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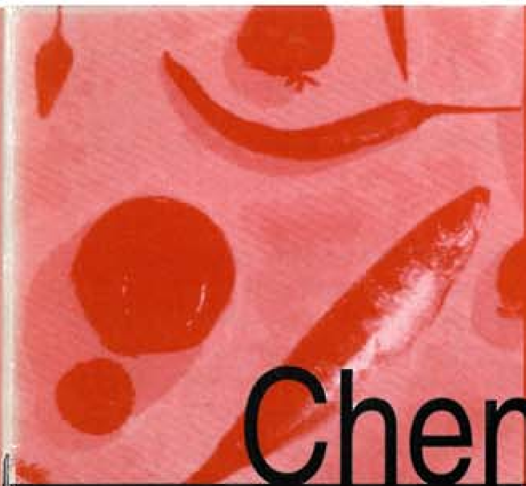

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ChemoSense

Welcome to the first issue of ChemoSense for 2000! This auspicious year marks the fourth year of operation of the Centre for ChemoSensory Research as well as an Olympic year for our home town. On the international scene major chemosensory meetings are scheduled in the USA in April (AChems) and in the UK in July (ISOT-ECRO). ChemoSense will continue to facilitate communication in our region and to support the next Australasian meeting (AACSS) in Adelaide in August-September.

In this issue Ernest Polak of the Université Paris reviews the fragrant subject of verterbrate olfactory receptors. He explains current ideas and evidence about how different odorant molecules translate into odour perception. Is it the size, shape or functionality of a molecule that dictates its smell? Polak describes how scientists have rejected the idea of a single olfactory receptor per odour, and how they now believe that each odorant is encoded by a combination of olfactory receptors. This knowledge brings us closer to inventing new odorants with predictable odours.

Graham Bell addresses some aspects of the psychology of food choice in humans, a topic we will see more of in future issues.

Also in this issue we have an article by Mimi Halpern of New York State University, who discusses her work on the chemical senses and animal behaviour. What is the neural basis of natural behaviours like prey recognition? Halpern has shown how it is not the main olfactory sense, but the vomeronasal organ of the garter snake that is imperative to its ability to select its favourite foods, from a choice of earthworms, goldfish or slugs.

Readers can find more articles at www.chemosensory.com.

Understanding Odour

- VERTEBRATE OLFACTORY RECEPTORS

by Ernest H. Polak, Université Paris VI

It only takes a tiny fraction, about 1%, of the air we breathe to contain the molecules that stimulate our sense of smell. Odorants at the part per million, or even part per billion, level impinge on a 2cm² area of the human olfactory epithelium (OE), and suddenly we smell perfume, or roast chicken, or a ripe mango.

The OE is located at eyebrow-level in the upper nasal passages. Incoming odour molecules dissolve in a thin layer of thick mucus (1) that covers the OE, and then they diffuse through the mucus to make contact with the specialised cilia of the olfactory receptor neurons (ORNs). The ORNs, millions of them in humans, are completely embedded in the OE except for their "heads" from which a dozen or so microscopic cilia float in the overlying mucus above each cell.

Elusive receptors

It is now known that molecular olfactory receptor (OR) sites are located on these cilia. Here, the signal created by contact with an odorant molecule is converted, after transduction, into an electrical one. Response time is estimated to be in the millisecond range.

Two decades ago not much was known about the exact location, nature and functioning of ORs. The first breakthrough came in 1985 when an odour-signal amplifying biochemical transduction system was discovered in ORNs(2). This was followed in 1991 with the DNA sequencing of a family of olfactory genes in rats (3).

Since then, additional molecular biology labs are intensively researching this area. The number of human OR genes is estimated (4) at about 1000, making it the largest gene family in the human genome. Each gene codes for one OR protein. To actually isolate one of these from olfactory cilia is a daunting task, considering the minute quantities involved. So we still talk about putative ORs, since the ultimate proof, isolation of a functional OR protein, has not been reported as yet.

Odorant/OR interactions

Structure-odour relationship studies have shown that odour quality depends on the size, shape, and electronicity (distribution of electrical charges) of the odorant molecule. The interaction between odorant and OR seems to

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be mostly a weakly hydrophobic (water-repelling) one and not a chemical one. The introduction of water-solubilising (hydrophilic) groups in odorants leads to odour disappearance.

