Vol. 11 No.3 July 2009

Chemo Sense

Editorial

By Graham Bell
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The science of vision has been greatly enhanced since the Nineteenth Century with experimentation and theory of visual perception. Figure-ground illusions, colour and brightness adaptation, completion of objects, movement detection, perceptual constancy, stereoscopic depth, and many other phenomena, excited and challenged generations of psychologists and physiologists. Not so, the science of the chemical senses, in which the workings of higher order processes upon inputs of sensation seem much less obvious, and hence, perhaps, have not attracted experimental attention. That is changing. In this issue, Sakai shows that hedonic and perceptual experience of liquids in the mouth (Japanese tea) can be significantly distorted by expectation and mental images

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Cognitive and Contextual Factors Affecting Olfactory and Gustatory Perception and Palatability of Beverages

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In our daily lives, we are exposed to advertising commercials, or "commercial messages" (CMs) about foods and beverages, on the assumption, by the advertisers, that consumers use the information at the time of decision to purchase the products.

Previously, Sakai (2008) asked 124 university students what the key decision factors are, from the following list, when they purchase foods and beverages: Packaging, CMs, names, prices, manufacturers, retailers, nutrition facts, and/or ingredients of the products. Over 60% of students selected CMs as a key factor when purchasing foods and beverages.

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EDITORIAL CONTINUED

Editorial continued

created by viewed advertising. What rules can be defined for such phenomena, and what higher brain processes are involved? We will learn more in the coming years.

Bookings are open for AACSS at Heron Island (2-6 December 2009) and you are urged to register and secure accommodation immediately, to avoid disappointment. AACSS has a beautiful new website at www.aacss.org which is your gateway to the Great Barrier Reef meeting.

Another new website of interest is that of the sponsor of ChemoSense: E-Nose Pty Ltd. Learn more at www.e-nose.info.■

Cognitive and Contextual Factors Affecting Olfactory and Gustatory Perception and Palatability of Beverages continued

"Brand images" are also developed through CMs, typically in cola flavored beverages. Although there are many cola brands in world, the best known brand in 2008 was Coke (Coca Cola) and the second was Pepsi, which has 31.1% of USA carbonated beverages share, compared with Coke's 42.8% (Sicher, Beverage-Digest, 2008). Coke's lead is greater in Japan: According to Nikkei point of sale (POS) data in 2006, Coke's market share was 27%, while Pepsi's was 9%. This relative position in sales has been found to contrast with palatability ratings of the products by consumers. Both Americans (McClure et al., 2004) and Japanese university students (Sakai, not published) preferred Pepsi to Coke in a blind tasting test.

Exploring this trend, McClure and his colleagues did an interesting experiment (McClure et al., 2004). Participants were asked to taste "de-carbonated" cola while being MRI scanned. Before tasting a cola, an image, which signaled what stimulus would be presented, was presented. Half of the images presented were a picture of the beverage packaging (a can of Coke or Pepsi), and the other half presented were of a colored circle. When the pictures of packaging were presented, participants could expect taste of incoming cola, but not when the colored circles were presented. The experimenters measured brain activities during tasting a cola, and comparing the activities with the anticipatory cue (picture of cola) and without the cue (colored circle). When the participants tasted Coke with the cue, they evaluated the cola more palatable, and their hippocampus, midbrain and dorsolateral prefrontal cortex showed greater activities than when tasting stimuli without cues. However, when the participants tasted Pepsi, no differences were found in their preference and brain activities between presentations with and without cues. The experimenters also showed an activity in the ventromedial prefrontal cortex correlated with participants' preferences for cola. Thus, it is suggested that the Coke brand evokes activities in the memory-related brain regions (hippocampus and dorsolateral prefrontal cortex); creates the participants' expectations for the taste, and that this brand effect is independent from the evaluation of palatability that is executed by the emotional judgment systems in the brain (ventromedial prefrontal cortex).

The author reports here some studies of effects of brands or CMs on palatability evaluation, and discusses the impact of CMs or information about the product on our sensory and evaluative processing.

Several kinds of bottled-green tea were chosen as the target stimuli. In Japan, green tea is traditionally drunk in homes and in restaurants. Since 1991 and the development of bottled green tea, the sales of bottled green tea have grown rapidly: e.g. sales in 1996 were 500kL, rising by 2006 to 2,500kL. There are now many brands of bottled green tea in the Japanese market. Although, the brands show big differences in sales, differences in sensory properties among these products are not obvious, because most of these products are mild in flavour and do not include sugars and additional flavors.

