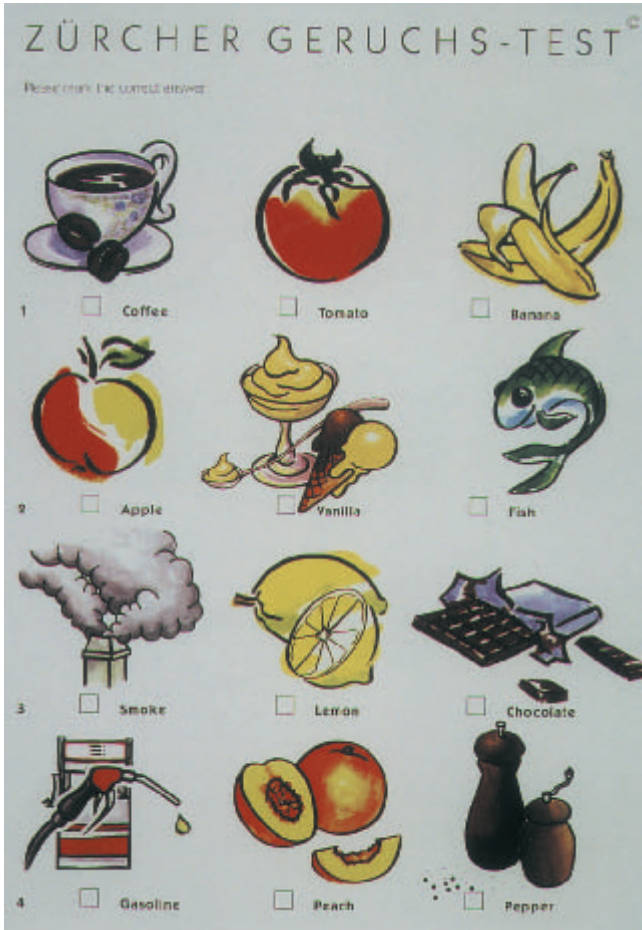


Figure 2. Questionnaire with illustrations.

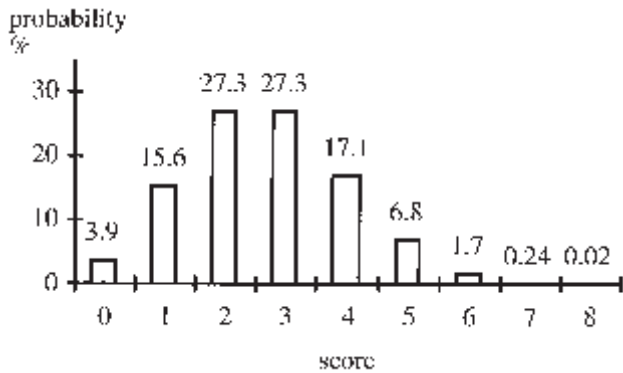


Figure 3. Binomial distribution of the triple forced multiple choice test used in the screening test smell diskettes.

forced multiple choice test, resulting in a score from 0 to 8 correct answers. The answers were presented on a questionnaire with illustrations (Figure 2). There was no time limit given for sniffing on the diskettes, however, in most situations the whole test could be done in less than 5 minutes. The binomial distribution for this test indicating the probability to reach a certain score by chance (for example by an anosmic patient) is shown in Figure 3. For this study, the diskettes filled with odorants were produced by Givaudan-Roure Research LTD, CH-8600 Dübendorf, Switzerland. Since 1999, the whole test is commer-

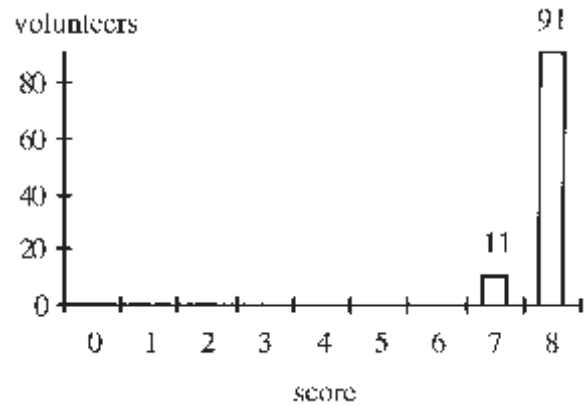


Figure 4. Smell diskettes: score of volunteers with normal olfaction (n=102).

cially available (Novimed Medizin Technik, CH-8953 Dietikon, Switzerland).

