

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

Gonville and Caius College,
Cambridge.



7 - 8 September 2010

WORKSHOP PROGRAMME

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Day One

- Noon – 12.55pm **Registration.**
- 1:00pm **Lunch**
- 2:20pm Welcome and Introduction
- 2.25pm **Clinical session** chaired by Dr. Glenis Scadding, RNTNE hospital, London.
- 2:30pm **How are Smells Perceived: The Nanotechnology of Olfaction**
Prof. Marshall Stoneham, UCL.

The sense of smell is remarkable in the way we can respond sensitively and selectively to small molecules. Simple shape-based ("lock and key") ideas do not work well - for instance, molecules of the same shape can smell very different. Our "swipe card" picture makes more sense: the shape must be good enough, but something else carries the crucial information. I shall discuss just what that extra information is, how one checks the ideas, what are the implications, and - very important - ask what is missing from our understanding.

3:00pm

Psychophysics of the swipe card model of human olfaction

Simon Gane, UCL.

Using human beings as the animal model for investigating the biophysics of smell has its drawbacks. A review of other work showing the unreliability of humans in comparing smells and flavors shows the difficulties in this type of research. Nevertheless we present some preliminary data from the investigation of the modified Turin "swipe card" model using these techniques.

3:30pm

Defining psychophysical testing of olfaction for the 21st century

Carl Philpott, University of East Anglia, Norwich

There are a number of commercially available kits for smell testing, however, undertaking olfactory testing in the outpatient clinic remains an infrequent occurrence, despite the prevalence of olfactory disturbances in patients. This talk will focus on the development of an olfactometer for routine clinical use and the considerations taken during this process. The role of potential confounding factors during olfactory testing will be discussed, including the results of studies undertaken to date.

4:00pm

Tea Break

4:30pm

Adapting smell tests for cross-cultural use

Dr. Laura Silveira Moriyama, Reta Lila Weston Institute of Neurological Studies, UCL Institute of Neurology

Olfaction is impaired in a series of neurological and medical conditions, and can be evaluated in clinical practice through standardized smell tests which are commercially available. The most popular smell tests involve naming. The majority of such tests has been developed in Europe and the US, making its application across the world very limited. The development of new smell tests is a costly process and can take a long time. We have managed to successfully adapt commercially available smell tests for the use in South American and Asian cultures, and would like to share common pitfalls and insightful tips for the cross-cultural adaptation of such tests.

5:00pm

Review of hyposmia treatment- what really works?

Dr. Glenis Scadding, RNTNE hospital, London.

Partial, (hyposmia, 10-20%) and total (anosmia, 0.5-1%) loss of smell is a prevalent symptom in the general population. The main causes are: common cold, CRS ± nasal polyps, and head trauma. Allergic rhinitis (moderate/severe) and CRS ± nasal polyps have an important impact on the loss of smell -which may predict the severity of asthma. Intranasal and oral corticosteroids improve the sense of smell when due to inflammatory diseases.

Treatment of neurogenic smell loss has not yet been well evaluated but there are reports of benefit from sodium valproate and from theophylline in some patients .

The Dave Kelly Lecture

5:30pm **Olfactory evolution**

Prof. Dr. Bill S Hansson, Max Planck Institute for Chemical Ecology



Fruit flies of the genus *Drosophila* are attracted to fruit at different degree of decay. To allow attraction to volatile chemicals emitted by the fruit the flies have evolved highly specific and sensitive detectors on their antennae and palps. In previous studies we could show that differences in dietary width has had a profound effect on olfactory characteristics. In recent experiments we could show that diet specialization also has a strong effect on learning capabilities.

In my talk I will dwell on physiological mechanisms underlying food odor detection in fruitflies. Receptor function and antennal lobe integration of information will be the two main topics, but also recent behavioral data will be included.

7:00pm **Workshop Dinner**

Day Two

9:00am **Psychology of Olfaction session** chaired by Mr. William Andrews, P & G Prestige Products.

9:05am **Olfaction does not always smell**

Prof. Francis McGlone, John Moores University, Liverpool.

Our sense of smell has long been considered a residual sensory system, with little impact on our behavior. However, we now know that olfactory stimuli can modulate a wide range of behaviors such as emotions, attention, and even mate selection. In other words, our olfactory sense still plays an important role in our everyday life. There are still some very basic questions that need answering and we still underestimate its impact on well-being and are only just beginning to recognise that people who lose their sense of smell often suffer from depression, their quality of life being greatly diminished. In this talk, recent advances in our understanding of how odours affect our behavior and how this is manifested in the brain will be reviewed. Examples will be provided from chemical signals hidden in body odours and their effects on social recognition, and how the hedonic properties of aromas affect judgments of facial attractiveness.

