
**THE UK SEMIOCHEMISTRY
NETWORK
CHEMICAL SIGNALS IN
VERTEBRATES,
BRITISH WORKSHOP XXVII**

Gonville and Caius College,
Cambridge.



16 - 17 July 2019

An informal one-and-a-half day
workshop on
“The Sense of Smell”
in humans and other vertebrates.

WORKSHOP PROGRAMME

Day One

Noon – 12.55pm Registration.

1:00pm Lunch

2:20pm Welcome and Introduction

2.25pm **Physiology: from receptors to processing**
chaired by Hugh Matthews, University of Cambridge.

2:30pm **Olfactory transduction in small cilia and response stability in a changing environment** –
Johannes Reisert, Monell Chemical Senses Center, Philadelphia.

Olfactory cilia, the cellular compartment of olfactory receptor neurons that recognize and transduce odorants into a receptor potential, reside in a mucosal environment with changing ion concentrations. They also have a very small internal volume, where even smallest currents can already change ciliary ion concentrations. Furthermore, olfactory receptor neurons use excitatory cationic and anionic currents to mediate the odorant-induced response. Using a modeling approach, we will address how, given these constraints, olfactory receptor neurons can reliably respond to odorants.

3:00pm **The OR37 subfamily: Unique odorant receptors involved in social communication** – Jörg Strotmann, Universität Hohenheim, Germany.

3:30pm **Cooperative excitation and release at the reciprocal granule cell spine of the olfactory bulb** –
Veronica Egger, Universität Regensburg, Germany.

Olfactory bulb granule cells interact with the excitatory mitral and tufted cells of the olfactory bulb via reciprocal dendrodendritic synapses that are housed in large spines. These spines respond to single inputs with local action potentials ("spine spikes"), which activate presynaptic NPQ Ca²⁺ channels - as in conventional axons. Release of GABA from the spine requires the presence of the spine spike, but surprisingly also NMDA receptor activation. Ultrastructural and computational evidence supports cooperative Ca²⁺ entry via NPQ channels and presynaptic NMDA receptors. These results reconcile older conflicting studies and to our knowledge present the first functional evidence for a presynaptic role of dendritic NMDARs in release of GABA.

4:00pm **Mammalian olfaction is a high temporal bandwidth sense** – Andreas Schaefer, Francis Crick Institute, London.

Odours are transported in turbulent plumes resulting locally in highly fluctuating odour concentration. Yet, whether mammals can make use of the ensuing temporal structure to extract information about the olfactory environment remains unknown. Here, we show that temporal correlation of odour concentrations reliably predicts whether odorants emerge from the same or different sources in normal turbulent environments outside and in laboratory conditions. In order to assess whether the mammalian olfactory system is able to use such temporal structures, we trained mice to discriminate between correlated and anti-correlated odour stimuli at different frequencies. Mice can indeed reliably discriminate the correlation structure of odours at concentration fluctuation frequencies of up to 40 Hz. Consistent with this finding, output neurons in the olfactory bulb show segregated responses depending on the correlation of odour stimuli with populations of 10s of neurons sufficient to reach behavioural performance. Our work thus demonstrates that mammals can perceive temporal structure in odour stimuli at surprisingly fast timescales. This in turn might be useful for key behavioural challenges such as odour source separation, figure-ground separation or odour localisation.

4:30pm Tea Break



The Dave Kelly Lecture

5:00pm **Algorithms and neural circuits in olfaction** – Venkatesh N. Murthy, Harvard University.

Animals sense the chemical world to guide their behaviors. Fluctuating mixtures of odorants, often transported in fluid environments, are detected by an array of chemical sensors and parsed by neural circuits to recognize odor objects that can inform behavioral decisions. Unlike other sensory systems, the olfactory system lacks an obvious topographic organization, has a shallow hierarchy and neural connectivity across brain regions is seemingly unstructured. These anomalies offer an opportunity to uncover common principles across different sensory systems. Our research group uses a variety of biophysical, neurophysiological and behavioral methods to understand how odorant features are encoded in the activity of neurons and transformed in different stages of processing. I will share our progress in seeking algorithmic and neural explanations for how animals solve some specific olfactory tasks.

