

This is a post-peer-review, pre-copyedit version of an article published in European Journal of Pediatrics. The final authenticated version is available online at: <https://doi.org/10.1007/s00431-020-03778-2>

This version is available from <https://hdl.handle.net/10195/77155>



This postprint version is licenced under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0.International](https://creativecommons.org/licenses/by-nc-nd/4.0/).

The influence of a child's age on the evaluation of smells and their hedonistic assessment

Abstract

Olfactory function in children is most commonly evaluated using the odour identification test despite the fact, that it is difficult to properly name odorants for young children. The goal of this study was to evaluate the pleasantness rating of odorants by children. The participants were 182 healthy children: the first group included 63 girls and 59 boys (aged 6 – 7) and the second, included 31 girls and 29 boys (aged 11 – 12). We assessed olfaction using 1) standard method of odorant identification using a U-Sniff test and 2) classifying the hedonic tone of the odorants into 5 categories. The identification test's median differed in younger and older groups of children, the median was 8 and 10 respectively ($p < 0.01$). The unpleasant hedonic tones were butter, fish and onion. The pleasant hedonic tones were apple, orange and peach. The younger usually categorised hedonic tones as pleasant, compared to the older children, who categorised the odorant's hedonic tones more often as neutral ($p < 0.01$).

Conclusion: This study demonstrated that older children are able to identify odours better than younger. The categorisation of hedonic tones differed depending on the subject's age. The younger children tended to categorise odorants as being pleasant and older children as neutral.

Keywords

olfaction, children, hedonic, odour pleasantness, U-Sniff test

Introduction

The standard tests for smell evaluation of adults are long time available UPSIT (since 1984) [1] and Sniffing Sticks test (since 1996) [2] compared to tests for children. There was a recent study on U-Sniff test published in 2018 [3]. The test is based on odour identification. There is a need for experience with odorants to identify them properly. The interpretation of tests of odour identification can become problematic when evaluating the sense of smell in children. Thus, for young children, it can be difficult to properly identify the odorants. Hedonic evaluation seems to be more reliable in young children [4]. Further, hedonics may be considered as being one of the most important functions in olfaction. In olfactory perception, the primary response a person has to an odour is the evaluation of how pleasant or unpleasant it smells. The olfactory test of odour pleasantness may prove to be a new addition to the comprehensive battery of chemosensory tests that are used in clinical settings [5, 6]. The results of the study done by Bensafi et al. [7] suggest that the subjects involuntarily categorised the odours by their pleasantness [7]. Although the loss of smell in children is rare [8], olfactory testing maybe useful in some diseases such as obesity, head trauma, cleft palate, attention-deficit/hyperactivity disorder, and autism spectrum disorder [9]. The assessment of the olfactory function after mild head injuries still provides valuable information because it is believed to be an indicator of frontal brain damage [10]. Olfactory testing can be useful in the early detection of disorders such as Kallmann's syndrome, which if detected early, it can be treated [8]. The ability of smell can serve various purposes. The sense of smell can act as a warning system, which can prevent dangerous situations. Also it can greatly influence interpersonal communication, assists in tasting as well as drinking. The present study aimed to evaluate olfaction using pleasantness rating of odorants in healthy children. The study is the first step in the implementation of olfactory testing of odour pleasantness in children in clinical practice. Universal Sniff (U-Sniff) test was used to test the sense of smell in our

study. The U-Sniff test was developed especially for children. Basically it consists of 12 scents that are familiar to children thus being able to reliably test the sense of smell. Normative data was generated and the test's validity and test-retest reliability was evaluated [3]. We also used the smell identification test in children to measure the degree of a smell's pleasantness in our research. Among the identification tests, the forced-choice technique is the most common psychophysical testing method used [2]. In the test, only one answer can be selected among the four descriptors of one odorant. We applied the same technique to measure the degree of the pleasantness of a smell. Our subjects were to decide whether the presented odorant was pleasant, neutral or unpleasant. Our task was to find out, whether older children categorise odorants differently than younger ones. Further, we were interested in whether the correct identification of odorants was connected to the evaluation of pleasantness.

