Assessment of Olfactory Functions with 294 people in Dresden: a report from two science fairs

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Abstract:

The present study aimed to compare established and more innovative tests of olfactory function in a large group of people. In addition to (1) an established test for odor identification (Sniffin Sticks) we used methods that had (2) been introduced more recently, namely the olfactory sorting task for phenylethanol (PEA), and eugenol (EUG). Data were collected from 294 participants. According to the results, self-rated olfactory function was found to correlate with nasal patency, age, odor identification, and the results from the odor sorting tasks. Across the entire group age correlated were negatively (smell ability, patency, PEA sorting task, Eugenol sorting task) and positively (odor identification) with measured parameters. In the age group older than 17, age correlated only with self-rated smell function, in a negative way. Additionally, negative correlations between sorting tasks and odor identification test results were found suggesting that lower performance in the sorting task was associated with lower ability to identify odors.

Keywords: Olfaction, odor identification, smell ability, patency, sorting task test

Introduction:

One of the crucial functions of the nasal airway is chemosensation (3) - the perception of chemical stimuli. It directly interacts with the external environment and regulates our behaviors essential for survival and reproduction such as finding food, avoiding predators, identifying conspecifics, caring for offspring, and selecting mates (4).

Smells are perceived by olfactory receptor neurons (ORNs). These receptors are located in the epithelia which cover the roof of the nasal cavity, superior nasal conchae, and superior nasal septum. After the odor molecules in the air reach the epithelia in the nose, they dissolve in the mucus covering the mucosa and interact with the ORN.

Odorants have different affinities for different ORNs. Therefore, depending on receptor specificity, some odorants bind at low concentrations to certain ORN, while higher concentrations are required to activate others. This characteristic explains why the perception of an odor can change as a function of its concentration (5). Olfactory detection thresholds are thought to reflect ORN activation. Other dimensions of olfactory function include odor discrimination and odor identification, both of which strongly depend on verbal abilities and memory functions (6). The olfactory function can be changed due to neurologic (7), metabolic (8), and psychiatric (9) diseases. Age also influences olfaction (10). Tests have been developed to assess olfactory functions like UPSIT (11), Sniffin' sticks" (12), or "Quick Sticks" tests (13). The tests generally evaluate the three characteristics of olfaction: odor discrimination, identification, and threshold.

Here we report the results from the use of different methods to evaluate olfactory functions during two Science Fairs in Dresden, Germany.

Methods:

In July 2023, "The Long Night of Science" and the "Museum Night" were held in Dresden. Visitors received olfactory testing at these events, attended by thousands of people. A total of 294 people participated in this study (117 male and 175 female volunteers). Participants were volunteers who wanted to participate in the study, with varying ages, genders, and nationalities. Data were divided into 6 groups according to the volunteers' age. In group 1 there were 18 male and 12 female participants aged between 4 and 8. There were 23 males and 38 females aged 9-12 in Group 2; 7 males and 29 females aged 13-17 in Group 3; 34 males and 42 females aged 18-30 in Group 4; 30 males and 39 females aged 31-55 in Group 5 and 6 males and 15 females aged 56-86 years in Group 6 (Table 1). There were no exclusion criteria for this study.

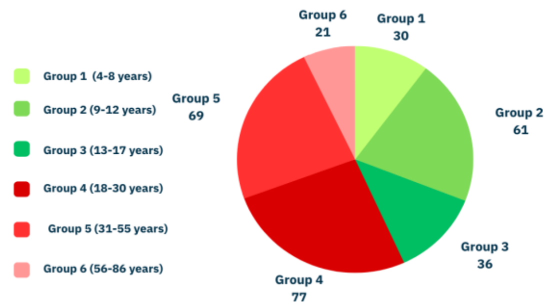

Table-1: Age group distribution and number of participants

In the study, odor identification, self-rated olfactory function, nasal patency, and sorting task tests were performed. Firstly nasal patency was evaluated. Nasal patency is a measure of how open the nose is, and it is not equivalent to airflow or resistance to airflow (14). The patency test of the nose was done by ratings. Participants subjectively gave points to their nasal patency from 0 to 10.