While the nose can distinguish thousands of different smells, it would make a terrible analytical chemist, for several reasons:

Firstly, it cannot even manage to distinguish between functional groups of an odour molecule, such as aldehyde, alcohol, ketone and nitrile. Low molecular weight odours form an exception because the functional group occupies such a big part of the molecule. Fig 1a illustrates how very similar smelling odorants can nevertheless differ in functional group and size.

Also, the nose cannot consistently tell the difference between odorants that have an aromatic (benzenoid) ring and those that have the corresponding fully hydrogenated cyclohexyl ring (Fig 1b).

Polarity (the separation of charges along poles), while usually present in odorants, is not always essential (Fig 1c). Finally, there is the need for weak non-chemical binding between odorants and ORs so that odours can be quickly desorbed and make place for new odours. This is essential for quick survival responses in nature. Chemical binding would imply the danger of saturation (all responding ORNs occupied = no response).

What are the molecular properties that odorants transfer to ORs?

Up to 3 decades ago one of the best hypotheses (5) was inspired by the specialised pheromone ORNs found on insect antennas. It envisaged "primary" odors, defined as those odorants for which some people (anosmics) were deficient in sensitivity. For each primary odour quality, there was a corresponding primary OR site. For example, a camphoraceous odorant, like camphor, would fit into a complementary OR site on a camphoraceous-only signalling ORN. For many years the primary odour concept confounded chemists attempting to invent new odorants with predictable desired odours.

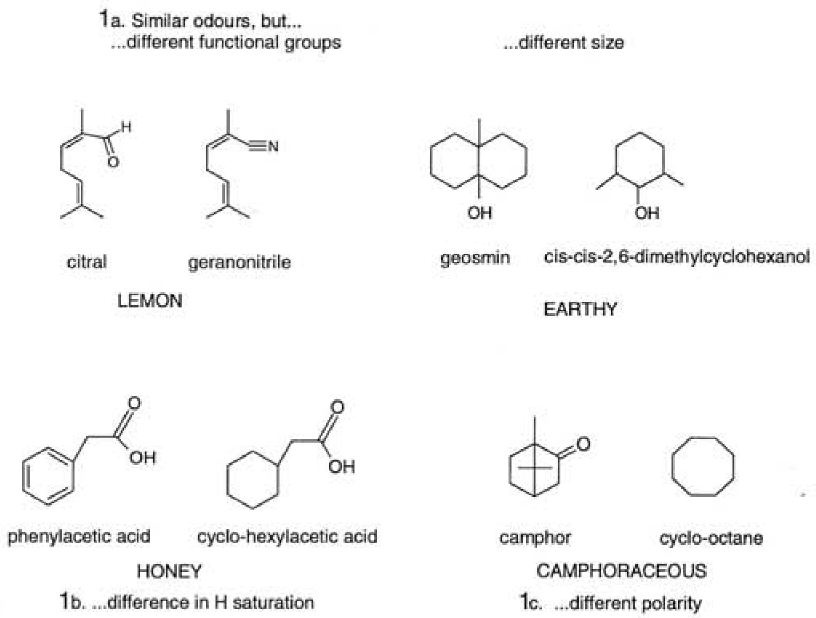
To get away from the single receptor per odour concept, an alternative was elaborated in 1973 (6). It postulated that each odorant had several molecular profiles (viz structural features). Each profile could interact with a corresponding OR. For example, if an odorant presented 3 profiles (a,b,c,) that interacted with 3 types of OR (A,B,C), the resulting interactions, aA+bB+cC, would trigger depolarisation of corresponding ORNs, resulting in a characteristic neural activity pattern spelling out a particular odour quality. That pattern was envisaged to form an "odour-image" in the brain; the olfactory equivalent of a visual image. Since then the Multiple Profile-Multiple Receptor model has found experimental support.

Experimental evidence

A French group (7a,b) managed to record voltage changes from single ORNs in frog OE. They found that single ORNs had their own characteristic response spectrum towards a wide variety of odorants. Over a decade, 75 odours were tested. It was found that an ORN would usually respond to several odours, even when these appeared to be dissimilar in odour (to humans) or structure.

Another approach was to use selective chemical modification of the OE in order to block one or several ORs (8). An English lab found (9a,b) that after perfusing rat-OE with a Mannose complexing protein (ConA), the resulting electro-olfactogram (EOG) was partially inhibited for certain odorants, dependent upon their length and functional group, while it had no effect on others. (The EOG is the summated olfactory response, in mVs, of perhaps 1000 ORNs in the area covered by a fine glass elctrode-tip placed on the OE.)

