Olfaction Disorders in Children

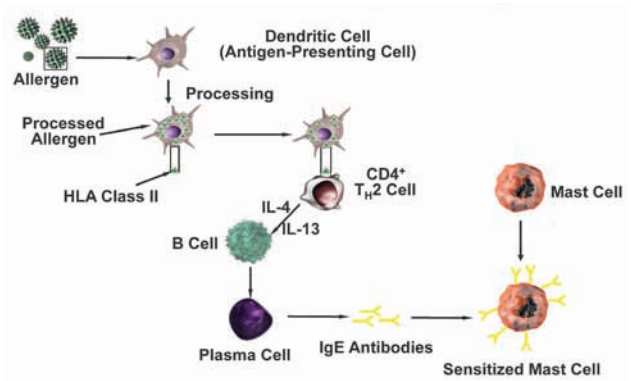
James S. Reilly

I will take another look at children's issues, with an emphasis to their nasal function. I are going to discuss allergic rhinitis in general terms but, specifically, I will look at some recent clinical studies that I participated in investigating the prevalence of olfaction function and disorders in children.

We can have several questions that might be asked relative to the nasal condition of children. Probably, the answers are supposed by all of us as clinicians, but often times not actually verified. First, certainly would be that allergic conditions might affect the ability of the child to smell. Although this is a common observation among our "day to day" activities, we really can not often test that hypothesis in a suitable fashion. More importantly, when the data is stratified by age, there is an absence of normative data to identify what specific odors might be best to test and how often a child might correctly identify them.

We have heard a lot about different allergic phenomenon (**Figure 1**) and this is a rather simplistic diagram. However, allergens are interacting with antigen-presenting cells that are eventually processed, and initiate some CD4 Th cell response with each IL-4 and IL-13 being activated. This is done to mobilize B Cells, which interact again with T Cells and Plasma Cells. These intermediaries will eventually sensitize the Mast Cells and create histamine release and congestion in the nasal cavity.

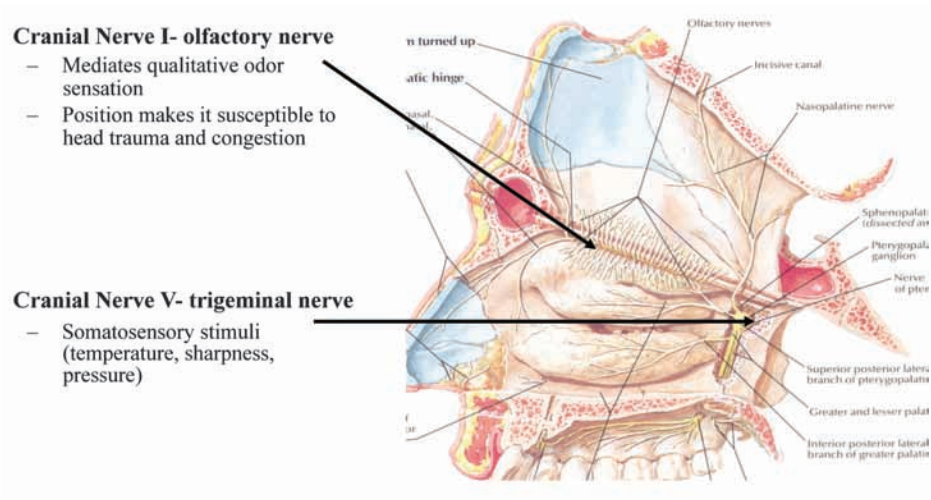
Figure 1. Initiation of the Allergic response



It is assumed that the allergic conditions which I described causes congestion and edema, which will affect the nasal turbinates and nasal air flow. The question that I will approach today is how this may affect the ability of the child to smell. What testing is available? Can we start to develop normative data that will help us identify certain odors for testing all children?

I am going to briefly review some of the anatomy. In this diagram (**Figure 2**), where the nasal septum is elevated to the top of the illustration, we realize that high above the superior turbinate is the Cranial Nerve I. The olfactory nerve is that portion of our cranial nerve system that gives qualitative odor sensation and Cranial Nerve I is vulnerable to injury or congestion. The Cranial Nerve V, which is in the posterior portion of the nose, provides fibers that spread out throughout the nasal cavity and is primary somato-sensory, involving different effects such as pressure, temperature and sharpness.