Then Sniffin' sticks test (1) was used for odor identification. It was assessed in a 4-alternative forced-choice paradigm in which subjects had to name 16 odors from 4 alternatives given with each odorant. Then the self-rated olfactory function test was done. It was a subjective test, participants gave points for their olfactory function from 0 to 10.

Finally, Phenylethanol (PEA), Eugenol (EUG), and PEA-EUG sorting tasks were done. Sorting task tests (2) are based on the alignment of the odors in accordance with their intensity. This test required several abilities for example odor memory, sensitivity to odors, and limited olfactory adaptation. Five dilutions each were prepared for the fragrances PEA and EUG, starting from a 1% concentration using the solvent propylene glycol, in dilution steps of 1:2. Odors were presented in brown glass jars. It was a time-limited test, participants had 8 minutes in total but all participants finished the test earlier.

After the collection of data, analysis was done by the Student t-test using the software SPSS (IBM, Chicago, Ill., USA).

Results:

Odor identification scores: Particiants at the age between 31 and 55 years had the best results in this test (Table 2). Still, there was no clear negative or positive correlation between identification and age (p>0.01). When comparing odor identification scores with gender, there was no significant gender-related difference (p>0.01) (Table 2).

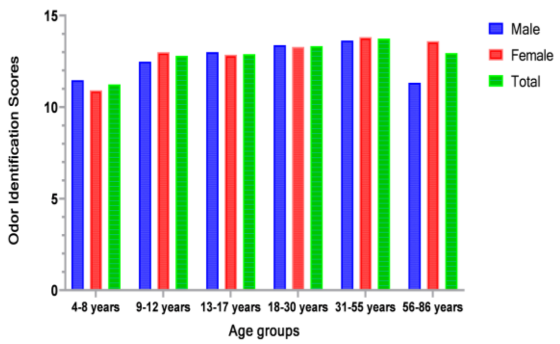

Figure 2: Odor Identification Scores with Gender

Self-rated olfactory function: In terms of olfactory function, the youngest participants (4-8 years) rated themselves best and the oldest participants (56-86 years) rated themselves the worst (Table 3). There was no meaningful correlation between self-rated olfactory function and age (p>0.01) and there was no significant difference between males and females (p>0.01).

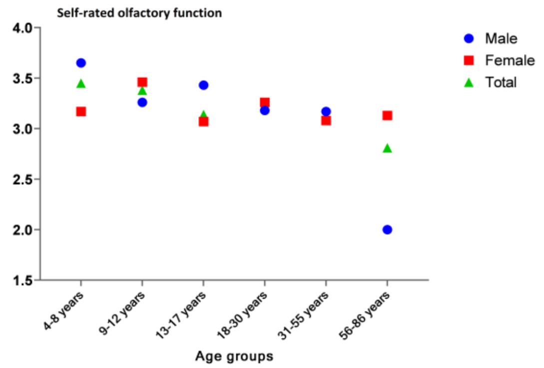

Figure 3: Self-rated olfactory function

Phenylethanol (PEA), Eugenol, PEA-Eugenol sorting tasks, and patency test: There were correlations in the whole group according to the test results (Figure 4). Age and smell ability were moderately negatively correlated (15) (r= -.20, p<0.01). Patency and age were weakly negatively correlated (r= -.13, p<0.05). Odor identification (ID) and age were weakly positively correlated (r= .18, p<0.01). PEA sorting task total score and age were weakly and negatively correlated (r= -.19, p<0.01). Eugenol sorting task total score and age were moderately and weakly correlated (r= -.24, p<0.01). PEA and Eugenol's sorting task total score and age were moderately negatively correlated (r= -.28, p<0.01).