To validate the developed test, 102 volunteers with normal olfaction and 22 patients with hyposmia and anosmia were assessed.

To compare the results of the developed test with an already validated and standardized screening method, the same group of volunteers and patients also performed the sniffin' sticks test (Stufe 1, Firma Sniffin' Sticks, Marquardsenstr. 9, D-91054 Erlangen, Germany). This test also presents 8 odors, resulting

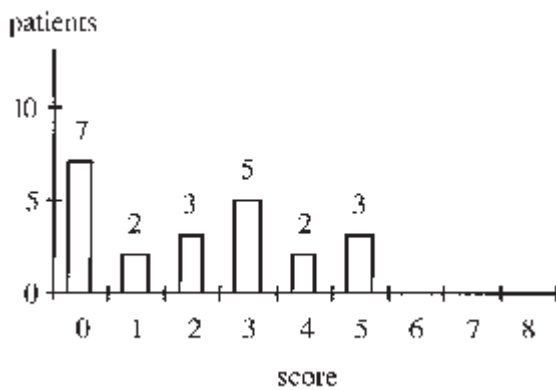


Figure 5. Smell diskettes: score of patients with subjective hyposmia or anosmia (n=22).

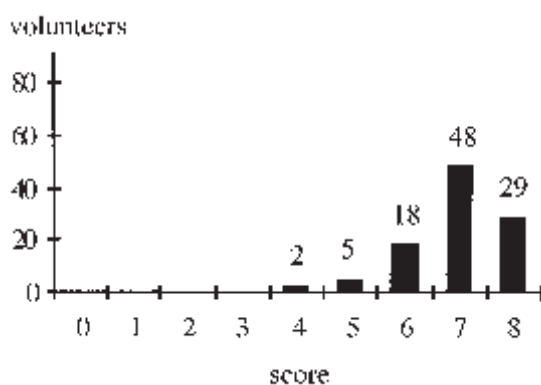


Figure 6. Sniffin' sticks: score of volunteers with normal olfaction (n=102).

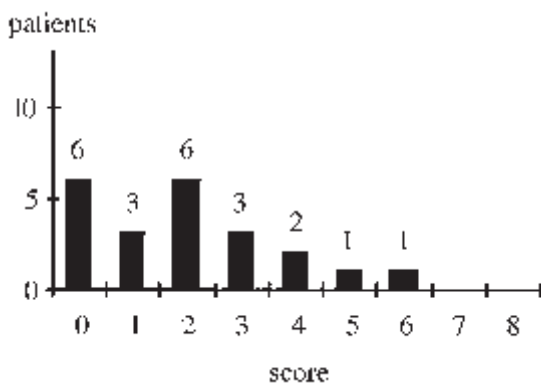


Figure 7. Sniffin' sticks: score of patients with subjective hyposmia or anosmia (n=22).

in a score from 0 to 8 correct answers. A score of  $6.2 \pm 1.0$  for the age group of 18-50 years and a score of  $6.0 \pm 0.9$  for the age group of 51-80 years is defined as normal. Subjects were tested by either the diskettes or the sniffin' sticks first, on an alternating basis.

## RESULTS

Among the 102 volunteers with normal olfaction, there were 26 males and 76 females with a mean age of 35 years (range 15-60 years). The 22 patients (13 males, 9 females) with subjective hyposmia or anosmia had a mean age of 48.5 years (range 20-73

years). The smell disorder was caused in 16 cases by extensive nasal polyps, in 2 cases by a fracture of the anterior skull base, in 2 cases by surgery for a macroadenoma of the hypophysis, and in 1 case each by an irradiated prolactinoma and a viral infection.

