THE UK SEMIOCHEMISTRY NETWORK
CHEMICAL SIGNALS IN VERTEBRATES, BRITISH WORKSHOP XXV

Gonville and Caius College,
Cambridge.

18 - 19 July 2017

An informal one-and-a-half day workshop on
"The Sense of Smell"
in man and other vertebrates.

WORKSHOP PROGRAMME

Day One

Noon – 12.55pm Registration.

1:00pm **Lunch**

2:20pm Welcome and Introduction

2.25pm **Insights into information processing in the accessory olfactory system** chaired by Marc Spehr, RWTH Aachen University, Germany.

2:30pm **Temporal Features of AOB responses: Limitations and Opportunities for decoding** – Yoram Ben-Shaul, Hebrew University of Jerusalem.

One of the notable properties of the vomeronasal system is the slow nature of stimulus uptake. This initial sampling stage is a major (but not the only) determinant of the temporal dynamics of neuronal responses in this system. In my talk, I will discuss our recent efforts to characterize the temporal response features of AOB neurons and the implications of these properties for decoding of stimulus information.

3:00pm **The origin of chemical communication by means of toxic waste perception** – Pavel Stopka, Charles University, Vestec, Czech Republic.

John Maynard Smith and David Harper defined a signal as '…any act or structure which alters the behaviour of other organisms, which evolved because of that effect, and which is effective because the receiver's response has also evolved'. Thus, evolution of chemical communication seems to require two steps. However, our current theory requires only one step because it presupposes that only the receiver's response has evolved as an adaptation to already existing sources of individual VOCs/odours which resulted from metabolic degradation. Moreover, this theory expects that the level of degradation correlates with energy intake and immune system efficiency, and thus reflects an inherent quality of the signaller. The aim of the talk is to discuss potential causes of evolution of chemical communication from the perspective of tear, saliva, and urinary proteomes of the house mouse.

3:30pm **Entrainment of infraslow oscillations in the mouse accessory olfactory bulb** – Chryssanthi Tsitoura, RWTH Aachen University, Germany.

The accessory olfactory bulb (AOB) is the first stage of central information processing in the accessory olfactory system. Here, mitral cells (MCs) receive sensory input from peripheral vomeronasal neurons and project to the vomeronasal amygdala. Sensory coding mechanisms in the AOB, however, remain poorly understood. We recently demonstrated that a subpopulation of MCs is intrinsically rhythmogenic and exhibits slow stereotypical oscillatory discharge. We now identify an excitatory circuit within the AOB that entrains oscillatory activity in a second MC subpopulation. These MCs display periodically increased synaptic input that correlates with their respective rhythmic discharge patterns. Entrainment largely depends on an intact glutamatergic network. Together, our experiments indicate that infraslow rhythmicity in the AOB is likely to affect limbic processing of pheromonal information.

4:00pm **Tea Break**

4:30pm **Intrinsic oscillations - a dance to the rhythm of ion channels** – Simon O'Connor, University of Hertfordshire.

Neurons like all cells have a bi-lipid membrane that is impermeable to ions. Embedded in this membrane are populations of protein structures called ion channels that gate the flow of ions across the membrane. Using modelling software we demonstrate how the measured properties of these ion channels can be used to explain how the intrinsic rhythmogenic behaviour of a population of AOB MCs is generated by a specific set of ion channels.

The Dave Kelly Lecture

5:00pm **Molecular Phrenology?** – Andreas Mershin, Massachusetts Institute of Technology.

<Abstract>

Perfumery Presentation

6.00pm **Fragrance as the communicator of choice** - Mike G Evans, ex Givaudan UK.

A slightly ambiguous title that highlights the modern way humans communicate consciously using the sense of smell. We choose between people and products with different smells, and we choose smells for ourselves to help us communicate to those around us. In this talk we will review some great modern perfumes, discover what they seek to communicate, and discuss the component parts that enable their success.

6:30pm Break

7:30pm Workshop Dinner

Day Two

9:00am **Clinical session** chaired by Carl Phillpott, University of East Anglia, Norwich.

