OUTLINE OF PRACTICAL OLFACTOMETRY

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In **Cottle's "golden age" of Rhinology,** the time of Joseph, Mosher, Freer, Zwaardemaker and many others, this important organ was on equal terms with the ear and the larynx and olfactometry was a matter of interest to every one. In the first half of this century, the fascinating development in ear and larynx surgery overshadowed the nasal problems, problems mostly not involving life and social validity. Lately after development in the fields of ear and larynx slowed down, technics and tests having been stabilized, we discovered that the third organ entrusted to our care — the nose — was highly neglected and badly needing attention. It is due to the energy and inspiration of men such as **Fomon, Cottle, Aubry, Sercer** and others, that rhinology is now ascending "de profundus" into the floodlight of medical attention.

The backbone of this resurrection is the growing interest in septum surgery and reconstruction of the external pyramid. But also the development in nasal physiology was of the utmost importance. The nasal mucous membrane (this wonderful organ not long ago in the mind of many surgeons a nuisance to be removed as soon and as completely as possible) threatens now to become for many of us a "noli me tangere" to be approached if not with religious awe, surely with appropriate knowledge. Notwithstanding the progress in rhinology, still one field does not get the medical attention it deserves. This is the field of olfaction, a small area hidden high up in a narrow cleft at the border of our speciality. As a fact, most doctors and E.N.T. specialists do not ask their patients wether they smell or not and most patients do not bother to mention this discomfort.

Nevertheless, smell and its associate taste are in animal life vital functions for selection of food, avoiding of danger and in mating. In human civilized life in these same field smell is of great importance. The enormous capital invested in the perfume and deodorant industries and the even greater interest of every one in gastronomy is essentially based on "civilized lust" provided by that hidden organ in the upper layers of the nose.

Olfactometry as audiometry is the science of measuring quantitatively and qualitatively a sense by means of ingeniously constructed instruments. The ideal of these instruments — olfactometers and audiometers — is to administer to the organ in every aspect known stimuli in order that the response of

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the organ (objectively) or of the patient (subjectively) can be evaluated. In both, we depend on sensation and the threshold is our mainstay.

In sound, the stimulus is exactly measurable but in olfaction an objective yeardstick, comparable to sound pressure, is lacking. In sound, the sensation can be graduated between the threshold, the comfortable level, the uncomfortable level and pain sensation in decibels above the sensation threshold. In olfaction, such a highly wanted graduation is never achieved.

Molecules of very different dimension and nature smell. Already in the end of the last century, Henning and Zwaardemaker tried to classify the odors and to formulate a theory of smell. Recently, **Amoore, Johnston** and **Rubin** added a new very attractive theory and classification based on a stereochemical conception. According to them, seven primary odors can be distinguished: camphoraceous, musky, floral, pepperminty, ethereal, pungent and putrid.

Each of these primary odors should be detected by a different receptor in the nose because each molecule of smell should fit into its peculiar receptor in the nerve endings as a key into its lock. This is due to its overall geometric shape rather than to any details of its composition or structure. Most odors are supposed to be composed of several of these primaries combined in various proportions. This theory is corraborated by impressive chemical and physiological evidence and up to now, contrary to the other 30 existing theories, no important contradictory observations are known. Being the best classification available, it seems good to accept these seven smells as basic stimuli for olfactometry.

What is the aim of olfactometry in the every day practice of an all round rhinologist? Its first and foremost task is to distinguish between perceptive and conductive anosmia and secondly to measure hyposmia as exactly as possible with a practical and reliable instrument.

Perceptive anosmia means that the organ is damaged. This may be due to the loss of all or a part (even a special part) of the receptors in the olfactory epithelium, caused for instance by local damage (nose drops), infection, intoxication, or it may be due to damage of the olfactory tract and bulb, for instance, by cranial trauma or to a central lesion in the brain.

Conductive anosmia means that the odor-molecules cannot reach the receptors in the olfactory epithelium. This happens when the nasal airway is blocked by polyps or tumor or simply by swelling of the mucous membrane in the olfactory cleft. As a layer of air on the epithelium is essential for the molecules to reach the nerve endings, already some secretion in this narrow cleft will be enough to hinder smelling.

