

Evaluation of Olfactory Function in a Pediatric Population

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ABSTRACT

Objective: Evaluate a simple, easy-to-use test of olfactory function that is suitable for use in a pediatric population for inclusion in the NIH Toolbox.

Background: Studies of the prevalence of olfactory dysfunction in the pediatric population are rare. Since there is also evidence that olfactory learning may be robust during childhood, identifying deficits in this age group could be an important marker for developmental issues. Despite this, there is no commercially available test of olfactory function suitable for use with children.

Methods: A total of 367 children and 280 adults were recruited during outpatient visits to a tertiary care medical center and a chemosensory research facility for this cross-sectional study. All were given questionnaires and a six-item scratch-and-sniff test. Odors utilized were banana, lemon, PlayDoh™, coffee, cinnamon, mint, grape and bubble gum.

Results: All but one child completed the task, which required less than 5 minutes. Greater than 90% of all children and parents indicated that they were familiar with the odorants. Children were grouped by age 3-5, 6-8, 9-11, 12-14, 15-17 years old. Average scores for each age group were 3.46, 4.04, 4.38, 4.54, 4.74 respectively. Analysis of variance (ANOVA) showed significant differences ($p < 0.05$) for both age group and for odor. To further delineate the differences, a post hoc analysis was performed using an parabolic and non-parabolic unequal N HSD test, which showed that children in the 3-5 year old group did significantly worse ($p < 0.05$) on odor identification, and both bubble gum and peanut butter showed significantly worse performance as odorants ($p < 0.05$).

Conclusion: The Monell Brief Smell Identification Test is a brief, easily conducted test that is useful in evaluating olfactory function in children. Further study needs to be done to determine which odorants should be used.

INTRODUCTION

Although smell loss has many potential etiologies (allergic rhinitis, enlarged adenoids, head trauma) that are common among children less than 18 years of age, studies of the prevalence of olfactory dysfunction in the pediatric population are rare. Since there is also evidence that olfactory learning may be robust during childhood, identifying deficits in this age group could be an important marker for developmental issues. Despite this, there is no commercially available test of olfactory function suitable for use with children. The NIH Toolbox initiative seeks to evaluate sensory function across the lifespan, including olfaction. The purpose of this study is to evaluate and refine a child-specific olfaction test that includes standardized, easily obtained stimuli and that utilizes both picture and word responses and that can be efficiently administered in a brief period of time.

METHODS

A total of 367 children (between the ages of 3 and 17) and 280 adults were recruited during outpatient visits to a tertiary care medical center and a chemosensory research facility for this cross-sectional study. Each was given one of two Monell Brief Smell Identification Tests, a 6-item scratch and sniff test that was developed using microencapsulated odorants that have broad cross-cultural familiarity². Test 1 utilized the encapsulated odorants banana, lemon, PlayDoh™, coffee, cinnamon, and bubble gum and was given if there was no report of peanut allergy. Test 2 utilized the odorants peanut butter, chocolate, flower, mint, PlayDoh™, and grape. Test materials are shown in Figure 1. Before commencing the test a brief interview was conducted with the parents and the children to explain the purpose and protocol of the study. To determine familiarity with the odor stimuli, the accompanying parent or guardian also took the same version of the test.

Prior to introduction of the scratch and sniff portion of the test, parents and children were screened for familiarity with the odorants. Participants were shown a picture card of all possible odorants used in the study. They were asked individually if they knew what the particular item in question was, then they were asked to point to it, finally they were asked if they knew what said item smelled like. For example: "Do you know what a banana is? Could you point to a banana? Have you ever smelled a banana? Do you know what a banana smells like? This was done for all possible odorants used. If participants failed to correctly identify the item or said that they were unfamiliar with the smell of that item, responses for that item were disregarded. Odorants were introduced via six individually numbered scratch and sniff cards. These were scratched and presented to the children by the study conductor. The participant was then asked to identify the smell either by pointing to a picture of the item from a choice of four possible choices or identifying the item from a four choice word list. A response was collected for all entries. With each odor stimulus, there are four response options shown: one is correct and three are distracters. Among the distracters, one item is categorically or perceptually similar to the correct item (e.g. chocolate vs. coffee) and considered a "near-miss". The other two are very dissimilar and are considered true distracters. A correct response is given a score "1" and a near miss a score "0.5". Distracters are scored at "0". Points for each participant were summed, with a possible maximum score of 6 and a minimum score of 0.