Recently, a new brand of bottled green tea captured a remarkable share of sales. A business review of this phenomenon described this success as a result of TV advertised CMs (Mine, 2006).

In a preliminary experiment, university students, who were frequent users of bottled green tea, could not discriminate between brands of the bottled green tea in a blind presentation, but showed significant difference in palatability evaluation when they were shown the packages of the products. Thus, we aimed to investigate here, whether the taste and palatability evaluations of bottled green tea are affected by the CMs of the product.

In first experiment (Sakai, 2007), 20 female university students (18~21 year old) were asked to watch a CM and to drink a cup of green tea. After drinking a cup of green tea, they evaluated the perceived intensities for umami, bitterness, aftertaste, flavor and palatability on 100mm graphic analogue scale. They repeated this session three times, watching different CMs in each session. Three 15sec CMs broadcasted on TV were used. The brands associated with the CMs were lemon *(CMi)*, Namacha *(CMn)* and Hajime *(CMh)* (a part of the CMs are shown in Figure 1). The green tea stimulus was same in three sessions: the participants drank same green tea (*Oi Ocha*: ITO EN Inc., *To*). After drinking *To*, the participants made actual ratings of its taste and palatability.

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NEWS

ADVERTORIAL

OLFACTOMETERS and GUSTOMETERS

KNOSYS Olfactometers Inc., the only company devoted to the production of automated olfactometery and gustometry equipment for small animal research now offers odor generators for fMRI and EOG studies.

Background

KNOSYS was organized in 1995 by a small group of scientists in response to numerous requests by investigators who wished to duplicate or purchase the small animal olfactometer first described by Slotnick and colleagues in a series of papers on behavioral and neurobiological aspects of odor learning in rats and mice. The earliest product versions and software, designed around the Apple IIe computer, combined with a relatively primitive interface, soon evolved to a more sophisticated instrument that employs virtually silent pinch valves to control delivery of the stimulus, a USB based digital interface compatible with all Windows operating systems, and highly flexible software routines for automated initial training and discrimination training using odors or taste stimuli or a combination of both stimuli.

KNOSYS established a web site in 1998 but, until now, has never advertised its products. Inquires have come from 'word of mouth' and citations in published reports. To date, KNOSYS products have been installed in more than 50 universities and research centers world wide including those in Australia, Europe, Korea, Japan, and the United States. In the last 10 years, studies in more than 80 published reports in scientific journals have used KNOSYS products. Indeed, the KNOSYS small animal olfactometer has become the unofficial standard for small animal olfactometery.

Recently, KNOSYS has expanded its product line to include a simple, low cost but very effective odor generator for fMRI studies, a combined olfactometer and gustometer, and a vapor generator for EOG research.

A guiding principal in the design of KNOSYS equipment is simplicity. We produce functional robust units that are easy to use and, if needed, easily modified. Our major effort goes into quality components, not fancy packaging or enclosures. The open architecture design makes all components, including wiring connections, available to the user. We are pleased to assist 'do it yourselfers' to duplicate any of our products. Despite this, all users we know of have found it more convenient and less expensive to purchase these as ready made systems from KNOSYS.

Some of our products:

- The rodent liquid dilution olfactometers
- The fMRI odor delivery system for studies using magnetic resonance imagining
- The EOG odor generator for vapor stimulation in electrophysiological studies
- The rodent gustometer

Each of these systems controls up to 8 independent channels (a maximum of 12 channels for the EOG unit) and is supplied with appropriate software routines for timed presentation of liquid or vapor stimuli. The rodent olfactometer and gustometer are designed for operant conditioning studies of detection and discrimination behavior in rats or mice.

For further information, pricing, or inquires of whether a KNOSYS system is suitable for your needs please address inquiries to our marketing representative, Shelia Lendman at shelia@knosyknosys.com. ■

Cognitive and Contextual Factors Affecting Olfactory and Gustatory Perception and Palatability of Beverages

continued

Figure 1. One scene from each 15-sec CM. From left to right, Iemon *(CMi)*, Namacha *(CMn)* and Hajime *(CMh)*, respectively.