A further experiment on straight-chain and cyclic hydrocarbons (10) confirmed that inhibition correlated with molecular size. Subsequently, a behavioral experiment confirmed the EOG findings (11). Rats whose noses had been perfused with ConA, no longer recognised dimethyldisulfide, while their recognition of a control odorant remained normal.



SIMILAR ODOUR ...BUT DIFFERENT STRUCTURE

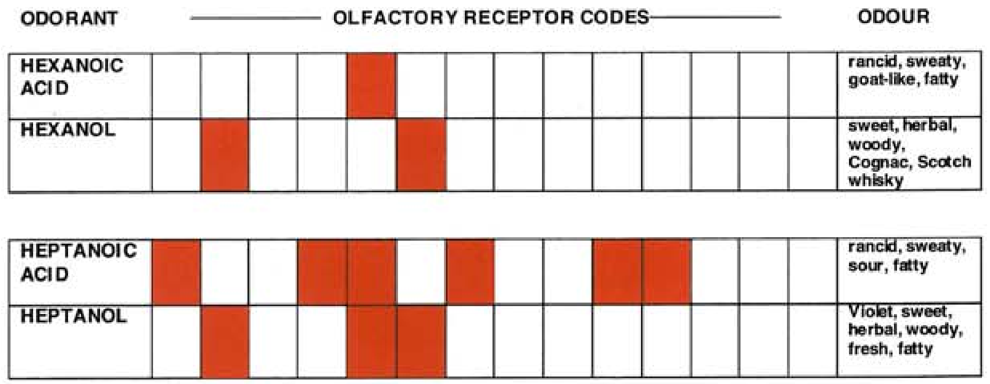


Figure 2 Different combinations of ORs (each box represents a receptor) recognise these different odorants. Thus, despite their having the same carbon chain length, the acids and corresponding alcohols have different odours. (based on Reference 4, Figure 7)

SIMILAR STRUCTURE ...BUT DIFFERENT ODOUR

Single olfactory receptors

The above data, however, did not prove the response spectrum of single ORs. Using complex techniques from molecular biology, some ingenious methods were devised to circumvent the difficulty of isolating a single and still functioning OR. In one experiment (12) a rat OR gene (OR17) and a fluorescent marker gene were both inserted into an Adenovirus. The recombinant virus was then used to infect rat noses. The OR17 gene was now overexpressed in the 2% of infected fluorescing ORNs. Comparing EOGs from infected and control areas with 74 odorants showed that the OR17 response was highly specific for n-Octanal.

In another experiment (4), 14 mouse ORNs, sensitive to aliphatic odorants and stained with a dye that fluoresces on odour response, were tested with 5 alcohols and 9 carboxylic acids. The results are shown in Fig2 (4) and resemble the frog results mentioned earlier (7a,b). Examination of genetic material demonstrated that each of the 14 ORNs expressed only one OR. To quote the authors: "We found that one OR recognizes multiple odorants and that one odorant is recognized by multiple ORs. Thus the olfactory system uses a combinatorial receptor coding scheme to encode odour identities".

The future

Our understanding of how vertebrate odour reception functions has vastly increased over the last decades. Future research will hopefully lead to isolation of functional receptor proteins and further insight into what molecular features they sense.

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Making Sense of Scents - *Chemical senses & behaviour*

by Mimi Halpern, State University of New York

In some of their most interesting behaviours, animals make use of information provided by the chemical senses. Many species mark territory with urine or faeces, females may secrete pheromones that cue males that they are reproductively receptive, and most animals use the chemical senses to determine the appropriateness of potential food objects. In vertebrate evolution, the chemical senses have played an important role in the development of the brain and in the moulding of species-typical behaviours.

Neuroethology

In recent years there has been a resurgence of interest in the nasal chemical senses. This interest has been sustained by insights obtained from research into the roles of the chemical senses in complex natural behaviours, mechanisms of sensory transduction and the organisation of brain systems processing chemosensory information.

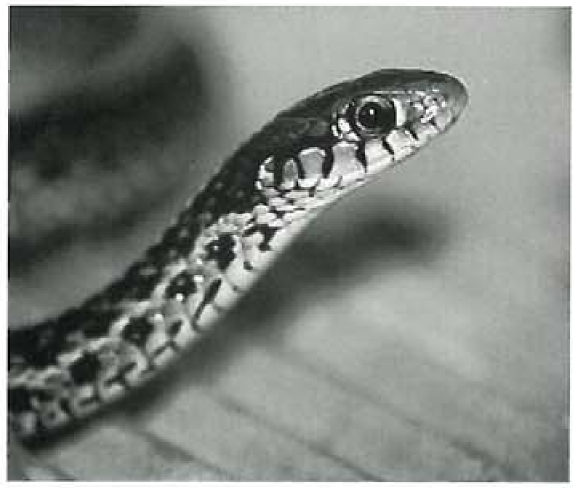
Over the past 25 years I have been studying the nasal chemical senses as they participate in natural behaviours of animals, particularly garter snakes. This work primarily involves understanding the neural basis of these natural behaviours, and belongs to a discipline called Neuroethology.