RESULTS

We tested 367 subjects who were between the ages of 3 and 17 years; 185 were tested at the Monell Center and 182 at Nemours/A.I. DuPont Hospital. Subjects were presented with 6 cards, each of which was affixed with a scratch-and-sniff sticker. For 55% of the children the odors on the cards were lemon, coffee, Play-Doh™, floral, bubble gum and peanut butter; whereas for the remaining children (particularly those whose parents reported they had peanut allergies), the odors were the same with the exception that peanut butter was replaced by cinnamon. All but one child (3 years) completed the task which took less than 5 minutes. Greater than 90% of all children and parents indicated that they were familiar with the odor of the odorants used. Children were grouped by age into epidemiological subsets as follows: 3-5, 6-8, 9-11, 12-14, 15-17 years old. Average scores for each age group were 3.46, 4.04, 4.38, 4.54, 4.74 respectively. A two factor analysis of variance (ANOVA) was performed (age category, odor) with the total identification score out of a maximum of 6 as the dependent variable. This showed significant effect ($p < 0.05$) for both age group and for odor. To further delineate the differences, a post hoc analysis was performed using an unequal N HSD test. Parabolic and non-parabolic statistical modeling was used as the number of subject in each group was not equal. This showed that children in the 3-5 year old group did significantly worse ($p < 0.05$) on odor identification and both bubble gum and peanut butter showed the significantly worse performance as odorants ($p < 0.05$). Details of accuracy of children's responses with respect to odor and age are shown in table 1.