Figure 2. Anatomy



There have been prior studies looking at odor identification in children. A recently published study from San Diego (San Diego Children's Odor Identification test), shows that certain odors can be proven to be tested and which were highly recognizable by children using hand-drawn pictures. However, the substance that was presented was not standardized or reproducible.

Another study in the United States, at the University of Pennsylvania, there has been what is called the UPSIT test, (University of Pennsylvania Smell Identification Test). UPSIT provides are series of odors, but which are not particularly common to children. UPSIT is both lengthy and expensive.

A more recent study of children, performed in Australia, has been published but with odors that are familiar to children as young as five years of age. The test was good, but had a relatively small sample size.

So we have looked at different assessment tools that have been developed. There was a "match-to-sample" odor discrimination task, developed by doctor Richman, 1995. He presented five common items in microencapsulated form. The microencapsulated form is important because the quantity of the presenting odor can be controlled and unified. Each trial consists of one probe a match and a second distractor.

Other tests by Doctor Doty, from the Monell Chemical Center used a 12 item scratch-n-sniff test, with four different response vehicles [1].

Earlier, I have referred to the San Diego Odor ID test, has eight common items presented in opaque bottles, and matched to the appropriate line drawings, out of a possible 20 odors [2]. However, most of this data comes from children five years old and up, and some tests performance for children in this appears to be similar to adults as they go into adult life.

So, we did this study which is ongoing looking at children from three years old and up. We obtained consent and assent to participate. We did a demographic questionnaire and also a survey to see if the test odors would be familiar to the child: the child was given a familiarity test verbally.

Testing children is difficult and can be time consuming. Obviously, for anything to be practical, it has to have a certain amount of appeal and not be too lengthy, so the children do not get distracted. So, we tried to make it age-appropriate. We asked that children simply matched the odors to pictures. This is a common and widely used technique for children. We tried to make it as game-like as possible. Each child would play it as a game, where odors that you would like, would be given to one figure, such as the cartoon Big Bird, to the left side of the picture, and the less attractive ones to the figure of the Oscar the Grouch (**Figure 3**).

Figure 3. Considerations for testing children. Disguise as a game

Spectrum of items were varied and it ranged from floral odors to lemon, chocolate, coffee, peppermint and a toy called play-dough which has a familiarity with children (**Figure 4**).

Figure 4. Familiarity

Odors were microencapsulated and again used as scratch and sniff standardized presentations. We tested both parent and the child, with six different stickers, and with four choices per odorant. The parent performed the test independently and the testing sessions lasted ten minutes or less.

We felt that this might have potential to create a widely available standardized test that would try to separate out or identify what were normal ranges of odor identification. In addition, children that might be either injured could have this is as screening test for either allergic phenomenon or others conditions that may lose the smell.

This also has benefits, if it correlates well, with avoiding radiographic examinations and exposure to radiation from multiple CT scans. Many other children who have neuropathies and have problems with hearing or vision. Further testing will confirm as to whether their olfaction might be equally impaired.

In the analysis of olfaction disorders, there are obviously some differing categories: (**Classification**):

● completely lose their sense of smell – **Anosmia**;

● some that have a diminished ability to smell – **Hyposmia/microsmia;**

● more commonly, there are transient conditions that either cause diminished ability to smell. This condition is known as **Parosmia** or **Dysosmia**, causing a distorted sense of smell. This is commonly seen in patients recovering from head trauma or upper respiratory infection (URI) [3].