Consequently, the diagnosis of conductive anosmia or hyposmia depends largely on inspection of the nasal airway completed by a careful anamnesis. If a patient reports that on a certain hour, perhaps weeks ago, suddenly he could smell, be it for a short time, we may conclude to a conductive anosmia and our therapy will be directed accordingly. If after operation or after decongestion therapy with vasoconstrictors or cortico--steroids, olfaction returns, again the trouble must have been with the conduction of the stimulus to the receptors. If taste is preserved, olfaction cannot be absent.

The so-called haematogenous olfaction has been recommended in order

to distinguish between conductive and perceptive anosmia (a.o. **Clemente, Langfelder).** A smelling substance, for instance camphor, introduced into the bloodstream, was thought to stimulate the nerve endings directly even if the olfactory cleft is obstructed — similarly to a bone conductive sound stimulating the conchlea when the air conduction is blocked. However, this "Rinne test for smell" proved to be incorrect. We found that the injected camphor was excreted in the lungs and reached the olfactory cleft on exhaling. So, in normal test persons the proof was negative as long as the breath was held or the nose filled with water. Also in laryngectomised patients camphor sensation was absent.

With these experiments, we found that in some patients suffering from hyposmia, on exhaling a distinct sensation occured. From this observation, we concluded that expiratory smelling is superior to inhalatory, most probably because the expiratory air current passes higher in the nose. For this reason, taste is not so often damaged as smell. As a diagnostic, in cases of inhalatory hyposmia we bring camphor through the mouth on the pharynx, inviting the patient to exhale forcibly.

Total anosmia is easily detected. All we need is an assortment of bottles containing the primary odors in high concentration, which we invite the patient to sniff in turn. Partial anosmia, meaning that the patient smells only parts of these odors, occasionely is met with. So far, olfactometry is simple. The difficulties arise when we try to measure the smelling sensation quantitatively in order to establish the degree of hyposmia of a patient.

We know the incredible smelling capacity of the dog, the bee, and some kinds of butterflies (Fabre) and notwithstanding that man belongs to the microsmates, the sensitivety of his nose is by far superior to any chemical instrument. Consequently, the test should be extremely sensitive and more or less quantitatively balanced according to Weber's law. Moreover, a modern olfactometer should provide distinction between olfactory, trigeminal, and gustatory stimulation by the appropriate selection of the stimulus.

Olfactometers are based on the principles of diffusion, dilution and on controlled volume and velocity of the odor-carrying air stream.

The wellknown diffusion olfactometer of **Zwaardemaker** (1910) was designed for clinical use. The stimulus material is enclosed in a long hollow tube perforated on the inner surface. This tube glides over a glass tube open at both ends, which leads through a screen to the patient's nose. As less and less of the inner tube is covered by the outer tube, more and more of the latter's perforated inner surface is exposed, allowing a greater amount of the odorous substance within to escape into the glass and into the patient's nose when he sniffs. This Dutch-olfactometer was in the beginning of this century widely in use in Europe and we still think it should not be forgotten.

For clinical routine examination, dilution methods are useful. Very simple are the bottles of **Proetz** containing dilutions of odorous substances in the non smelling medium of liquid paraffin. In imitation of Zwaardemaker's "olfactie", Proetz called the threshold dilution "one olfact", five olfacts being five times this concentration of molecules.

In other more complicated olfactometers a not smelling air stream is mixed

with a weaker odor-carrying air stream, both controlled by valves and flow-meters **(Bozza, Stuiver).**

Together with Versteeg we introduced a simple method for olfactometry in children based on the selection of a bottle containing peppermint out of a number of similar not smelling bottles.

Objective olfactometry in young children. Six flasks filled with placebos and one filled with peppermint - all five covered with gauze - are presented to the child. Conducted by smell he will select the flask with peppermints. By covering one nostril with tape, each side can be tested separately.