My interests concern the natural use by snakes of the chemical signals to identify prey, mates and same-sexed conspecifics.

Snake vomeronasals

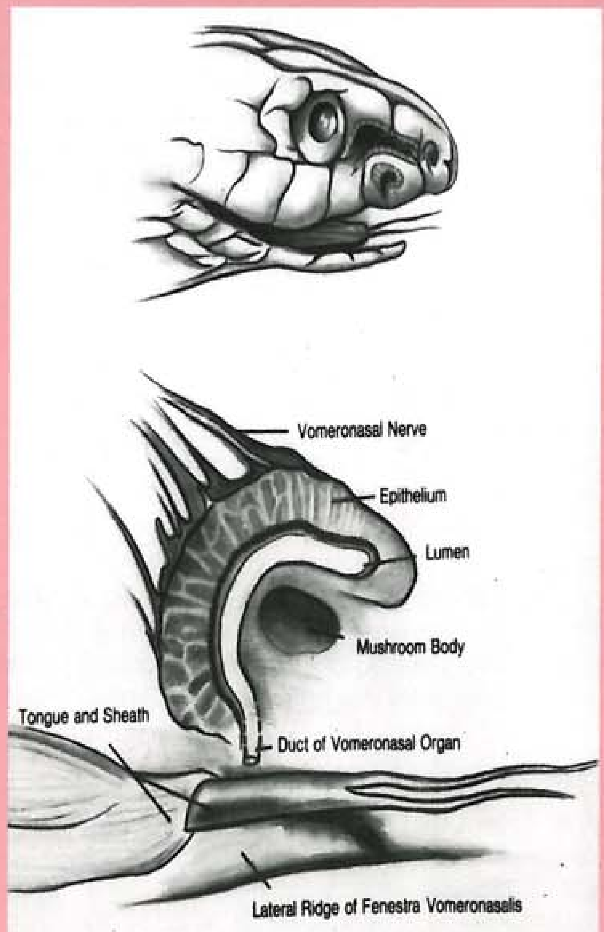
Two sensory systems appear to provide the major pathways for chemical information to enter the garter snake's brain. These are the main olfactory system and the vomeronasal system. The vomeronasal system is also referred to as the accessory olfactory system. The vomeronasal organ (VNO), which is located in the base of the nasal septum, is also referred to as Jacobson's organ. Whereas the olfactory system is particularly sensitive to volatile odorants, the vomeronasal system is preferentially stimulated by large, complex, naturally occurring molecules that are not usually volatile.

In order for chemical stimuli to effect behaviour, they much reach the appropriate sensory epithelium. For this reason behavioural adaptations have been developed by animals to bring chemicals into the VNO. In snakes the tongue is used for this purpose.



Above: Florida blue garter snake (Thamnophis sirtalis sirtalis) , (Dr Alan Francis, http://freespace.virgin.net/alan.francis2/photographs.htm)

Below: Close up and cross-section of garter snake head showing detail of the vomeronasal system.



Prey recognition and attack

This natural behaviour is particularly interesting because it has both innate and learned components.

Young and adult garter snakes alike must discriminate between prey and prey-like objects, and determine within a very short interval whether a presumed prey object is appropriate for ingestion. What is the neural basis for this behaviour? Before I began this research, other studies had strongly suggested that the vomeronasal (accessory olfactory) system played a major role in prey detection by snakes. The relative role of the olfactory system was less clear.

The ability of animals to detect prey is for the most part dependent on functional chemical sense systems. However, it has only been in snakes that the vomeronasal system has been implicated in feeding behaviour. Gordon Burghardt demonstrated in the late 1960s that newborn, ingestively naive garter snakes respond to aqueous washes of species-typical favourite prey with increased tongue flicking and attack. In the absence of discriminated visual cues, this response had to be mediated by one of the chemical sense systems. Garter snakes do not have taste buds on their tongues, and have a relatively sparse distribution elsewhere in their mouths, so it is unlikely that taste (gustation) was mediating this response.

