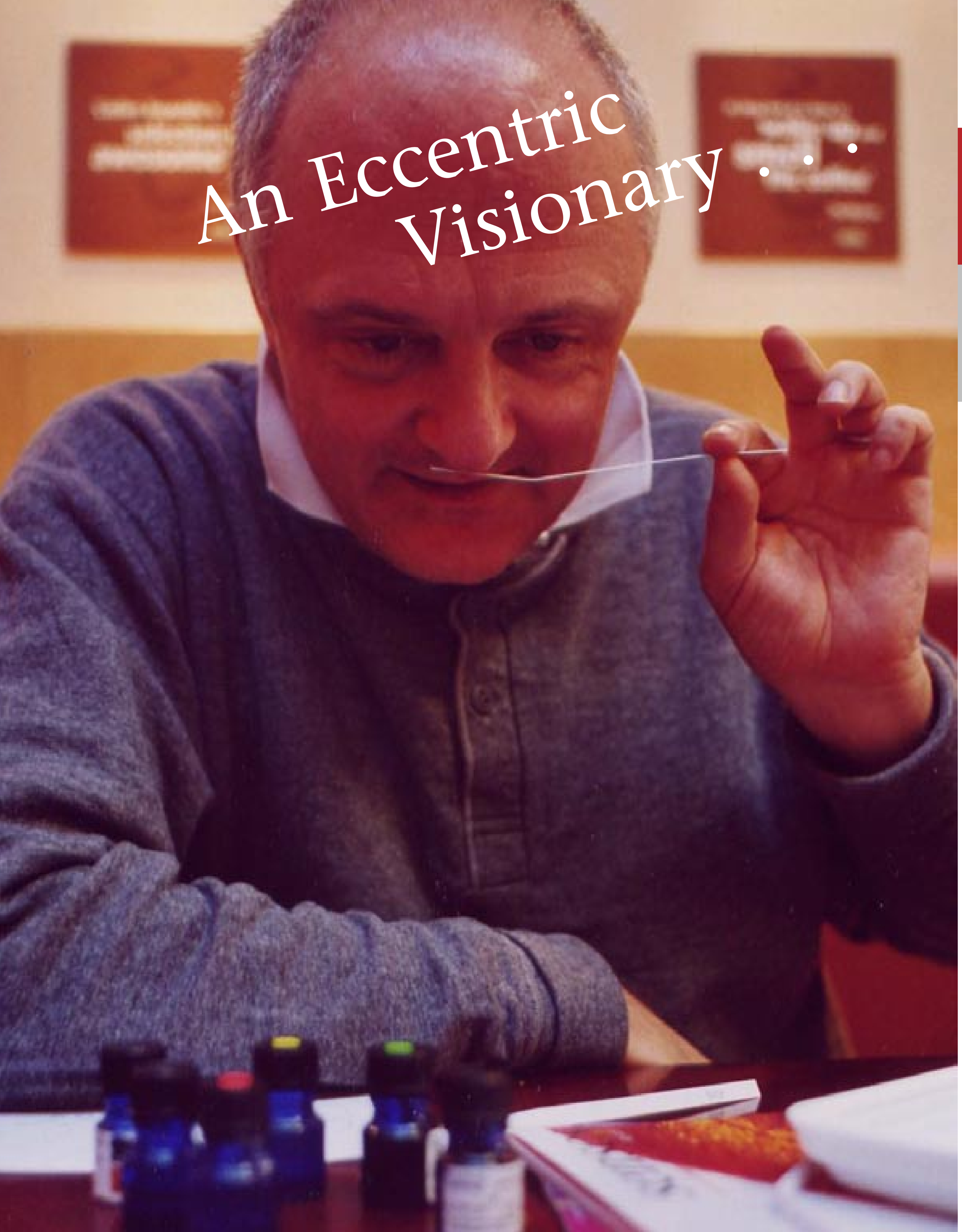

An Eccentric Visionary . . .

. . . with a Fine Nose

On some people it's large, on others it's tiny and delicate. For many people, it seems to always simply get in the way, while others use it to track down the minutest details. We're talking about the nose. The precise process by which this organ is able to identify odors at all is still unknown. But for the past several years, biophysicist Luca Turin has been irritating the scientific world with a highly unique theory of his own.