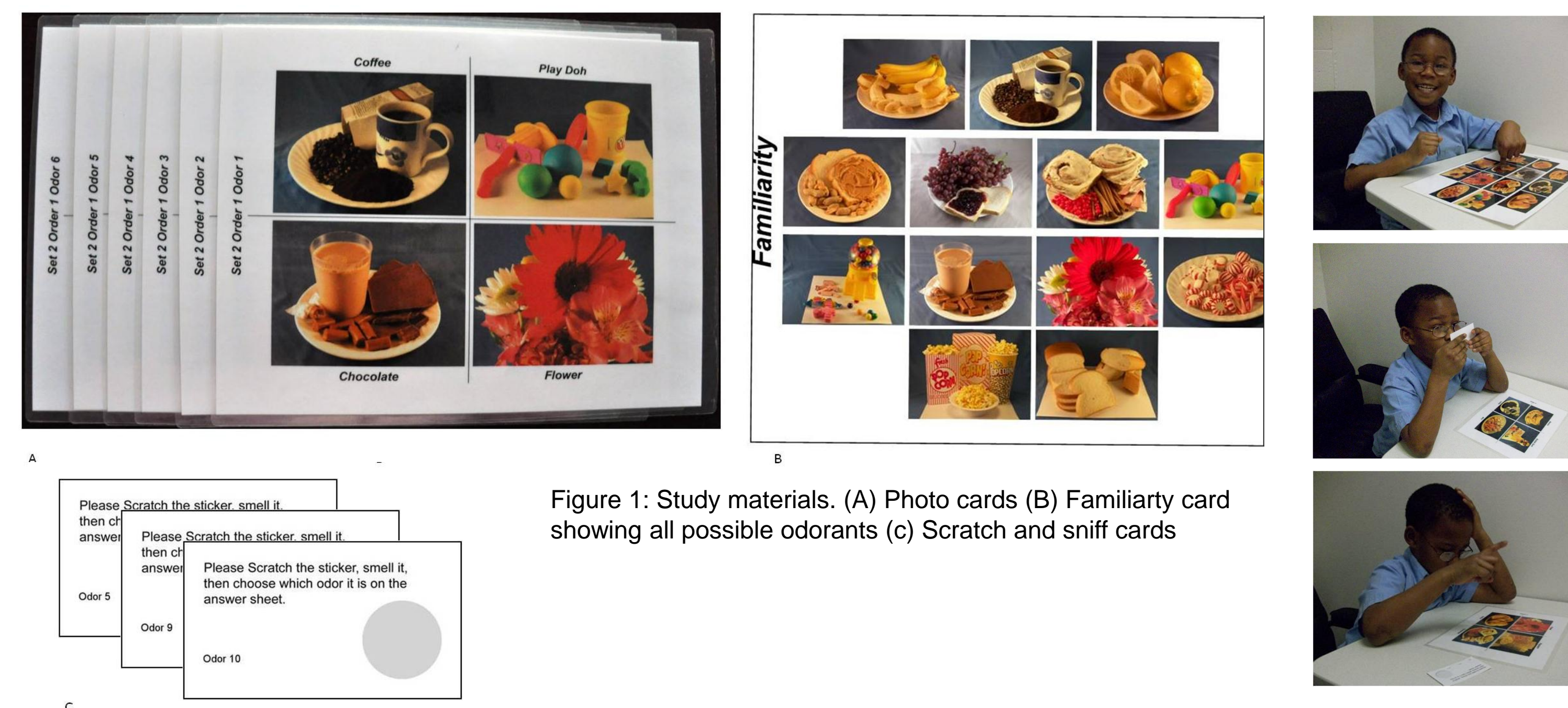


Figure 1: Study materials. (A) Photo cards (B) Familiarity card showing all possible odorants (c) Scratch and sniff cards