In the screening test of olfaction with smell diskettes, 11 of the 102 volunteers with normal sense of smell reached a score of 7, and 91 achieved a score of 8 (mean 7.89, SD  $\pm 0.31$ ) (Figure 4). All patients with subjective hyposmia or anosmia reached a score between 0 and 5 (mean 2.09, SD  $\pm 1.78$ ) (Figure 5).

In the sniffin' sticks test, 95 volunteers with a normal sense of smell reached a score in the normal range of 6, 7 or 8 points, whereas 7 achieved a score of only 4 or 5 points (mean 6.95, SD  $\pm 0.91$ ) (Figure 6). The patients with hyposmia or anosmia scored between 0 and 6 points (mean 1.95, SD  $\pm 1.69$ ) (Figure 7).

During the test period of 6 months, neither the diskettes nor the sticks had to be replaced because of a fading liberation of odorants. Experiences from the perfume industry show, that the smell diskettes maintain a high odor concentration for up to one year, nevertheless we propose to replace them after 6 months to avoid the risk of inaccurate test results.

## DISCUSSION

The application of odors by diskettes is easy and fast, and eliminates the risk of contaminating the hands of the investigator or the test person with the odorant. Furthermore there is a minimal risk of contaminating the diskettes with nasal secretion because they are held with both hands and therefore the distance to the tip of the nose is easy to be controlled. Regarding this aspect, the risk of contamination is higher for the sniffin' sticks because they are usually held with only one hand. An additional advantage of the diskettes is the higher amount of odorant that is liberated compared with other modern application forms like the scratch and sniff method or the sniffin' sticks. This allows a measurement of smell function at a high suprathreshold level, which is favorable for a screening test (Herberhold and Rödel, 1992; Hüttenbrink, 1995). Eight odors with a high degree of familiarity in the middle European population were chosen, avoiding odors like root beer, which are well known in the USA but not in Europe.

One odorant (acetic acid) not only stimulates the olfactory bulb but also stimulates the fibers of the trigeminal nerve. Patients with anosmia should be able to identify this odor, so this item allows us to identify possible malingers. As in other screening tests, a multiple-choice design was used. Based on the binomial distribution of the triple forced multiple choice test with 8 items, the probability of an anosmic patient scoring either 7 or 8 is only 0.26%. Therefore a patient achieving a score of 7 or 8 has a 99.74% probability of having normal olfaction.

In the screening test with diskettes, all volunteers with a normal sense of smell achieved a score of 7 or 8, whereas the patients with hyposmia or anosmia reached a score between 0 and 5. This indicates that the developed test is able to detect patients with a normal sense of smell. As mentioned above, patients with a score of 7 or 8 have normal olfactory function with a probability of 99.74%. On the other hand, patients with a

score between 0 and 6 have a hyposmia, an anosmia or are not cooperating. This group of patients needs further investigation to determine the degree of their smell disorder (Herberhold and Rödel, 1992; Hummel et al., 1997).

In the sniffin' sticks test, 7 volunteers with subjective normal olfaction did not reach a score considered as normal. This indicates that this test offers a lower odor concentration compared to the diskettes. On the other hand, 1 of the patients with subjective hyposmia or anosmia reached a score of 6, which is considered normal.

This shows that the two tests do not define the threshold value between normosmia and hyposmia at exactly the same level. However, both tests compared in this study showed a good ability in distinguishing persons with normal olfaction from persons with subjective hyposmia or anosmia.

#### CONCLUSION

The application of odors with smell diskettes is a fast and reliable method and allows testing of olfactory function in the clinical setting. A screening test with smell diskettes was designed using 8 different odors. Based on the design of this test, a person achieving a score of 7 or 8 has a 99.74% probability of having a normal olfaction. All volunteers with normal olfaction reached a score of 7 or 8, whereas patients with subjective hyposmia or anosmia reached a score between 0 and 5. These results indicate that the developed test is reliable in recognizing patients with normal olfaction and can distinguish them from patients with hyposmia or anosmia.

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