9:05am **Taste disorders in humans** – Basile Landis, Hôpitaux Universitaires de Genève, Switzerland.

The exact pathway of gustatory fibres has been a matter of debate for at least the last two hundred years. Important parts of the knowledge on human taste anatomy we know currently, is based on clinical observations done in patients with known and circumscribed lesions and consecutive symptoms or taste deficiencies. This is has been the case for the description of peripheral but also central human taste anatomy. It is only recently that functional imaging techniques further confirmed what had been assessed or postulated based on observations in patients with lesions.

The presentation gives a short historical and patient based overview about current knowledge in human taste anatomy and related peripheral and central gustatory impairments.

9:35am **Usefulness of structural MRI of olfactory pathways in clinic** – Caroline Huart, Université catholique de Louvain, Belgium.

MRI is the imaging modality of choice in the clinical evaluation of patients with olfactory disorders. The aim of this talk is to present findings that can be observed on structural MRI of patients and to discuss their diagnosis and prognosis values. Among other structures, the assessment of the olfactory bulb has consistently shown its prominent role in the evaluation of patients. Hence, particular attention will be paid to it and to the link between its morphology and the functional state of the olfactory system. The link between smell disturbance, olfactory sulcus and central olfactory projection areas will also be discussed.

10:05am **Patient Accounts of Anosmia - a Qualitative Research Project** – Sally Erskine, University of East Anglia, Norwich.

There are large numbers of patients with olfactory disturbance in the UK and shortfalls in assessment and support amongst mainstream practice, in both primary and secondary care, leading to significant quality of life impairment and potential missed diagnoses.

This work uses qualitative research methods to determine key themes and issues identified through written and verbal accounts of loss of sense of smell. The work explores whether there are any key areas to target for future research or service development and assesses the educational needs for doctors in order to be better equipped to deal with such problems.

10:35am **Tea Break (Including AGM).**

11:05am **Psychology session** chaired by John Behan, University of Kent, Canterbury.

11:10am **What are Odors: Qualitative Objects or Qualitative Relations?** - Ann-Sophie Barwich, Columbia University, USA.

Conceptualizing odor qualities is a daunting task: Is there a physical order to perceptual odor space? While smells seem to come in general classes (e.g., garlicky, burnt, floral, green), their number appears almost limitless (e.g., violet, iris, lily, etc. in the class of floral). In comparison with the visual or auditory system, the physical stimulus of smell has not been captured in a comprehensive classification. Notably, this is not a result of the seemingly subjective nature of smells but rather the actual physical characteristics of the olfactory stimulus. Instead of being based on a single, linear parameter such as wavelength and having a spatial component, the molecular basis of smell is non-spatial and multidimensional. This talk engages with the underlying challenge to stimulus classification and the description of smells from an integrated historical and philosophical perspective. I recover the hidden experimental records of research on smell as an intriguing, yet untold, history of creativity in scientific reasoning. The different approaches to defining odor and odor perception are evaluated in their potential as a heuristic source for widening our theoretical understanding of smell today.

11:40am **Multi sensory fragrance design: Designing the invisible messenger** - Ninela Ivanova, London College of Fashion and Joanna Norman, Pandora ltd. and Kingston University.

Humans communicate emotions and needs in a multisensory context. Fragrance provides a means to interact with this multidimensional world in a way that can reflect changing, individual needs. The general public find it difficult to articulate fragrance needs, but clear fragrance design enables product developers to get their communication right.

12.10 pm **The olfactory Sandman: Fragrance benefits to sleep quality** - Ioannis Kontaris, Gill McCabe, and Anne Churchill, Givaudan (UK).

Sleep is a vital aspect of human existence. It is a period of behavioural dormancy though is not necessarily associated with a quiescent nervous system: Sleep is by the brain, for the brain. The mechanisms behind this phenomenon are unclear, but previous research has elucidated many molecular, physiological and behavioural aspects of sleep.