Newborn snakes with their tongues removed do not make this differential response to washes of favourite prey. In the species used in our lab (*Thamnophis radix, T. parietalis, T. butleri*) the favourite prey are earthworms, but could, in other species be fish, amphibians or slugs.

The role of the VNO

To determine the roles of the main and accessory olfactory systems in garter snake response to prey odours we tested snakes in two paradigms. In one experiment we tested snake responses to cotton swabs dipped in earthworm wash or distilled water. Preoperatively snakes only attacked cotton swabs dipped in earthworm wash. Postoperatively, snakes with sham and olfactory nerve lesions continued to attack cotton swabs dipped in earthworm wash, but snakes with vomeronasal nerve lesions did not.

In a different paradigm, it was also found that garter snakes require functional VN systems to follow earthworm extract trails in a maze.

While garter snakes will follow trails of earthworm wash that are wet or dry, they are unable to follow a vapour trail placed below a perforated false floor. It should be remembered that volatility is the *sine qua non* for olfactory stimuli.

The neural connection

To understand the neural mechanisms involved in response to chemicals derived from prey we began a series of studies utilising electrophysiological monitoring of neuronal activity in response to prey chemicals. We found that neural activity increased when the VNO was stimulated with earthworm wash.

It was necessary to determine whether there was an intrinsic mechanism based on volatility and odorant access that separated those stimuli that would activate the vomeronasal system differentially from the main olfactory system. In order to do this we investigated the effects of prey odour vapours and prey liquids in their ability to activate neurons of the vomeronasal and main olfactory systems. These neurons are found in the accessory olfactory bulb and main olfactory bulbs, respectively, and receive information from the peripheral organs.

Only snakes that ate both goldfish and earthworms were used. Liquid delivery of earthworm wash to the vomeronasal organ was an effective stimulus for activation of neurons in the accessory olfactory bulb, as was goldfish wash. However, neither earthworm wash **vapour** nor goldfish wash **vapour** were effective stimuli. Conversely, either of the two wash vapours, delivered to the olfactory epithelium, activated the main olfactory system but not the two washes themselves. These findings suggest that there is an intrinsic mechanism in the main olfactory epithelium that preferentially responds to airborne odours and conversely there is a similar mechanism in the vomeronasal epithelium that preferentially responds to odorants delivered as liquids.

VNO receptors

To understand the cellular and molecular events that occur during prey stimulus recognition and transduction, we need to identify, characterise and purify prey-derived ligands that could eventually be used to identify the receptors in the VNO that recognise prey.

In our lab we isolated, purified and characterised a 20 kiloDalton protein from earthworm shock secretion, which was labeled with a radioisotope and used to study the binding of the protein to the vomeronasal sensory epithelium. This binding was found to be specific to the VNO; the protein did not bind to other tissues, such as the olfactory epithelium. We cloned the gene for this protein and were able to demonstrate that the fusion protein has strong chemoattractive properties.

Current work

More recently my laboratory has been exploring the mechanisms of sensory transduction in the snake VNO. We have demonstrated that the binding of the earthworm protein to the vomeronasal epithelium induces a cascade of events. Elements of these events include the activation of G-proteins, second messengers (inisotol-trisphosphate) and the eventual generation of an electrical signal that transmits information about the nature of the vomeronasal stimulant to the brain.

Currently our lab is further investigating the nature of the sensory transduction process in the snake VNO. Our hope is eventually to gain an understanding of the neural circuits in the brain that produce appropriate responses by the garter snake to its external chemical environment.

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In perspective: food choice

by Graham A. Bell, Centre for ChemoSensory Research

People choose food in a variety of situations and contexts. Food choice is usually limited by what is available and what is affordable, and culture and economics largely drive this. Modern societies like Australia, provide ample options and there are few major economic, geographic or cultural impediments to the context in which food choices are made. In such circumstances what are the determinants of food choice? How much do physiological and psychological factors determine what we choose to eat?

Physiological Variables

The nutritional status of the individual, and the time since his last meal is an important driver of food choice.

In the animal kingdom, there are examples of diet selection driven by deficiencies in minerals in the diet. For example, cows will dig up bones and eat them to restore calcium and other mineral deficiencies; and lab rats have been shown to balance their nutrient needs when given an *ad lib* diet of a range of choices – so-called "cafeteria feeding".