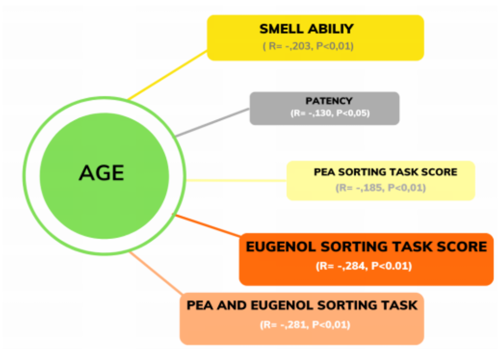

Figure 4: Age correlations for the entire group

Correlations in people older than 17 years old:

There was a weakly negative correlation between age and smell ability (r= -.18, p<0.05). There was no other meaningful correlation between age and other parameters.

Self-rated olfactory function: Although self-rated olfactory function and PEA sorting task total scores were weakly negatively correlated (r= -.17, p<0.05), there was no correlation between the Eugenol sorting task scores and self-rated olfactory function. Besides that patency and self-rated olfactory function were weakly positively correlated (r=.25, p< 0.01); odor identification and self-rated olfactory function were weakly positively correlated (r=.17, p<0.01).

Odor identification scores: PEA sorting task total score and odor identification test score were weakly negatively correlated (r=-.18, p<0.01); Eugenol sorting task total score and odor identification score were moderately negatively correlated (r= -.31, p<0.01); PEA and Eugenol's sorting task total score and odor identification test were moderately negatively correlated (r= -.35, p<0.01).

Discussion:

Age was correlated with measures of olfactory function. Regarding the whole group, there were negative (smell ability, patency, PEA sorting task, Eugenol sorting task) and positive (odor identification) correlations with age. However, when investigating the age group older than 17, there was only a negative correlation between age and smell ability.

The other point is the odor identification score, there was no clear negative or positive correlation between identification scores-age (p>0.01) and identification scores-gender (p>0.01) according to our analysis. Hummel et al. found that the identification scores of the youngest and the oldest participants were lower than the scores obtained by people aged 20–60 years (16). In our study, the youngest participants had the lowest score but the scores of the oldest participants were not the lowest ones. The reason for the different results may be that we included individuals aged 56-60 years in the oldest group. Hummel et al. also observed an age-related increase in the olfactory abilities of children. This result is consistent with the present results (Table-2).

Öberg el al. suggested that women's odor identification score is better than that of men (17). In the present study, we did not find such dffeeneces. Ins ome age groups women had better results but in the other groups the ydid not. This could be the consequence of including unequal numbers of men and women in the groups. In addition, the results appear to indicate that gender-related differences are not as strong as they are frequently reported.

According to the analysis, there was no meaningful correlation between self-rated smell ability and age (p>0.01) and self-rated smell ability and gender (p>0.01). However, the literature clearly shows that age influences smell abilities negatively (10). In the present sample the oldest group had the lowest self-rated smell ability and the youngest ones had the highest levels.

Regarding the sorting tasks Lötsch et al. maintained that these tests would provide a well-fitting extension existing clinical tests of olfactory function. They used fewer participants (n = 135 individuals) than in the present study and they found that the sorting tasks were more sensitive than the other tests for patient assignment to various groups of olfactory function (2). In the present study, we found moderately (EUG, PEA-EUG) and weakly (PEA) negative correlations between sorting tasks and odor identification test results. These correlations are important to compare the sorting task with other methods. It appears that the sorting tasks can be added on to other tests o olfactory function.

Because there were no exclusion criteria for the present study patients with neurologic or cognitive disorders may have been included. Additionally, participants were not screened regarding nasal anatomical disorders. Although the tests were made during science fairs, similar future activities may also include brief screening tests in the direction of nasal anatomy and cognitive function.

Conclusion:

The present examinations confirmed that age is a dominant factor in olfactory function with lower olfactory abilities in older people. In addition, the tests showed meaningful correlations between standard tests of olfactory function and the odor sorting task.

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