Perfumery Presentation

6.00pm **Creating food inspired odours with high impact molecules** - Angela Stavrevska, CPL Aromas Ltd

In perfumery the recreation of food type odours relies on the use of materials that undiluted can be extremely unpleasant. They include sulphur compounds, thiols, butyrates, pyrazines and possibly mercaptans. When these materials are used at the right dilution and in combinations with other more obviously pleasant odour molecules they accurately recreate the perception of food odours. In my presentation I will guide you through some examples of this type of use for high impact molecules and illustrate the talk with samples for you to smell.

6:30pm Break

7:30pm Workshop Dinner

Day Two

9:00am **Chemosensory food perception** chaired by Jessica Freiherr, Friedrich Alexander Universität Erlangen-Nürnberg.

9:15am **Olfactory-visual integration during food perception** – Natalia Filvarova, Fraunhofer IVV Freising, Germany.

Although many sensory and cognitive processes decline with age, multisensory integration performance seems to strengthen with age. It is argued that this occurs as a compensatory mechanism allowing for sensory perception to be enhanced when one or more senses are diminished. In the present study, we investigated the integration and perception of visual and olfactory stimuli related to food, and how this is modulated by the pleasantness of the stimuli. Three groups of healthy adults (aged 43-53; 54-64; and 74-82) took part in the experiment and were asked to rate the pleasantness of the stimuli that were either congruent or incongruent. Age-related sensory perception and integration differences will be discussed in the talk.

9:45am **Influence of nutrition labels on taste perception** – Qendresa Rramani, Universität Bonn, Germany.

Understanding and improving food choices remains one of the priorities of research in a world with high obesity rates and high costs associated with it. A strategy to improve food choices has been using efficient nutrition labels and nutrition claims. In addition to providing information regarding the nutritional value of the foods, these labels and claims may elicit certain expectations that can in turn influence valuation and other decision-making processes. On this background, we investigated how context induced via nutrition claims influences food valuation processes in terms of expected and perceived qualities. Our results indicate that having a nutrition claim on a drink compared to not having such a claim is associated with (1) different expectations and (2) different perception of several qualities such as tastiness, healthiness, and satiety derived from the drink. (3) Moreover, our data shows that some of these effects are different depending on the type of the claim that is accompanying the drink. Overall these findings provide insights on the effects of nutritional claims on food valuation, and may have practical implications for public policy interventions.

10:15am **Sensory perception in obese patients** – Annette Horstmann, University of Helsinki, Finland.

Obesity is a major health problem that is driven by the modern food environment. In recent years, it has been shown that smell perception plays a key role in unconscious decisions for foods and is therefore closely related to eating behaviour. Altered smell perception seems in obesity might crucially contribute to a poor diet leading to weight gain. However, the underlying mechanisms of impaired olfactory perception and altered hedonic response to food odours in obesity are not well understood yet. Since the olfactory system is closely linked to the endocrine system, hormonal shifts that are associated with obesity might explain the relationship between obesity and altered smell perception. In an experimental setup with non-food and food odours, odour sensitivity did not depend on body weight status/BMI or metabolic state (hungry vs. sated). Interestingly, we identified a strong negative relationship between baseline insulin resistance and olfactory sensitivity for the food odour in the sated condition. Thus, odour sensitivity in healthy individuals is not predicted by body weight status or BMI, but by metabolic health. This illustrates the intimate link between endocrine signals and central processing of remote food cues.

10:45am **Tea Break (Including AGM).**

11:15am **Clinical session** chaired by Simon Gane, University College London

11:20am **The importance of olfactory cleft in olfactory disorders** – Aytug Altundag, Acibadem Taksim Hospital, Istanbul.

Olfactory cleft variations is important for olfactory disorders. By the time in surgical and medical treatment protocols olfactory cleft become more popular with new treatment modalities. So for clinicians evaluate olfactory cleft before treatment increase the success rate of treatment. We know that not only obstruction of olfactory cleft is important, as a controversial phenomenon wide olfactory cleft is also a risk of olfactory dysfunction. For nose to brain pathway olfactory cleft area is most important region and manipulation of this area gives many positive results in our treatment.