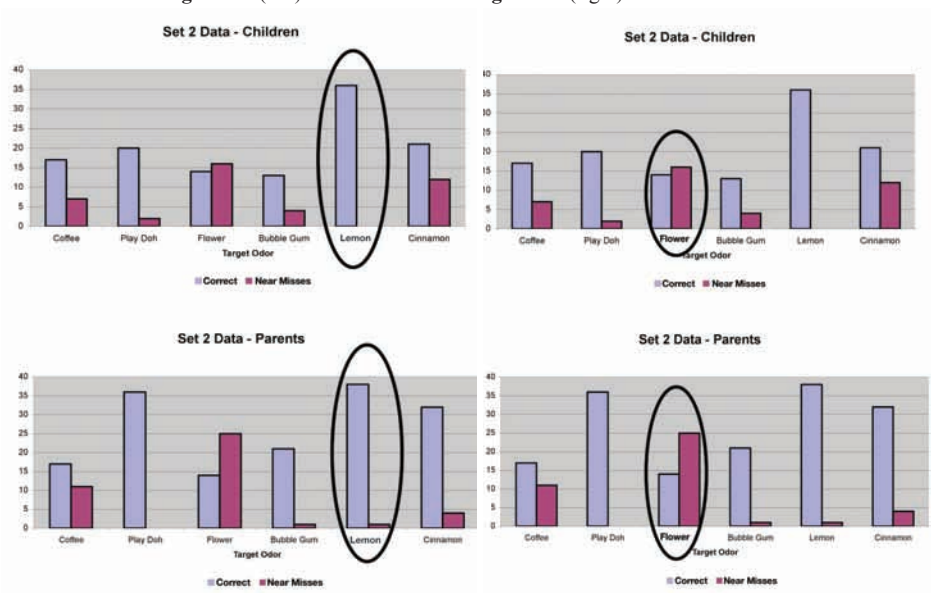
Which populations would be at risk for these types of deficits? Certainly many children with allergic rhinitis, those with head injury [4] and we see a lot of these children at our hospital and there is also a publication in 2005, by doctor Konstantinidis [5] that children with adenoid hypertrophy have decreased airflow through the nose and decreased olfaction. And of course, other factors such as lead poisoning may come into play.

For our Odor Stimuli test we use two sets of test odors. Set A (Banana, lemon, play doh, coffee, cinnamon, bubble gum). Set B (peanut butter, chocolate, flower, mint, pay doh, grape). We had a scoring sheet which included different gradations for the things that would be presented. Final scores would include both what is called a correct answer or a "near-miss".

Our results from the first 400 children, there was approximately an average score of 3.59 which included both the correct responses as well as the near-miss for total score 68%. The parents obviously did better, at 85%, with an average score of 4.44, again with this test items.

I am going to call your attention to the lemon and to the flowers. When the correct answer is plotted, with the score compared to the near-misses some odors have distinct separations, and are better for testing. For example, lemon tended to have a very accurate scoring phenomenon (**Figure 5A**), whereas the flowers (**Figure 5B**), the differentiation between a correct score and a near-miss was poorly obtained.

Figure 5A (left). Better for lemon. **Figure 5B** (right). Better for flowers



So, in summary, there are commercial olfactory tests that are available. They all have limitations in terms of cultural specificity, time and cost. Among the specific odors tested, it appears that lemon as a differentiator seems to be an effective test odor. The bottom line is that olfactory tests are improving and soon there will be tests more suitable for children.

I would like to thank again my colleagues from the University of Pennsylvania and the Monell Chemical Sciences Center, which specializes in testing olfactory chemical senses in the mid-Atlantic Philadelphia region where I practice.

References

1. Doty RL, Frye R. "Influence of nasal obstruction on smell function" Otolaryngol. Clin North Am. 22 (1989) 397- 411.
2. Murphy C, Morgan CD, Geisler MW, Wetter S, Covington JW, Madowitz MD, Nordin S. " Olfactory event-related potentials and aging: normative data" Int. J. Psychophysiol 36 (2000) : 133-145.
3. Kern RC, Conley D, Haines K, Robinson AM "Pathology of Olfactory Mucosa: Implications for the treatment of olfactory dysfunction" Laryngoscope 114 (2004) 279-284.
4. Sanford AA, Davidson TM, Herrera N, Gilbert P, Magit AE, Haug K, Gutglass D, Murphy C. "Olfactory Ddysfunction: A sequela of pediartric blunt head trauma" IJPO (2005) 70:1015-1025.
5. Konstantinidis I, Triaridis S, Triaridis A, Petropoulos I, Karagiannitdi K, Kontzoglou G. "How do children with adenoid hypertrophy smell and taste? Clinical assessment of olfactory function pre- and post-adenoidectomy" IJPO (2005) 69, 1343-1349.