Accuracy for Odorants Between Ages

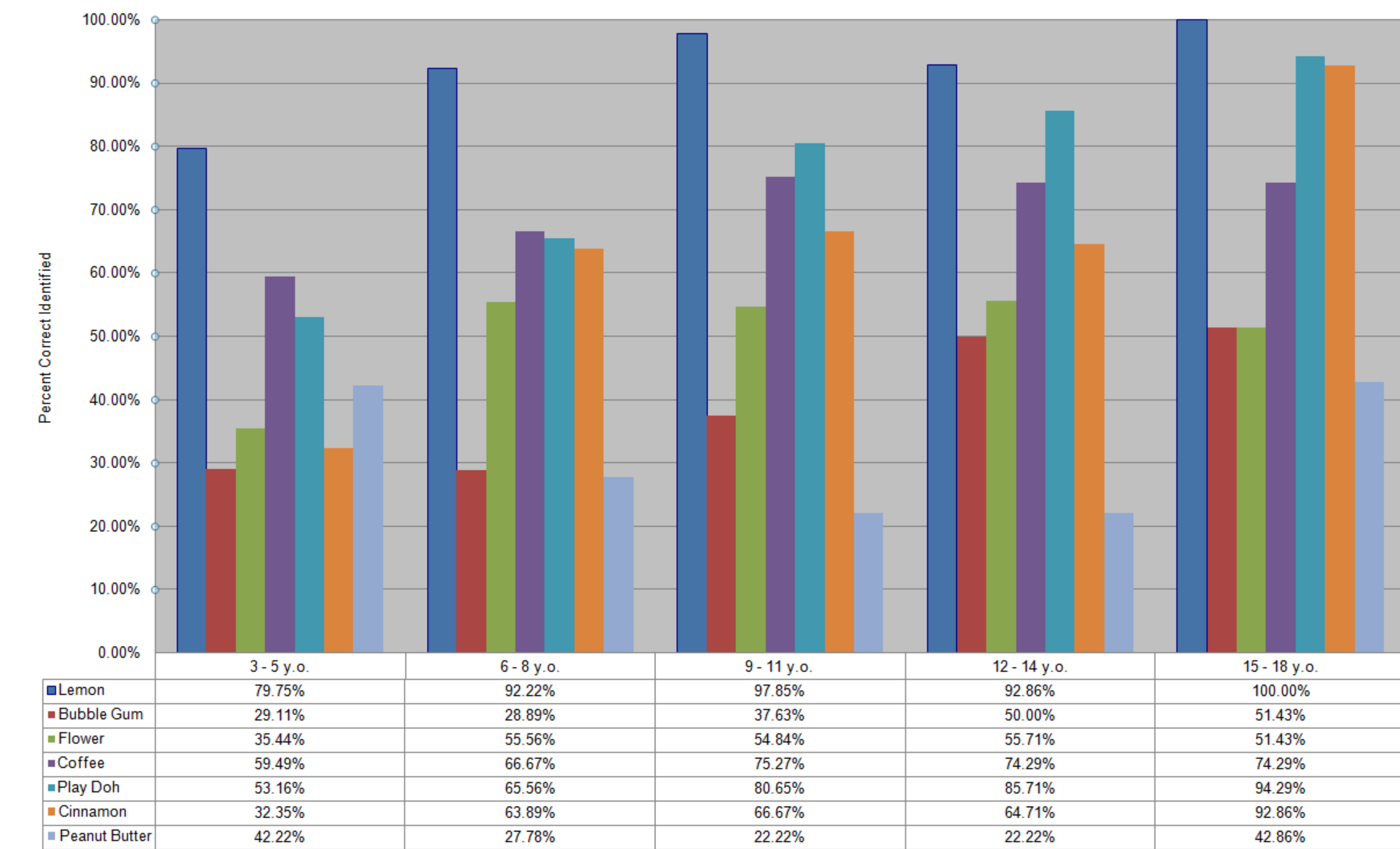


Table 1: Percent of children who identified odorant correctly. Those in the 3-5 age group did significantly worse across all odors, while peanut butter and bubble gum show significantly worse performance as odorants.

DISCUSSION

Loss of olfactory function may occur from a variety of conditions that are common in a pediatric population, including upper respiratory infection, nasal and sinus disease¹, and endocrine disorders². Despite this, studies of the prevalence of olfactory dysfunction in the pediatric population are rare. Since there is also evidence that olfactory function and discrimination are linked to learning and that this process may be robust during childhood³, identifying deficits in this age group could be an important marker for developmental issues. Additionally, olfaction plays a role in safety and prevention of injuries⁴. The commercially available tests of olfactory function, the 40-odorant UPSIT Smell identification Test⁵ and the Sniffin Sticks Test⁶ are not suitable for use with children as they are too cumbersome and contain odorants not familiar to children². The results of this study show that children as young as 4 years of age understood the task and could reliably identify the odorants used. The number of correct response items increases with age categories ($P < 0.05$). Identification of some of the odors was difficult for all age groups (peanut butter, bubble gum), thus leading us to conclude that the quality of some of the fragrances may not be adequate. Certain items are better recognized even among the oldest age group. The Monell Brief Smell Identification Test is a brief, easily conducted test that is useful in evaluating olfactory function in children. Further study and testing is necessary to determine which odorants will be best suited for this mode of olfactory assessment.

REFERENCES

- Doty RL, Mishra. Influences of Nasal Obstruction, Rhinitis, and Rhinosinusitis on the Ability to Smell. *Laryngoscope* 2001;111:409-423.
- Laing DG, Segovia C, et al. Tests for Screening Olfactory and Gustatory Function in School-Age Children. *Otolaryngology-Head and Neck Surgery* 2008;139:74-82.
- Li W, Luxenberg E, Parrish T, Gottfried J. Learning to Smell the Roses: Experience-Dependent Neural Plasticity in Human Piriform and Orbitofrontal Cortices *Neuron* 2006;52:1097-1108
- Schiffmann SS. Taste and Smell in Disease. *New England Journal of Medicine*. 1983; 308:1275-1279
- Doty RL, Shaman P, Dann M. Development of the University of Pennsylvania Smell Identification Test: a standardized microencapsulated test of olfactory function. *Physiol Behavior* 1984;32:489-502
- Hummel T, Sekinger B, Wolfe SR, et al. "Sniffin Sticks": olfactory performance assessed by the combined testing of odor identification, odor discrimination and olfactory threshold. *Chemical Senses* 1997;22:39-52