Humans, however, are not so clever. While cravings for specific foods do occur at times (the celebrated pickles and ice cream for pregnant women) indulging these cravings does very little to redress imbalances, such as iron deficiency in women. Cafeteria feeding in humans is a myth. People who "work" on balancing their diets can still get disastrously deficient without any corrective signals manifesting. A prime example of this is iodine deficiency, where goitre and cretinism set in, in the absence of medical intervention. Food craving does not redress the imbalance – in fact no iodine-containing food cravings arise.

Nevertheless, people do express food cravings. The drivers of these cravings have not to date been linked with nutritional deficiencies but rather to breaks in routine – eg the Australian traveller who yearns for a decent steak – and non-specific body states such as blood sugar level – eg the 3pm candy bar (1).

Age

Age is another matter entirely. A plethora of physiological mechanisms change with maturation. The food choice of young children differs from their parents for reasons as simple as not having a fully developed nervous system. Nutritional needs for protein and carbohydrate are different in the child, as is most obvious during the growth spurt that precedes adulthood.

Age is a potent determinant of food choice, but surprisingly little study has been made of this variable in humans. Very little is known about drivers of food choice in children, and most foods are "unformulated" for children below 8 years old. Even baby foods, according to some people I have met in the industry, are almost 100% guesswork.

Old age is better understood, in terms of failure of the olfactory system, which, despite dentures and oral obstructions starts to decline, on average, from about 60 years of age (2). Still, food companies largely ignore this market. We can expect more attention to the "grey market" in the years 2000 to 2010 as the affluent "Baby Boomers" reach 60 years of age.

Gender

Gender differences exist in food choice and it is largely assumed that these are socially determined. However, recently Linda Bartoshuk's group at Yale have shown that more women than men are supertasters – that is, have a higher sensitivity for taste, tend to reject fat and alcohol and strong tasting foods, particularly bitter foods. This, they have shown, correlates with density of taste buds on the tongue (3).

Recently at the Centre for ChemoSensory Research we also found that women were far better at discerning rancidity in porridge than were men of the same age.

Health

People in good health are assumed to be the norm. "Eating well" is regarded as an indicator of good health – but what does this really mean? If fitness for sport is regarded as the pinnacle of good health, then these "healthy" people are very odd – piling down high carbohydrate food and raw protein. This, clearly, is not normal.

We need more information on how food choice relates to well being and healthiness.

Do all people discern the same foods equally?

We have found, very consistently, in our Asian-Australian comparisons that *ability to judge*/discern is a constant across these cultures. However, what they *prefer* is different and variable. Therefore, any food company wanting to enter a new and foreign market will, perforce, find it necessary to understand the preference factors that its products will become subjected to.

It is interesting to note that people's palates change when they move to a foreign country, just as the palate seems to convert or rebuild itself when a person gives up sugar or meat. For example, after consistent exposure to very spicy food for a period of time, traditional Australian/English food will be perceived as very bland. Careful studies of the time it takes to make such a change, and the detailed nature of change to specific perceptions and preferences is needed.

So, why choose certain foods?

Confronted with choices of foods that are differently priced and promoted, the consumer behaves according to her culture, affluence, health, nutritional status, gender, age, supertaster status AND her personal preferences!

We need to look at each of these influences and learn to recognise when and to what extent they are operating on consumer behaviour. The message for the food industry is that understanding the operators in food choice can directly instruct its market strategy for its products. It is now timely for sensory food science to explore all the possible ways it can contribute to market strategy.

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Mapping Opportunities in Korea

"The South Korean Government is running a strong program of industry reform…the next step is to encourage foreign investment. These factors, combined with South Korea's declining agricultural sector, will provide more opportunities for Australian food exporters over the medium to longer term. Our continuing support now…will pay dividends in the years to come." Jim Kennedy, Executive Director of Supermarket to Asia, May 1999

An understanding of Korean food habits and preferences can only serve to benefit Australian exporters. The Centre for ChemoSensory Research is currently planning a major study of the food habits and tastes of the Korean population. The aim is to create a detailed geographical map of Korean consumers' food preferences, perceptions, food culture and of Korean market information.

Australian trade will clearly benefit from this information, which can be used to develop food commodities, ingredients and manufactured food products that maximise acceptance by Korean consumers.

Key aims

As a direct result of the Korean study we hope to:

- Map variations in the Korean population's taste preferences
- Extend previous knowledge to understand regional differences
- Identify niche markets for Australian exporters
- Establish friendship and contacts for further research of value to Australia and Korea

Korea's Regrowth

South Korea may have been one of the first countries to feel the brunt of the 1997 Asian economic collapse; but it has also proved to be one of the first to emerge from the depths of crisis.

