Pure & Appl. Chem., Vol. 62, No. 7, pp. 1381–1383, 1990.
Printed in Great Britain.

Odour, a fascinating phenomenon

Peter Schudel

Givaudan Forschungsgesellschaft AG, CH-8600 Duebendorf, Switzerland

Abstract - Odour, a perceptive term, can be looked at as information bound to molecules as information carriers. The quality of odour (as such) is therefore not accessible to the methodologies of natural science. The problematic nature of describing odours is mentioned. Based on the assumption that the pattern of activated brain neurons does not represent perception, one can conclude that everything we smell, touch, hear or see is but a human concept of what is there.

Science activities connected to fragrances and flavours often lead to a question, the answer to which lies at the basis of any research made in this field: WHAT IS ODOUR ?

According to Webster's Dictionary odour is "that characteristic of a substance, which makes it perceptible to the sense of smell".

Assuming that our human senses have the functions of information receivers - odour can therefore be looked upon as information received through our sense of smell. Since in our scientific world information is bound to information-carriers, the aroma-chemicals can be looked upon as odour information carriers.

What we deal with - if we chemically transform or synthesize aroma chemicals - are the material carriers of odours (informations) which can be perceived by the human or animal organism. The quality of odour (as such) - and which actually is perceived - however is, a priori, not access-ible to methodologies of natural science.

This statement might come as a surprise - but is logically derived from the criteria which form the basis of any investigation within the realm of natural sciences. It might be worthwhile to briefly list some of them again.

Any natural scientific data or result, is based on:

- Experiments arranged in such a manner that they are free of disturbing influences,
- the measurability of the phenomena studied and
- the intersubjective reproducibility of the experiments made and the data obtained.

Based on this frame of science it is immediately evident that, what is perceived as odour, is not a phenomenon accessible to natural scientific investigations. Therefore the following statement must be classified as irrealistic: An electronic nose..."would be useful in the many industries, especially foodstuffs, beverages and perfumes, in which the human nose is still the arbiter of odour quality" (ref. 1).

No electronic device will ever be able to perceive nor measure odour quality. Odour and odour quality are perceptive terms and not to be used within a range of functionalities.

Nevertheless scientists in the field of fragrance, try to find a quasi scientific grip on the odour phenomenon: They proceed scientifically in trying to categorize and/or classify odour qualities. However, this can only be done if language (our means of intersubjective communication) allows them to do so.

Here again we face difficulties, because our everyday language created no terms for odour perceptions. The only ones available are: scent used for a positively accepted odour and stench applied for a negative, rejectable smell. Otherwise one is obliged to describe odour qualities in referring to objects or contexts that emanate a similar smell (e.g. it smells like a rose, or this odour reminds us of the kitchen smell while frying meat, etc.)

Furthermore, it is well known that verbal descriptions of odours have a tendency of originating from the describing person's own experience, thereby hinting at objects, situations, contexts, etc. (ref. 2). It often happens that we clearly recognize an odour,

but strangely enough, do not find the linguistic associative expression for it. This phenomenon was described by the writer Vladimir Nabokov in his early novel "Mary":

> "Memory can restore to life everything except smells, although nothing revives the past so completely as a smell that was once associated with it"

T. Engen (ref. 2) added the remark that this does not happen with the odour description or name alone in the absence of stimulation of the nose.

In addition Cain (ref. 3) published a study which clearly demonstrates that verbal association for odour impressions are not easily learnt by subjects of average intelligence.

With all these phenomena in mind, one is therefore faced with the problem how to meet the desperate scientific need of odour-classifications, which e.g. form the basis of any chemical structure-odour relationship investigation.

Various fragrance houses created artificial classification systems, following more or less a common principle consisting of setting standards with well defined odorous mixtures and positioning a new odour in relation to them.

The system of Haarman and Reimer called odour genealogy (ref. 4) or Givaudan's odour analogies (ref. 5) are well known in the field of perfumery.

These approaches however, are not the ones apt to be used for research on structure-odour relationships, because they use commercial perfumes as references.

Seemingly the only possibility for scientific odour classifications of practical use for chemical research is the following:

A multidimensional "odour space" of defined coordinates, represented by chemically clearly characterized odorous substances is set up. A constantly trained panel of subjects guarantees coherence in descriptive terms. The panelists are asked to describe new odours with descriptors referring to the standards, listing them e.g. according to diminishing intensities.

Difficulties arise when setting the standards, which ideally should exhibit non overlapping (orthogonal) odour impressions.

Odour Perceptions: What can be measured ?

1) The chemicals carrying the odour information can be trapped and their quantities measured.

2) The molecules can be analysed and their structures determined (ref. 6).

3) The minimum amount of molecules needed to perceive the odour can be measured (use of an olfactometer (ref. 7) and determination of threshhold values (ref. 7)).

4) The dimensionless, so called odour values (ref. 8) representing the ratio of the concentration of the odorous molecule in air at a given temperature (headspace concentration in ng/l) and of the corresponding threshhold value (ng/l) can be calculated.