»Here, just smell this.« Luca Turin selects one of the many cobalt-blue flacons, dips the smelling strip into it and passes it over. A brief, expectant look – and before it's possible for you to put into words what you've just perceived, he's already explaining: »Like freshly mown grass on the one hand, and banana on the other.« Two scents in one and the same substance.

It wasn't merely by chance that this Janus-headed molecule was discovered. The substance smells exactly the way Turin wanted it to. When this 50-year-old biologist synthesizes a new fragrance compound in his laboratory, it's not merely a case of trial and error; he already knows exactly how the substance will smell. In doing so, he's aided by a revolutionary theory of the olfaction mechanism. His own.

Actually, nobody really yet knows how the sense of smell works. However a diffuse consensus does exist that the shape of a molecule determines into which of the more than 350 different types of receptors in the nose it will fit. And thus which olfactory impression will be forwarded to the olfactory center. But Turin wasn't satisfied with this theory, which holds that odorant molecules fit into receptors like a key in a lock. There are simply too many phenomena that can't be explained by it. Why, for example, do so many substances smell like bitter almond, yet differ so greatly with respect to their molecular shape and structure? On the other hand: why do molecules that have virtually identical shapes smell different?

It was his hobby that originally prompted Turin, who initially worked in the field of marine biology in France after earning his Ph.D., to take an interest in the physics of the nose. At some point in his early life, Turin, the son of Italian parents, had begun to collect perfumes. What's more, he delighted in verbalizing the scents. And he finally put them down in writing: His book, »Parfums: le guide« – currently out of print – was published in France.

Turin's descriptions read like this, for example: »This perfume succeeds in arousing a longing and satisfying it with flawed recollections of a fictitious past.« Or: »This is a paltry, powdery-sweet thing that belongs in a tree-

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shaped flacon dangling from the rear-view mirror of a Moscow taxi.« Even though far from all of the products he described came off well, his originality and way with words popularized his book in the industry. The author was even granted access to the laboratories of olfactory chemists – where he learned what a tedious endeavor it is to find a new odorant.

The nose as a spectrometer

How helpful it would be to have a viable theory that would enable one to determine how a molecule smells on the basis of its chemical formula. Turin now believes he has found that theory: »The nose isn't interested in a molecule's shape, but in its vibrations,« he asserts. The nose, he explains, works like a spectrometer that registers the vibration spectra of the substances (see sidebar). This kind of equipment normally consists of large metal boxes in analytical laboratories. It irradiates a specimen with infrared radiation and measures which wavelengths are absorbed. The resulting spectra depict the chemical structure of a molecule – and thus characterize a substance.

How could the nose be capable of doing something like that? When Turin learned about so-called »inelastic electron tunneling spectroscopy« from a physics journal in the mid 1990s – he was now a lecturer in biophysics at University College London – he had found his explanation. Since then, it has been his belief that the receptors in the nose »shoot« electrons of different energy levels at the olfactory molecules and then measure which energy is absorbed.

For many, it's a crazy idea. Yet Turin has made observations that thus far can only be explained by his theory. Such as the fact that compounds comprising boron and hydrogen, so-called boranes, smell similar to mercaptans. Why? Turin demonstrated that the vibration spectra of boron-hydrogen compounds are similar in appearance to those of the sulfur-hydrogen compounds found in mercaptans. It was a glorious moment.

And Turin can also explain why many substances alter their smell when the hydrogen in the molecules is replaced with the heavier isotope deuterium. Since there is no change in either structure or chemical properties, conventional wisdom holds that there should be no change in odor. In actual fact, though, Turin found that the substance acetophenone smells like glue, while the deuterated version smells fruity. The explanation is simple for him: »The carbon-deuterium vibration is totally different from the hydrocarbon vibration.« This difference would also appear to be perceived in the animal kingdom. In searching for new insecticides, for example, researchers at Kansas State University found that while 1-cineol causes cockroaches to scatter, they are unimpressed by the deuterated version of the same substance.