Materials and Methods

As mentioned before, the participants were 182 healthy children: the first group included 64 girls and 58 boys (aged 6 – 7 years) and, the second group included 31 girls and 29 boys (aged 11 – 12 years). The first group, who were the younger children, were examined at the ENT outpatient department and the second group, who were the older children, were examined at their school. We included only children who did not have any problems with their sense of smell at the time of testing. The parents were asked whether their children had any signs of olfactory malfunction. The parents provided the written informed consent prior to the start of the study.

The olfactory test is a non-invasive test and the odorants that are used in this test are not dangerous to the human body. The sense of smell was tested using the Universal Sniff (U-Sniff) test [3]. The U-Sniff test consists of felt-tip pens that are filled with an odorant. The pen

is held approximately 2 centimetres in front of the nostrils. The participant is asked to take a sniff by using a verbal command. In the first part of the examination, the participants had to identify a specific odour out of four distractors. The second part consisted of categorising the hedonic tones of odorants into five distinct classes: very pleasant (2) pleasant (1), neutral (0), unpleasant (-1), and very unpleasant (-2). The examination session usually took about 20 minutes.

Statistical Analyses

The data was analysed by using a statistical program software called “Statistica 12 StatSoft Czech Republic”. We applied descriptive statistics, contingency tables and the chi-square test for analysing the difference in the proportion of boys and girls. The chi-square test was used to evaluate the difference in both groups of children for “neutral” hedonic tone. The pleasantness rating of odorants was stated on the most frequently chosen hedonic character of each stimulant by healthy children. The relationship between the pleasantness ratings and the identification of the odour was analysed using a contingency table and the chi-square test. The Mann-Whitney U Test was used for the identification results, that depended on the age group and sex of the children. The alpha level was set at 0.05.

Results

In groups of subjects, there was no significant difference in the proportion of boys and girls ($p = 0.92$).

Identification

The median of the identification test was 9. The mean value was 8.2 (± 2.6): with the minimum being 1 point, and the maximum was 12 points for all 182 participants. The older children reached higher scores than the younger children: the median of the identification test was 8 in the first group of younger children and 10 in the second group of older children ($p < 0.01$) (Fig. 1). Between the sexes, there was found to be no significant difference in the score ($p = 0.36$). The percentage of correct answers in scent identification is depicted in Fig. 2. In both groups, the odorants that were the most correctly identified were peach, coffee and banana.

Pleasantness

Younger children (aged 6 – 7) often categorised hedonic tones as being very pleasant and pleasant (70 %), on the other hand, the neutral tone of odorant was rare (3 %). Nine odorants were categorised as very pleasant or pleasant. The odorants that were regarded as being the most pleasant, were apple, flower, orange, and peach. At least 79 % of participants considered these odorants as very pleasant or pleasant. Butter, fish and onion were regarded as being unpleasant or very unpleasant in more than 45 % of the younger children. *Older children (aged 11 – 12)* categorised hedonic tones of the odorant more often as being neutral (20 %). Very pleasant or pleasant odorants were apple, orange and peach for more than 75 % of the older children being assessed. Just like in the younger children, for the older children (more than 63% of them), butter, fish and onion were categorised as being unpleasant or very unpleasant.

The group of very pleasant or pleasant odours included nine odorants: apple, banana, coffee, cut grass, flower, lemon, orange, peach and strawberry. Our study indicated that only three

odorants - butter, fish and onion were rated as being unpleasant or very unpleasant. None of the odorants were considered as being neutral in the smell test.

The testing confirmed a statistically significant difference in the categorisation of hedonic tones as being “neutral” (0) between the older and younger groups of children ($p < 0.01$). Older children more often categorised odorants as being neutral in 20 % of odorants, compared to 3 % of the younger group.

In both groups, some of the odorants like apple ($p = 0.015$), cut grass ($p = 0.049$), fish ($p = < 0.01$), lemon ($p = 0.008$), onion ($p < 0.01$) and peach ($p = 0.003$), the correct identification of these scents was significantly related to the most frequently chosen pleasantness rating. The average of the hedonic evaluation - very pleasant (2) pleasant (1), neutral (0), unpleasant (-1) and very unpleasant (-2) and its relation to the correct/incorrect answers in scent identification is depicted in table 1.