While reduced, odour information accesses the brain during sleep, as evidenced by odour-evoked event related potentials, fMRI, odour modulation of dream content, odour modulation of sleep related memory consolidation, and odour learning during sleep (e.g. Arzi et al., 2012). In addition to influencing cognitive functions that occur during sleep, odours appear to be able to modulate sleep itself, though these results are generally based on very small data sets using single ingredients (e.g. lavender). Here we investigated whether fully formulated fragrances can influence sleep quality.

After evaluating well-established methods for assessing sleep quality used throughout the world of sleep research, over the course of different studies, we used a combination of self-report measures, sleep diaries and actimetry to assess effects of fully formulated fragrances on sleep quality. Our results show that fragrance can affect not just cognitive/emotional functions that occur during sleep, but also appears to be able to modulate sleep per se. Even though fragrance benefits sleep, not all fragrances show this sleep-enhancing effect. This research draws on knowledge from earlier sensory studies that elucidate links between odour character and human emotional response. Physiological and consumer research methods have been developed beyond the current state of the art to explore a sub-conscious behavioural benefit - i.e. sleep-enhancement. The possible brain mechanisms behind these effects, as well as the approach and implications for future sensory and consumer research will be discussed.

12:40pm **Lunch**

2:00 pm **Mammalian Semiochemistry session**
chaired by Stefano Vaglio, University of Wolverhampton and Durham University.

2:05 pm **Polymorphism and expression of mouse major urinary proteins: signals of identity and status** – Jane Hurst, University of Liverpool.

Major urinary proteins (MUPs) are secreted into the urine of mice at surprising high levels, and bind a wide range of low molecular weight volatiles in mouse urine. I will discuss how these proteins and their ligands are used by mice to signal both the fixed genetic identity of the scent owner at several different levels (individual, kinship, sex and species) as well as providing more dynamic information about the animal's current status including its health.

2:35 pm **Chemical signals in a changing world - reliable cues for animal health and behaviour?** – Jörg Hardege, University of Hull

Odour profiles potentially provide a wide range of information about the sender to any organism detecting such odours. This includes cues indicating age, sex, physiological state, social status and also health status, signals that can be utilised by the receiver. Amongst the many examples is that of ticks that are selectively attracted to sick hedgehogs over healthy individuals based upon the levels of indole released by the hedgehogs. Odour profiles are often a complex mixture of compounds that change over time as they are released into the environment but surprisingly little is known about odour variability and the factors affecting these. Environmental factors such as effects of temperature, humidity, CO_2 levels and in aquatic systems also pH and salinity can change odour profiles significantly and hence change the messages perceived. Climate change associated forcing may as such affect plant and animal odours impacting on species interactions. In the presentation examples of such olfactory disruption are reviewed and mechanisms highlighted that underpin these impacts.

3.05 pm **The role of human olfaction in behavioural immunity** - Mats Olsson, Karolinska Institutet, Sweden.

Contagious diseases have been a fatal threat to people throughout evolution. Recent research suggests that behavioral avoidance of sick individuals is the first, and probably most cost effective, line of defense against infection (Schaller, 2011). Indeed, statistical models show substantial disease containing effects from small adaptations in patterns of inter-individual contact (Cole, 2006). In addition, behavior can be seen as a vital part complementing and even regulating the classical immune system. This behavioral defense, also referred to as behavioral immunity, and its consequences are poorly understood and surprisingly few studies exist. We have in a series of studies examined the olfactory cues by which we detect disease; the neural mechanisms underlying disease avoidance; and how olfactory disease detection prepares the body for an attack together with classic immunity. In doing this we have utilized an experimental sickness model involving the induction of innate inflammation with an endotoxin (lipopolysaccharide) injection in otherwise healthy participants. Results show that after a few hours of systemic inflammation we smell more aversive from the skin, urine odor changes in character and show heightened concentrations of Pyrrole. Results also show that disgusting odors (believed to work as olfactory disease cues) increase levels of an inflammatory marker (tumor necrosis factor alpha) in the saliva. Altogether these results support the importance of olfaction in behavioral immunity.

Closing remarks and end of meeting