Unanswered questions

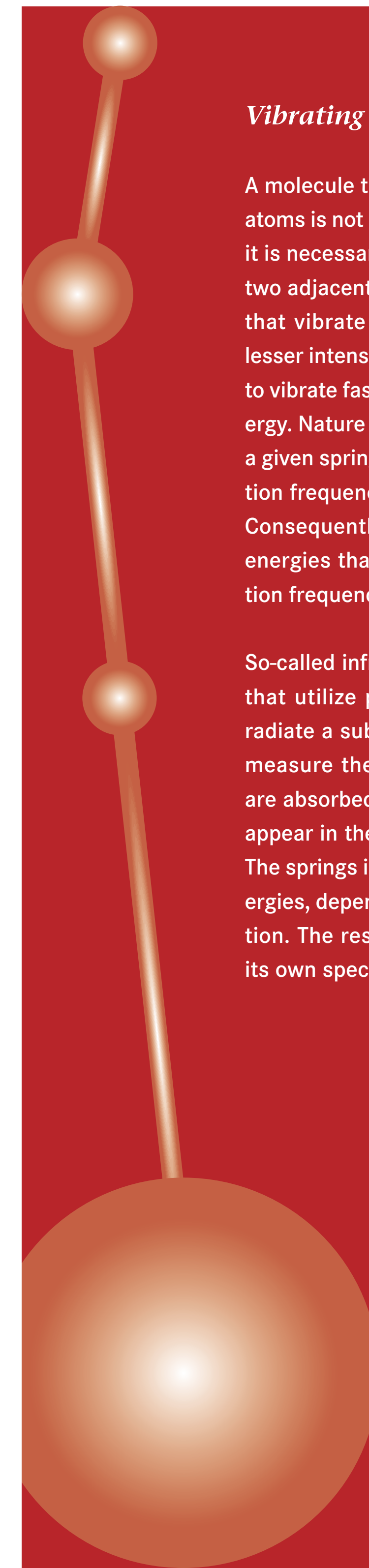
»My theory can explain phenomena that are otherwise perplexing,« says Turin. However there is »thus far no experimental proof of its full validity.« Moreover, Turin, who lives in London today, admits that molecular vibrations are unable to explain olfactory intensities. Turin attributes this to the shape of the molecules.

The biophysicist has thus far succeeded in winning over only few proponents in the scientific community. In fact, he was recently confronted with studies in the scientific journal Nature Neuroscience that would appear to weaken his theory. In an experiment, test subjects had failed to identify the supposed difference in the odor of the two acetophenone versions.

In spite of the unanswered questions, though, his theory has already been transformed into the business idea for an entire company: for the past two years, Turin has been the Chief Technology Officer of Flexitral, Inc., with headquarters in the United States and laboratories in London and Russia. His work at Flexitral focuses on producing specific odorants. For example, in order to be able to provide substitutes for substances whose usage rates in perfume formulations have since been limited by government regulation due to their allergenic potential. Turin employs a highly systematic approach. He looks at the vibration spectra of the molecules to be replaced and searches databases for molecules that have nearly identical spectra.

Using this method, he not only found the substance that smells like both grass and banana. Within a matter of weeks, he additionally developed a substance that Flexitral markets under the trade name Acitral. It serves as an alternative to citral, a citrus odorant that is also known as geraniol and is used primarily in the field of fine fragrances. It is not without pride that Turin points to the fact that the industry had been looking for a replacement for 30 years. »But couldn't find one.«

Literature tip:
Chandler Burr: The Emperor of Scent (a book about Luca Turin and his theory)
Internet: www.flexitral.com



Vibrating Molecules

A molecule that is made up of many different atoms is not a rigid structure. On the contrary, it is necessary to imagine the bonds between two adjacent atoms as being tiny coil springs that vibrate back and forth with greater or lesser intensity. These springs can be induced to vibrate faster through the application of energy. Nature has designed this system so that a given spring can not have any random vibration frequency, but only very specific values. Consequently, molecules absorb only those energies that produce the next-higher vibration frequency.

So-called infrared spectrometers are devices that utilize precisely this property: they irradiate a substance with infrared light – and measure the wavelengths (= energies) that are absorbed by the substance. These points appear in the spectrum in the form of peaks. The springs in a molecule absorb different energies, depending upon its chemical composition. The result: every substance possesses its own spectrum.