Discussion

The U-Sniff test is a valid and reliable method for testing olfaction in children [3]. Odour identification is the most popular because it is reliable, practical, rapid and commercially available [8]. The mean (SD) odour identification score of European countries was 10.2 (± 1.7) points. The participants in the Czech Republic scored significantly lower. The ability to identify odours improves with age in children [3]. The same result was confirmed in our study, which showed a higher score of identification in the older group of children compared to the younger ones, 9.5 (± 1.7) and 7.6 (± 2.7) respectively ($p < 0.01$).

There are not many studies on odours pleasantness or hedonics in children though hedonics can be considered as one of the most important functions of olfaction [6, 11 - 13].

According to the results of Hrdlička et al. [12] the orange was perceived as the most pleasant odour among autistic children and banana were regarded as the most pleasant among the healthy participants of the study [12]. In a study by Martinec Nováková et al. [13], the group of pleasant odours included orange and banana. In our research, the smell of orange was also considered as being very pleasant or pleasant by 83% of the younger children and 80% of the older children.

Our research showed that the older children categorised odorants as neutral significantly more often (20 % older group compared to 3 % of the younger group, $p < 0.01$). Bensafi et al. [11] studied 2 groups of subjects: 18 children (aged 5–6) and 18 students (aged 20–29). Young adults rated the odorants as being less intense and less pleasant than children. Children and young adults reacted differently in terms of the intensity and hedonic ratings. Perceived odour intensity was higher in children than in adults. The averages of the pleasantness ratings in children were higher than in adults. The unpleasant odorants were rated as more intense than the neutral odorants. This suggests another plausible explanation for young adult–child differentiation that would involve the differential use of the rating scales. Children rate all odorants as being more pleasant than adults, indicating perhaps that they may have a systematic bias to prefer the “more” intense or pleasant end of a continuous scale. Effective evaluation is certainly one of the critical early stages in the cognitive processing of olfactory information [11]. Children actively assess the olfactory facets of their physical and social environments. They develop knowledge of their odour skills [11]. The cognitive and linguistic demands of many existing tests confound the interpretation of the results from young children. Hedonic judgments disguised as a game have been shown to be reliable methods for children as young as three years of age. In slightly older children, matching odours to pictures is a successful method, if the child has experience with the particular odour that is being

evaluated [14]. In our study, children in the younger group were also able to evaluate pleasantness without difficulties.

In the study by Martinec Nováková et al. [13] there was found a positive association between odour identification and a pleasantness for fish. So, higher pleasantness ratings were exhibited by the participants who correctly identified these odours compared to those who failed to correctly identify them [13]. The results of the study by Martinec Nováková et al. [13], contradict the results of the presented study. In our study, the smell of fish was correctly identified by 60 % of the children in both groups together and 69% categorised the hedonic tone as being unpleasant or very unpleasant. Fish was incorrectly identified by 40 % of the subjects in both groups together and only 39% categorised the fish smell as being unpleasant or very unpleasant. Based on results of our study there was a relationship between the correctly identified odours and the most frequently chosen pleasantness rating. A higher rating of pleasantness (typical for peach, orange, apple and other odours) or unpleasantness (typical for fish, butter and onion) were exhibited by those participants who correctly identified these odours compared to those who failed to identify them correctly (Table 1). The study by Bensafi et al. [11], indicated that fish and garlic were rated as unpleasant, banana and mint as neutral and orange and apple as pleasant. Children aged 5 -6, perceived the set of odorants as being more intense and more pleasant than adults (20 - 25 years). Making an odorant's name available changed the hedonic ratings of neutral odorants (mint and banana), but it had no impact on the rating of odorants that were already affirmed as being pleasant (apple and orange) or unpleasant (fish and garlic) [11].

Conclusion

The present study showed that older children have an increased ability in identifying odours. The categorisation of hedonic tones differed depending on age: younger children were more

prone to categorise odorants as being pleasant. Older children more often categorised odorants as being neutral in character.