11:50am **Tumour necrosis factor inhibitors and olfaction: a preliminary report** – George Macfarlane, University of East Anglia, Norwich.

Two studies have shown benefit in using tumour necrosis factor-alpha (TNF- α) antagonist in murine models replicating inflammatory nasal disease and post-traumatic olfactory loss. However, there has been limited research in humans. This proof of concept study aims to determine the effect of TNF- α antagonists on olfaction in clinical practise.

12.20 pm **Heritage smells: characterisation and evaluation of historic odours in relation to authenticity, familiarity and safety.** – Cecilia Bembibre, University College London.

We don't know much about the smells of the past. Yet, smells play an important role in our daily lives and can be considered part of our intangible cultural heritage; not only for their own value, but through their connections to language, tradition and tourism.

This work focused on characterising the smell of historic objects and spaces and understanding their perception in relation to issues of authenticity, familiarity and safety.

The smells of a historic book & library were chosen as a case study of heritage smells for their familiarity and the fact that historic paper has been extensively researched. The volatile organic compounds (VOCs) emitted by the artifact and the space were sampled and analysed using headspace solid phase microextraction (HS-SPME) and gas chromatography mass spectrometry (GC/MS).

The smells were also characterised using a sensory panel, and authenticity perception was explored in a subsequent study. The chemical information was then combined with the odour descriptors to create a historic paper and historic library odour wheel.

These are new tools linking the human nose's experience of heritage smells to their chemical composition, opening up the potential to characterise, understand and preserve these aspects on intangible heritage.

12:50pm **Lunch**

2:00 pm **Mammalian Semiochemistry session**
chaired by Jorg D. Hardege, University of Hull.

2:05 pm **Species recognition via urinary scent marks in European badgers (*Meles meles*)** – Tanesha Allen, University of Oxford.

European badgers (*Meles meles*) use metabolic by-products (i.e., urine and faeces) and specialised glandular secretions to advertise their presence and fitness-related information to conspecifics. By doing so, they can improve their chances of gaining mating opportunities. However, even though badgers can distinguish the sex, age, and reproductive status of urine marks deposited by conspecifics, few studies have analysed if and how badgers can distinguish urine marks deposited by other species. Our scent-provisioning experiments conducted with Science Oxford and the Abingdon Science Partnership will look at how urine marks from European badgers and other species influences investigation and foraging behaviour, thus providing further insight into how badgers use urine for olfactory communication.

2:35 pm **The impact of Climate change on chemical communication** – Jorg D. Hardege, University of Hull.

Chemical signals coordinate marine animal behaviour, but relatively little is known on how these are affected by human activities. High CO₂ concentrations absorbed from the atmosphere leads to reduced water ie oceanic pH, a process termed ocean acidification. Disruption of behaviour including feeding, predator – prey interactions, larval settlement or mating can have dramatic effects on species interactions potentially threatening ecosystem stability and services. We provide an overview of studies that demonstrate impacts of seawater pH on functional traits at neural, signal detection and signal response level. Using synthetic pheromones and feeding stimulants we examined responses when individuals are exposed to pH levels expected for 2100. Most biological molecules with signalling function possess functional chemical groups that are sensitive to changes in pH levels. High CO₂ conditions reducing pH in aquatic environments impacts functional groups of many signalling cues, causing significant molecular changes and therefore impacts their successful reception. We show evidence for signal disruption through structural changes of cues, reduced and changed detection by the organisms, and altered behavioural responses. We conclude that signal disruption is likely to become a threat to marine eco systems and aquaculture impacting upon an organism's fitness. These impacts on signalling systems are not restricted to aquatic systems as evidence of pH sensitivity in receptor-ligand interactions, changes in odour profiles during draught and at high temperatures, altered scent marking profiles and reduced production of semiochemicals under CO₂ stress are increasingly throughout the animal kingdom reflecting the 'language of life' as being under climate change pressures.

Closing remarks and end of meeting