According to *Asiaweek* (4/2/2000) the Korean recovery has so far been driven largely by their exports – but now consumption must become the driver.

Australian food exports to Asia are continuing to grow steadily. In 1999 Korea jumped from number 10 to number 7 on Australia's list of top export destinations for our processed foods. It was the only country in the top ten to climb the ladder, with over 50% growth of its imports from Australia.

The Centre for ChemoSensory Research welcomes industry participation in the Korean Taste Map Study. For further information please contact Graham Bell on (02) 9209 4083 or email g.bell@unsw.edu.au

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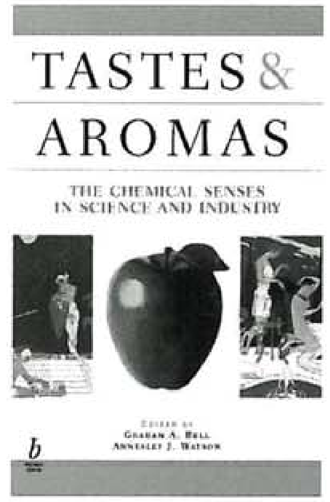
Upcoming Events

11 - 17th March	**10th World Water Congress**, Melbourne, IWRA-UNE-AWWA-IE Australia. More info: Tel. 03 9682 0244, Fax. 03 9682 0288, Email worldwater@icms.com.au
16 - 17th March	**Sanitarium International Nutrition Symposium, Nouveau Nutrition: Traditional Foods, Contemporary Science** Sydney, ANA Hotel, The Rocks. RSVP by March 1st: Shae Quabba at The Rowland Company Tel. 02 9291 3331 Fax 02 9221 2676
26 - 23rd April	**AChemS XXII 2000** Hyatt Hotel, Sarasota Florida, USA. Contact: AChemS central office 744 Duparc Circle Tallahassee, Florida 32312 or see www.neuro.fsu.edu/achems
20 - 23rd August	**33rd Annual AIFST Convention** 'Millennium Marketing through Food Science and Technology', Brisbane Convention Centre, Brisbane Australia. Further info: Ms Mel Malloch Tel. 612 9959 4499, Fax. 612 9954 4327 or see www.aifst.asn.au **Closing date for abstracts 15th March 2000**
24 - 28th September	**7th International Conference on Cell Biology**, at a joint congress with the 11th Meeting of the International Society of Differentiation, Inc., and the Australian and New Zealand Society for Cell and Developmental Biology. A key speaker will be **Linda Buck**, discoverer of the olfactory receptor. Conrad Jupiter's, Gold Coast, Qld Australia. For more info: www.celldiff.unsw.edu.au

Explore the Chemical Senses!



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IN THE NEWS

Calvin's Cool for Cats

In our August '99 issue, we carried a story about the Canadian lynx's attraction to the perfume Chanel No 5. The scent was used to lure the big cats into traps for re-location. But lynx aren't the only cats with a penchant for expensive colognes. It turns out that wild ocelots love the perfume 'Obsession' by Calvin Klein. Again, this is probably due to the presence of musk in its formula. Apparently the smell is so attractive to the ocelots that they will roll in it in order to 'adorn' themselves. This fixation was revealed by scientists investigating smells that might keep the ocelot away from potentially dangerous highways.

(Discovery Channel www.exn.ca 15/3/99)

New flavours - intense tastes

Remember the special gum from Willy Wonka and the Chocolate Factory? The one that tasted like tomato soup, then a juicy steak, and then, with disastrous consequences for the obnoxious Violet Beauregarde, blueberry pie? Flavour and fragrance manufacturers, Takasago International, can't quite deliver that kind of sensation yet, but they have been able to design some foods that change their sensory effects as they are eaten, mainly by using stimulation of the trigeminal system.

The confectionery, snack foods, beverages and sauces have been given cooling, heating, tingling, pungent and astringent effects using botanical ingredients, like menthol and extracts from tea. Only the active ingredients have been added so that the associated mint or tea flavour is not conveyed as well. One example is an apple-flavoured candy: it has a heating effect that builds up slowly as it is sucked, which eventually becomes lingering soothing effect.

(Prepared Foods, Feb. 2000)

Cyba – the smell that makes an impact

Where would you wear a futuristic scent that bears the stench of a fallen meteorite? Probably not on a first date. "Cyba", a "sulphurous, smoky, gunpowder-like, metallic" odour has been developed by Quest International in England simply to prove that they can manufacture just about any fragrance. "Cyba" was developed by scientists after they analysed the smell of an actual chunk of meteorite. (New Scientist Feb 5, 2000)

A whiff of chocolate can save

Finally! Scientific proof that chocolate cures all ills! Dr Angela Clow from the The Psychophysiology and Stress Research Group at the University of Westminster has found that the smell of molten chocolate stimulates the immune system, appearing to boost the production of antibodies, as measured in the saliva of subjects.