5) The so called transduction process (ref. 9) on the cell membranes of the many olfactive neurons in the mucosa can be investigated and clarified.

6) The frequency modulated nerve pulses used for information transmission into the brain, can be investigated.

7) Eventually every brain neuron, activated or non activated while smelling odorous molecules, might be determined and topographically mapped (ref. 10).

However, it should be noted that the thousand- or millionfold nerve signals received in the human brain while smelling, are meaningless as such (ref. 11). The mind asssociated to the human brain has to interprete the nerve signals and their sequences, as well as the eventual parallel ongoing physical or chemical processes. The brain is necessary, but not sufficient for achieving perception.

Therefore, with our brain we create our own world of smell sensations, smell experiences or smell imaginations. The brain does not smell (ref. 11).

Since the same holds true for the other 4 senses, it might be stated that our human mind (regardless of what this actually means) creates it's own world of sensations, pictures and imaginations.

This finding is not new. Two leading neurobiologists Humberto R. Maturana and Francisco Varela (ref. 12) describe similar deductions in their monography: "El árbol del conocimiento".
H. v. Foerster in "On constructing a Reality" (ref. 13) says: "The environmental world, such as we perceive it, is our invention" (ref. 13,14). In other words this means that everything we perceive while smelling, tasting, touching, hearing or seeing, is but a human concept of what is there.

This finding represents a deduction suggesting itself from the scientific picture of perception mechanisms, and the plausible assumption of presuming that a complicated, dynamic pattern of activated or non activated brain neurons is not what we call perception, but represents it's basis to be interpreted by what we call human mind.

It is (almost) impossible to grasp this seemingly folly conclusion. A faint analogy may help us to understand what actually is meant:

Figure 1. represents an irregular (chaotic) set of black and white dots. Looking at these neutral, meaningless signals, these are interpreted in the brain according to the momentary "perception structure" of the reader. He might first "see" a young lady, or if his structure of perception is different - first "see" an old lady. In other words: the reader creates (while perceiving) either a young or an old lady out of an irregular set of spots. Quod erat demonstrandum.

Fig. 1

In this connection, it is highly fascinating to refer to the Hinduistic Vedanta Philosophy, which claims Maya (a sanskrit term denoting deception, illusion, appearance) as a universal principle - permanently veiling the absolute, perennial, non-thinkable reality - Brahman.

Does this most ancient human wisdom describe similar knowledge to the one arrived at above ?

REFERENCES

1. G. Dodd, The History and Evolution of Electronic Noses, presented at ECRO 8'88 Congress, cp. Abstracts, p. 8, (1988).
2. T. Engen, American Scientist, 75, (No. 5) 497-503 (1987).
3. W.S. Cain, Chemosensation and Cognition, in Olfaction and Taste. H. van der Starre, ed. VII, 347-358, IRL Press (1980).
4. cp. H + R Duftatlas, 2, Damen-Noten, Glöss Verlag, (1984).
5. cp. M. Thiboud, Visual Approach to Fragrance Description in Olfaction and Taste, IX, Annals of the New York Academy of Sciences, 510, 119-123 (1987).
6. cp. R. Kaiser, Trapping, Investigation and Reconstitution of Flower Scents in Perfumery: Art and Technology, D. Lamparksy and P. Müller, eds. Elsevier, in print.
7. F. Etzweiler, Givaudan Forschungsgesellschaft AG, Duebendorf, Switzerland, unpublished; cp. U.A. Huber, Labor 2000, 182-188 (1986).
8. F. Etzweiler, cp. ref. 7. Cp. D.G. Guadagni, R.G. Buttery, J.J. Harris, J. Sci. Food Agric., 17, 142 (1966).
9. D. Lancet, Z. Chen, A. Ciobotariu, F. Eckstein, M. Khen, J. Heldman, D. Ophir, I. Shafir and U. Pace, Olfaction and Taste IX, Annals of the New York Academy of Sciences, 510, 27-32 (1987).
10. S. van Toller, Emotion and the Brain in Perfumery; The Psychology and Biology of Fragrances, S. van Toller and G.H. Dodd eds., 121-145, Chapman and Hall (1988).
11. Felix Baerlocher, Die evolutionäre Erkenntnislehre, Neue Zürcher Zeitung, Forschung und Technik, No. 63, (1988).
12. Humberto R. Maturana / Francisco J. Varela
German version: Der Baum der Erkenntnis, Wie wir die Welt durch unsere Wahrnehmung erschaffen - die biologischen Wurzeln des menschlichen Erkennens, Scherz (1987).
13. H. von Foerster, Environmental Design Research, 2, Dowden, Hutchinson and Ross, (1973).
14. Translated back from the german version, that says:
"Die Umwelt, so wie wir sie wahrnehmen, ist unsere Erfindung", Die erfundene Wirklichkeit, P. Watzlawick, p. 40, Piper (1988).