9:35am

Personalised Timed/Controlled Fragrance Delivery That Changes with Emotion

Dr Jenny Tillotson, Central Saint Martin's.

The way we use scent today in almost all applications is poorly targeted, inefficient and wasteful. However, there is a new, design-led '*Wearable Technology*' that fuses the ancient art of perfumery with emerging technologies. The evolution of the perfume industry has identified that there is increasing consumer preference for '*personalised*' fragrances to promote wellbeing. Development has commenced of a timed/controlled, therapeutic, user-worn, scent dispenser which can be embedded in '*responsive jewellery*' and '*smart clothing*' to create an enhanced experience. It has the capacity to alter mood and energy levels throughout the day, depending on your feelings and emotions. As an alternative therapy placed alongside those in vogue today such as aromatherapy and alternative healing practices, the new dispenser offers targeted controlled-release of personalised wellbeing fragrances tailored specifically to fit fluctuating moods throughout the day, in response to user driven stimuli. It is programmed to deliver scents on demand to improve an individual's sense of wellbeing by conscious control (timer) or bio-feedback (biometric sensor).

10:05am

The Universal Vocabulary of Odour

Mr. William Andrews, P & G Prestige Products.

There is no universal language of scent in any culture – we resort to metaphor, shared experience and commonly identified materials such as food or common plants and flowers. Within the fragrance industry, we have our own accepted language based around signature odours of raw materials, but this is not an intuitive solution for the untrained population. This means that in general, there can be challenges in describing odours, particularly between different cultures. The issue of odour communication becomes even more acute for the consumer products and perfume industry, where pre-purchase guidance at point of sale is key to guiding consumers to the right choice first time (very pertinent to fragrance gifting). A recent project with The London College of Fashion only succeeded in highlighting the challenges facing any developer of an odour vocabulary. Recent qualitative research indicated that there is no specific, organised 'language' used by consumers to describe fragrances. This talk shares our findings and thoughts so far, as we start the journey to develop a lexicon of odour.

10:35am

Tea Break (Including AGM).

11:05am

Mammalian semiochemistry session chaired by Dr. Christina D. Buesching, WildCRU, Dept. of Zoology, University of Oxford.

11:10am

Chemical communication in Eurasian beavers

Helga Veronica Tinnesand and Prof. Frank Rosell, Telemark University College, Norway.

The Eurasian beaver (*Castor fiber*) is a socially monogamous territorial rodent that uses chemical signals in intraspecific communication. In this talk we will provide examples from several chemical studies in Norway, with emphasis on one recent study. The peak in resident beavers' territorial behaviour occurs during spring when subadults disperse to find their own territory and mate to reproduce successfully. We conducted a behavioural bioassay to investigate whether resident beavers show a stronger territorial response towards anal gland secretion (AGS) from males that disperse (i.e. subordinate; 1 year old, or 2 years old and older) than towards AGS from territory owner males (i.e. dominant). Resident beavers spent significantly more time investigating AGS from subordinates, but only spent more time responding aggressively when the subordinates were two years or older. Differences in body size and dispersal behaviour between subordinates in different age classes can explain our results. Analyses of the AGS samples by gas chromatography-mass spectrometry showed a difference in AGS composition between the different groups of scent donors.

11:40am

Influences of conspecific odors on reproductive condition in mice

Dr. Sachiko Koyama, Department of Psychological and Brain Sciences, Indiana University.

As early as the 1950s it had been observed that odor was able to stimulate and induce conditioned changes in mammals (primer effects). The first such phenomena found were: postponed oestrus cycles when female mice are kept in groups without male odor and shortened oestrus cycle in females exposed to male odor. Since then, there has been a tendency in primer effect studies in mice to focus on effects on females. There have been extremely few studies on males. I will show my results for the influences of social status on sperm activities. These effects are considered to be mediated by the pheromone of dominant mice. This conclusion has been reached because the differences are diminished by the removal of vomeronasal organ of the subordinate mice. I will also show my results on the influences of the exposure of male mice to the odor of female mice on their sperm density. Influence of odor in conditioning, especially on reproductive conditioning, is very interesting not only for the understanding of the olfactory communication in mice but also for the possible implication to human. The studies of mice also suggest the possibility of the utilization of this knowledge for medical science.

12:10pm

Questioning an established theory: The role of latrines in badger territoriality

Dr . Christina D. Buesching, Wildlife Conservation Research Unit, Dept. of Zoology, University of Oxford.

Scent-marking is an important element of the behavioural repertoire of many mammals, and especially conspicuous in carnivores. To explain its function, several hypotheses have been suggested, which fall into one of three fundamental categories: a) scent-marks as “notes to self” (e.g. navigational aids, resource depletion); b) scent-marks as “notes to conspecifics” (e.g. individual advertisement; resource marking in social foragers); and c) scent-marks as “keep out signs” (intra- or inter-specific territorial defence).