These results were presented at a seminar on the science of chocolate in London. Unfortunately the effect was only observed in male subjects, which hardly seems fair. Next Dr Clow plans to research the reason behind this disparity of the sexes.

By comparison with chocolate, the smell of rotting meat caused antibody levels to drop, which proves that smelling a festering carcass isn't good for you.

(The Daily Telegraph, 15/2/00)

Curbing smoking cravings with odour

There are plenty of "cures" out there for smokers who want to beat their habit; but gum chewers and nicotine patch wearers still experience cravings that can be their undoing. The Aroma-Chology Review (Vol III, No.2) reports that researchers at the University of Pittsburgh have found that some odours may help to combat the urge to smoke. Strong, emotionally evocative smells were found to help smokers to forget their cravings. The researchers suggest that this is probably because the smells conjure up pleasant memories, thus distracting smokers from reaching for the cigarettes.

News from the CCR

The CCR

It's a new year (if not quite a new millennium) and we are beginning it with a re-vamped web site. Visit us at **http://www.chemosensory.com** for information about the services we provide, our research interests and for sensory-related links.

Some of our readers received surveys with the November issue of ChemoSense. We read your responses with great interest, and we are trying to take on board as many of your suggestions as possible. A free copy of "Tastes and Aromas" was won by Donna Ross in the lucky draw.

We said farewell to our 4 fourth year food science students at the end of 1999. All the best to Amy Leung, Siew Boon Gooi, Shu Jun Tong and Nadia Vedelago who have completed their projects, handed in their theses and are well on their way to fame and fortune. New fourth year students joining the CCR are Clara Yoon and Linda Nguyen. We have also had the company of Vee Nguyen and Jason Clark as Centre vacation scholars over the summer.

In February we will also say goodbye to Dr Jane Paton, our visiting fellow from the School of Food Science and Technology, UNSW. Jane has made a valued contribution to the CCR through her research and her representation of the Centre at the UNSW Expo and other memorable events. Dr Paton will be involved in teaching sensory science at UNSW.

Canadian Award

Dr Albert Farbman, of Northwestern University in Illinois, is the 1999 winner of the Frank Allison Linville's R.H. Wright Award in Olfactory Research.

The award of $25,000 is made annually to an individual who has recorded outstanding achievement in research in olfaction. Specific issues addressed by Dr Farbman's work include: the nature of the chemical factors specifying the development of olfactory epithelia and taste buds, and the influence of target tissue, ie, the olfactory bulb in the case of olfaction.

Dr Farbman will visit Simon Fraser University in March to accept his award.

Sensory Specialist Required

E. & J. Gallo Winery are recruiting a new sensory specialist to conduct sensory tests to support an innovative research program. Please Contact: Dr Isabelle Lesschaeve, E. & J. Gallo Winery Modesto, California. Fax: 209 341 7066 E-mail: isabelle.lesschaeve@ejgallo.com Or visit their website: http://www.gallo.com

Delicious Flavour of Melbourne Symposium and Workshop

Australia's new Sensory Neuroscience Laboratory launched itself into the consciousness of the Australian Food Industry with a tastefully star-studded symposium and workshop on February 15th and 16th. Six international speakers from USA, Germany and New Zealand and five Australians illuminated some sixty industrialists and scientists at Swinburne University of Technology, Melbourne. Paramount was the capability of and the need for chemosensory research in the food industry. Also highlighted was the need for Australian industry to position itself better to take advantage of the scientific information stream. In this regard, industry support for the Australasian Chemosensory Association (AACSS) was seen as crucial. The establishment of an industry-based research fund on the lines of the Olfactory Research Fund in the USA was discussed.

COMING UP in ChemoSense

The woozie world of wine judging

Flavour is more than we think!

Injury: the value of nose and tongue

Air pollution: whose stink is it?

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Vale Geoffrey Gold

A light has gone out in the chemosensory world with the passing of Geoffrey Gold in February 2000. Among his many achievements Gold's discovery of cyclic nucleotide-gated conductance in olfactory receptor cilia (with T. Nakamura, *Nature* 316: 442-444) was a landmark in the physiology of olfactory transduction.