If temperature, pressure, volume, saturation, etc. of the stimulus is known, still the amount of molecules reaching the epithelium depends on the uncontrolled factor of breathing or sniffing. For this reason, **Elsberg** introduced in 1935 his "dynamic blast injection olfactometer". Here, sniffing is replaced by the injection into the nose of a known amount of odor-saturated air. First, the air is compressed and than suddenly released into the nose.

However, force and impact of the blast on the olfactory cells should be of more importance than the volume. For this reason, Guerrier uses an air stream with a constant odor-saturation but changing velocity. The higher the velocity

the more molecules will be deposed on the epithelium. The patient is placed in this air stream, freely inhaling or sniffing.

The replacement of the natural "sniff" by an unnatural "blast" was introduced by psychologists but is not popular among rhinologists. Knowledge of nasal pathology and a clear conception of our aim are often lacking.

The aim of a quantitative olfactometry must be to test the organ in neutral conditions by bringing on the epithelium in the unit of time a comparable amount of molecules. Sniffing means sampling the presented air in a familiar and extremely efficient way. In this act of sniffing, the negative pressure in the olfactory cleft above the pathway of the main inhalatory air stream is for a moment increased and thus at the end of each sniff some air will enter the cleft. In order to reach the optimum amount the sniff is directly once or several times repeated. I wonder if this delicate process needs improvement by injection from a "known" amount of molecules of which an unknown quantity will reach an unknown surface of epithelium.

What do we imagine as the cause of a temporal hyposmia, for instance, in an allergic attack? In my opinion, part of the olfactory epithelium is covered by secretion or stuck together by swelling, leaving only a small part in contact with air. The above mentioned inhalatory negative pressure, the sucking power of sniffing, will be ineffective by lack of air space. We may assume that as every sense organ, olfaction enjoys a redundancy of receptors and that the normal threshold sensation can be illicited up to a certain limit by a reduced surface. Under this limit the threshold will be raised, but "the above threshold sensation" might be normal due to recruitment. In infection, apart from a reduced area, intoxication of the cells might play a role too.

On the influence of toxics and drugs on the organ of smell very little is known and systematic investigations, as is done for hearing, are needed. It is generally assumed that abuse of tobacco lowers and that certain hormones increase the acuity of smell. Wether this is simply due to congestion and decongestion of the membranes is not known.

For the time being, the olfactometry we use for everyday practice is a modified Proetz equipment consisting of seven sets of seven bottles, containing dilutions in liquid paraffin of the seven primary odors of Amoore.

The concentration of these bottles are -5, 1, 5, 10, 50, 100, 1000 olfacts. (This can be done by diluting a random concentration by try and error till the threshold is reached. This bottle is labelled 1 olfact, 10 times this concentration being 10 olfact, etc.)

For screening purpose our equipment is still simpler. The patients are invited to sniff at a 10 or 50 olfact bottle of camphor. Those who does not smell are hyposmatic and if they neither smell camphor in substance anosmatic. These patients are tested in a special room with all bottles and also for expiratory, gustatory and trigeminal sensations. The results can be noted on a special "olfactochart" and if after a septum correction or nasal reconstruction the olfactogram of the patient is improved, the patient and his surgeon will have an objective reason to be satisfied.

RÉSUMÉ

Une revue est présentée des differentes olfactomètres basées sur les principes de diffusion, (Zwaardemaker), dilutions en bouteilles (Proetz), volume d'air odorante controllée (Elsberg) et vélocité controllée d'un courant d'air odorante (Magnen). Toutes les méthodes de précision demandent une appareillage compliquée et pour cela doivent être réservé plutôt pour buts de recherches scientifiques. Pour la pratique journalière par nous les sept odeurs fondamentales de Amoore, Johnston et Rubin sont diluées en parafine liquide chaqu'une en 7 differentes concentrations partant de 0.1 olfact jusqu'à 1000 olfacts (un olfact présente la limite d'olfaction d'une certaine substance).

Le diagnostic de l'hyposmie et de l'anosmie est discuté ainsi que les problèmes de l'olfaction haematogène, les avantages du mechanisme de reniflement envers l'injection forcé d'air odorant (Elsberg) et l'odorat expiratoire.

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