A nose for controversy

Dubbed "the Emperor of Scent", biophysicist **Luca Turin** has stirred up a heated debate about the inner workings of our sense of smell. In the mid-1990s he revived the argument that the human nose detects the presence of a compound from its molecular vibrations rather than its shape, as most researchers believe. He has been busy piecing together evidence to support the vibrational theory, and his latest book, *The Secret of Scent*, chronicles his quest. **Mick O'Hare** talks with Turin about which smell convinced him that his theory is correct and what the future might hold for the world of perfumery.

Wasn't the mystery of smell solved by the time Linda Buck and Richard Axel won the Nobel prize for physiology or medicine in 2004?
Their work was hugely important. Until they discovered human smell receptors the field was a free-for-all and people could come up with any bullshit idea. Their work put a constraint on acceptable theories of how we smell – we are now bound by the fact that the receptors exist. However, the mechanism of how the receptors detect and smell an odour molecule remains a mystery. Buck and others believe it is connected with the shapes of molecules, or specifically parts of their shapes. This theory says two molecules smell the same because they have bits of shape that the receptors perceive to be the same. But which bits? This explains things away rather than actually explaining. It gets you out of a pickle but you cannot use it to predict smells as you can with vibrational theory.

Why is vibrational theory better than shape theory at explaining why molecules smell different?
Two examples. The first is, if you have an alcohol molecule containing an OH group [oxygen and hydrogen] and a thiol molecule of the same structure where the O is replaced by an S [a sulphur atom] to give an SH group, you might think that an olfactory system that depends on shape would become confused by these. They are very similar in shape – O and S are next to each other in the same column of the periodic table. Yet this is not the case. Pure OH ethanol smells like vodka and SH ethanethiol smells of rotten eggs. So why? Well, nothing else smells of rotten eggs like SH except for one thing – the boranes, a group of chemical compounds of boron and hydrogen. And borane has nothing in common with SH except for molecular vibration. They are the only two things in the world that smell of rotten eggs and they are the only two that have a molecular vibration of 2500 wave numbers. It's too marvellous to be a coincidence.

The second example is when you take two molecules that are "enantiomers", or the mirror image of each other. Most enantiomer pairs smell similar. But if smell recognition was based on shape, a specific receptor would be able to detect one enantiomer but not the other, because it would not fit. As far as the receptor is concerned the two enantiomers are as different as different can be. Yet they smell the same because they have something in common. And again, it's their vibrational spectrum. Shape recognition cannot explain this.

Yet vibrational theory is still a minority view. Why do others disagree?
It's unproven as yet. I'm not for a minute saying people should slap their foreheads and say "he's right". What I'm saying is that shape simply does not explain how the receptors work. Every scientist has two jobs – demolition and construction. I've done a good demolition job – people agree with that. Fragrance chemists have always agreed with me after two beers, which makes them honest. Demolition is OK, but what do you construct instead? Empirically the easiest test of vibrational theory would be if different isotopes of the same element smelled different. For example, if you replace hydrogen with heavy hydrogen, the molecular shape is identical but the vibration is different. So do isotopes smell different or not? There's no consensus.

But in your experience do different isotopes smell different?
They do, but to be honest I don't like the fact that they don't smell as different as I'd expect. The effect is there, but it's small. Dogs and insects can tell isotopes apart, but humans can only sometimes. Then again, humans have a poor sense of smell, although they referee scientific papers and insects don't.

Why do some scientists still hang onto shape as a mechanism for smell?
It's a one-party state. If you don't believe in vibration you are stuck with shape, but nobody can explain how it works. I understand why people won't take me on faith. We have to wait for scientific proof. However, the practical work I have been doing with my company offers a striking demonstration that something is working – using my theories we have created successful molecule after

Profile

Born in Lebanon in 1953 to Italian parents and raised in France, Luca Turin was a biophysics lecturer at University College London and worked for the CNRS, the French national research institute. He became interested in olfaction when he began collecting fragrances, and in 1992 wrote a guide to perfumes. In 2003 he was the subject of biographer Chandler Burr's book *The Emperor of Scent* (Random House). Turin now works for a start-up company, Flexitral, producing new smell molecules. His latest book, *The Secret of Scent* (Faber & Faber), is on sale in the UK and was published in the US on 7 November.

successful molecule. I think people thought we got lucky after the first two, but now we are up to 20. And we have a 1 in 10 success rate of producing smell – far better than the industry standard of 1 in 10,000.

If proved, what significance will vibration theory have for the perfume industry and in general?
I hope it will make my company a lot of money. Then one day the big perfume companies will start using it. What we do has a big impact on what they do. But perfumery is a little bit scientific endeavour. It's frivolous. However, the broader questions of how reception works is very interesting. For example, in pharmacology, the degree of shapers also a little shaky. The jury is still out over what is involved in drug/receptor reactions. The sort of thing I and others are proposing may be the tip of the iceberg. It could apply more broadly to drugs and similar fields.

How did you earn your "Emperor of Scent" soubriquet, and is it a nickname?
I had no control over it. It was chosen by publisher Random House as the title for Chandler Burr's book. It's a joke, and I'll never live it down. In some ways Chandler's book makes me seem like a prize arsehole. But I've got used to it. It was a rather corrupt Napoleonic promotion. First I was nothing, then overnight I became an emperor.

> "My favourite perfume smells like Brahms in a world of hip-hop"

What is your favourite perfume?
Mitsouko, the last survivor of the golden age of fragrance, created in 1919 by Jacques Guerlain in France. It's based on a mixture of bergamot, oakmoss and labdanum created in 1917. Guerlain added a touch of synthetic peach. It is superb, it smells like Brahms in a world of hip-hop.

Perfumery's wonderful attraction is the fact that you can write a chemical poem. You start out with things that don't smell bad in the first place, such as rose absolute or lavender, and by mixing them together you get something that is far more than the sum of its parts. It's not a trivial skill. I have a friend, a genius perfumer who doesn't take herself at all seriously, and I frequently tell her, "You're one of the greatest composers of the 20th century." ✱