The Eurasian badger (*Meles meles*), a nocturnal macro-osmatic mustelid, deposits it's faeces and urine in communal latrines, which are either shared by neighbouring social groups (termed “border latrines”) or used exclusively by members of the same social group (i.e. “hinterland latrines”), and are located along well-defined path networks. Over the past 40 years, badger scent-marking behaviour has been the topic of numerous scientific publications and established theory dictates that badger latrines demarcate the borders of their territory. However, with recent advances in detailed semio-chemical analyses of badger olfactory signals, genetic parentage analyses on population level, as well as fine-scale badger movement patterns, the concept of badger territoriality is becoming increasingly questionable. In this talk, we will review the usage pattern and semio-chemical information contained in badger latrines, and will provide an alternative interpretation for their social function.

12:40pm

Scent communication in the Eurasian Otter, *Lutra lutra*

Kean, Eleanor F., Müller, Carsten T., and Chadwick, Elizabeth, A., Cardiff University Otter Project

Eurasian otters (*Lutra lutra*) are thought to use scent as their primary means of communication but little is known about what information is communicated. Headspace SPME and GC-MS has been used to sample and analyse volatile organic compounds (VOCs) from anal scent gland secretion from 158 otters of differing sex, age and female reproductive status. Univariate and multivariate differences were clear between adult and juvenile otters. Complex sex differences were apparent in adult otters but not younger individuals, suggesting the use of this scent secretion in mate attraction. Analysis of repeated samples from known individuals is underway to test whether scent enables discrimination of individuals, if these differences are sustained over time, and if they correlate with stage of reproductive cycle in females.

12:50pm

Session questions and discussion

1:00pm

Lunch

2:05pm

Modeling chemical communication and olfactory systems session jointly chaired by Dr. Tim Pearce, Leicester University and Dr Marina Cole, University of Warwick.

2:10pm

First Order Processing of Complex Olfactory Information in the Moth

Dr. Shannon Olsson, Max Planck Institute for Chemical Ecology

The world is a cacophony of scent. What we perceive as a single scent is often several compounds acting in concert to form an odor blend. Yet how do animals decipher these complex mixtures from a noisy background and recognize a meaningful signal? Our goal is to examine mechanisms of complex host odor processing in the moth. In insects, the initial representation of odor blends occurs in the first olfactory neuropil of the insect brain, the antennal lobe. Using a novel multicomponent stimulus system, intracellular electrophysiology, optical imaging, and 3-D morphological reconstruction, we assessed the processing of blends of up to 7 host components in the antennal lobe of the Hawk moth, *Manduca sexta*. We found that the fine spatiotemporal representation of blends among single neurons in the antennal lobe revealed a highly combinatorial, non-linear process for coding blends that was shaped by the antennal lobe network. Blend responses exhibited an array of interactions including suppression, hypoadditivity, and synergism that established a multimodal code for blend identity. These results suggest that each neuron utilizes several different elements to produce the unique signal representing the entire blend, including the spatial location, rate, latency, and temporal pattern of the response.

2:40pm

Ratiometric Model of Blend Processing in Moth Macroglomerular Complex

Dr Tim Pearce, Leicester University.

I will present a model of the macroglomerular complex of the insect antennal lobe that is able to encode ratios between the concentrations of two pheromone components within a blend. The dynamical behaviour of the model is evaluated for two different operating regimes that arise as a consequence of the connectivity pattern between inhibitory local interneurons, which show ratio dependent responses comparable with those observed in antennal lobe neurons of different invertebrates. Our results show how the model generates ratio-specific trajectories in its projection neuron output population in both operating regimes. We compare the efficacies of the different population codes for reporting ratio-specific blend information to higher centres of the insect brain. Our key finding is that the complex spatiotemporal code observed during winnerless competition may be more efficient in transmitting blend information, but that in this case the dynamics of the stimulus can collide with those generated by the antennal lobe network itself.

3:10pm

Synchronisation of oscillations in a small network model of olfactory bulb mitral cells

Simon O'Connor, and Prof. Tim Jacob, University of Cardiff.

Smell molecules bind to their receptors in the nose. This binding triggers electrical activity in olfactory receptor neurons. The electrical impulse then travels along the axons of these neurons to the olfactory bulb. Here the axons terminate on the apical dendrite tufts of mitral cells. Mitral cells are grouped into distinct channels dedicated to carrying the input of a olfactory receptor neurons expressing a single type of olfactory receptor protein.

In this study, using a detailed biophysical model, we explore the group dynamic of the mitral cells within one of these channels and how gap-junctions can produce efficient synchronisation of action potential oscillations for this population of mitral cells. This synchronisation has important consequences for olfactory detection and discrimination.

Closing remarks and end of meeting.