The Physiology of Smell: From Nose to Brain

Key take-aways:

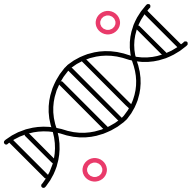
- ➔ Olfactory molecules bind to receptors in the nose resulting in a transduction of the chemical signal into an electrical signal which the brain can "read".
- ➔ Variability in the expression of olfactory receptors in the nose means that although we all smell in the same way, the way we perceive odours is subtlety different.
- ➔ The olfactory system is intimately linked with our emotions and memories and signals go directly to odour processing regions, not via the thalamus.

It starts in the nose.

Odour molecules from the air pass into the nose and arrive at a patch of specialised cells (called olfactory receptor cells) at the top of the nasal cavity. On the surface of these cells there are "receptors" which receive and respond to the odour molecules.

The complex world of olfactory receptors.

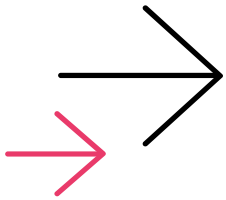
There are ~400 different types of olfactory receptors, expressed across ~50 million olfactory receptor cells. Science is only beginning to reveal the vast complexity of these olfactory receptor cells, which themselves form only a fraction of the complete odour processing pathway from nose to brain.



Genetic Variability. We are all the same, but different.

Our DNA codes for the particular repertoire of olfactory receptors present in our nose. The distribution (or "expression") of these receptors is controlled by both our genes and our experience. Individual differences therefore play a role in the way people smell fragrances. For example, although the basic olfactory hardware is similar across all people, there are subtle differences in how people detect and respond to the same smell according to their genes and experience.

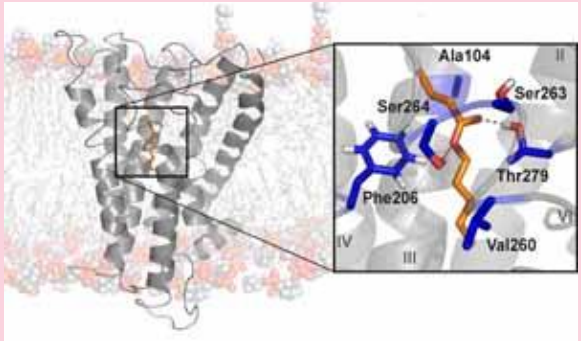
Olfactory Transduction converts chemical signals into electrical signals.



Odorant binding occurs in the nose to "activate" the receptors and send electrical signals along the nerve fibres to the olfactory bulb. The fragrance is therefore translated, or transduced from chemical message into an electrical message. It is these translated electrical signals which represent the odour in the brain, not the chemical molecules themselves.

Odorant-Receptor Binding in the Nose.

The molecules attach (or bind) to these receptors like a lock and key, or jigsaw pieces coming together. At a simple level, a molecule can bind onto a receptor when its shape allows it to fit into an appropriate "binding site" on the receptor. Each receptor type can receive and respond a few different molecular configurations.



Physiology of Smell

NeuroScentz™ Fundamentals

Signals are not sent via the thalamus.

The olfactory bulb sends signals directly to the primary olfactory cortex, not via the thalamus. This is in contrast to our other sensory systems. This direct connection means that smells can rapidly influence thoughts, feelings and behaviour.

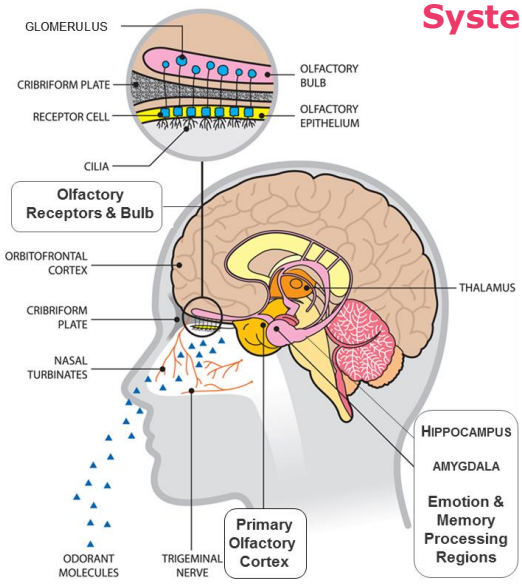
Fragrances are powerful at evoking emotions and memories.

The primary olfactory region has multiple functions. Some parts (e.g. piriform cortex) decipher and recognise the smell. Other parts evaluate emotional valence (amygdala) and associate memories (entorhinal cortex/ hippocampus). The anatomical overlap between odour, emotion and memory regions explains why smells have such a profound ability to evoke emotional feelings and remind us of people, places and events from our past. No other sensory system is as intimately linked with emotion and memory, something that is emphasised in people who have lost their sense of smell.

Which fragrance do I prefer?

Other regions are also involved in olfactory processing (e.g. orbitofrontal cortex, hypothalamus). These regions are involved in integrating together multi-sensory information, making decisions and actions, and evoking physiological responses.

The Olfactory System



Our sense of smell changes over the lifetime.

Olfactory abilities change with experience and training, as well as for other reasons. For example, aging can affect our sense of smell, as can diseases and disorders such as Alzheimer's disease, Parkinson's disease, Schizophrenia, Epilepsy, Obsessive Compulsive Disorder and Depression. People's lifestyle choices (e.g. smoking reduces olfactory acuity) and pregnancy (e.g. expectant mothers often display heightened acuity for some smells) also impact the sense of smell. Creating fragrances according to a segmentation strategy is one way of overcoming some of these differences to maximise fragrance liking.

Summary:

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Givaudan

For more information, please contact your local Regional Technology team

Prepared in collaboration with Dr Jennifer Summerfield & Professor Donald A. Wilson

Get Involved!

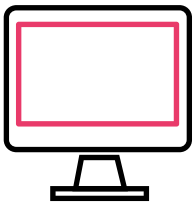
Try out the suggestions below to explore the ideas outlined in this fact sheet.

Decisions, Decisions.. Next time you are going to a store to buy a fragranced product, pause and think about the thought process that you went through to decide to buy that particular item versus other options. That is your orbitofrontal cortex talking. Talk to you colleagues about how they make decisions to compare.

I remember when… Ask a close family member if they can remember what fragranced products they used to wear when you were young. See if you can still get hold of them. If you can, smell them and see if they bring back any emotions or memories.

Odour Tracking. Try and navigate around your home or garden using smell alone. Close/blindfold your eyes and wear earplugs/headphones to block out any visual or sound cues. Take a moment to focus. Can you do it?

Alternatively, go to a place where there are lots of smells around (shop, market etc.) and spend a moment with your eyes and ears blocked just focusing on the smells around you.



Movie Time. Take a look at these short videos on the sense of smell:

Video 1: How fragrance molecules bind receptors.
https://www.youtube.com/watch?v=NmqLZd7s9qw
Video 2: How do we smell?
https://www.youtube.com/watch?v=snJnO6OpjCs
Video 3: The Scientist Stuart Firestein talking about Smell
http://bigthink.com/videos/from-nose-to-brain-the-neurology-of-smell