There were no significant main effects of CMs in umami, flavor and aftertaste ratings. On the other hand, there were significant main effects of CMs in palatability ratings, and its tendency in bitterness rating. The post-hoc analysis revealed that *To* after watching *CMi* was rated more palatable than after watching *CMh*. These results are shown in Figure 2. In the preceding study, *CMi* was evaluated as most preferable CM, followed by *CMn*. The result of actual palatability after drinking To was in the same order, and a significant correlation coefficient (r=0.61) between the preferences for the CMs and the palatability ratings was found. Thus, it is suggested that an expectation of the stimulus evoked by watching a CM, affected actual palatability rating.

In a second experiment, three kinds of bottled green tea, with matching CMs, were used: Iemon (Suntory Ltd.: *Ti*), Namacha (Kirin Beverage: *Tn*) and Hajime (Coca-Cola Japan Company Ltd.: *Th*). Eighty-three university students (20 male and 63 female) were randomly divided into three groups. As in experiment 1, participants were asked to watch a CM, to drink a cup of tea, and then to evaluate for their taste and palatability. The difference in procedure was following: one of three tea stimuli matched the CM, the others did not match the CM (see Table 1 for detail).

The results of effects of CMs showed that flavor intensity rating for teas after watching *CMi* was higher than those after watching *CMn* and *CMh*

A: Experiment 1

Groups of Participants	1st		2nd		3rd	
	CM	Tea	CM	Tea	CM	Tea
A	CMi	To	CMn	To	CMh	To
B	CMn	To	CMh	To	CMi	To
C	CMh	To	CMi	To	CMn	To

B: Experiment 2

Groups of Participants	1st		2nd		3rd	
	CM	Tea	CM	Tea	CM	Tea
A	CMi	Ti	CMn	Th	CMh	Tn
B	CMn	Th	CMh	Tn	CMi	Ti
C	CMh	Tn	CMi	Ti	CMn	Th
D	CMn	Tn	CMh	Ti	CMi	Th
E	CMh	Ti	CMi	Th	CMn	Tn
F	CMi	Th	CMn	Tn	CMh	Ti
G	CMh	Th	CMi	Tn	CMn	Ti
H	CMi	Tn	CMn	Ti	CMh	Th
I	CMn	Ti	CMh	Th	CMi	Tn

Table 1. Combinations of CM and tea. In experiment 1 (upper panel: A), all participants drank the same tea *(To)*. In experiment 2 (lower panel: B), all participants received an appropriate combination of a CM and tea and two inappropriate combinations of CM and tea.

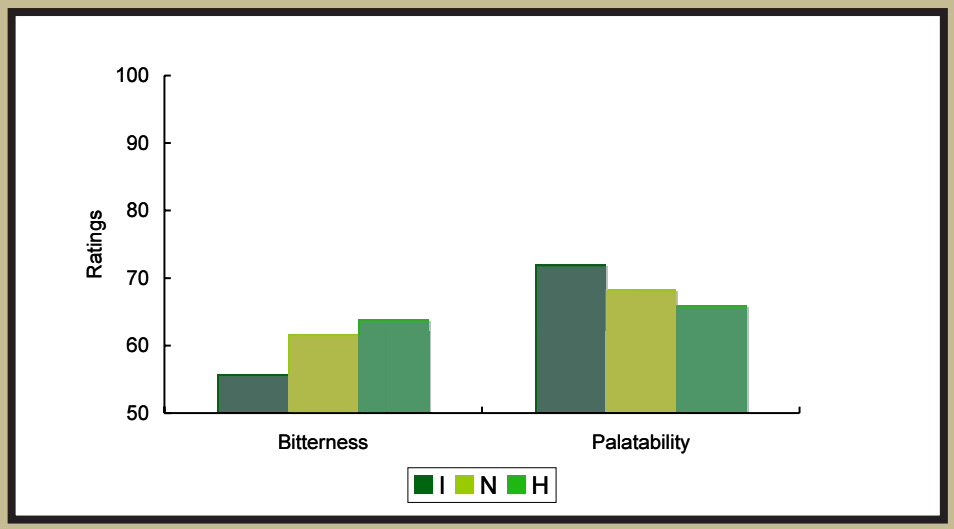

Figure 2. Bitterness and palatability ratings for *Oi Ocha (To)* after watching CMs.

and that palatability ratings for teas after watching *CMi* or *CMn* were higher than those of *CMh* (See Figure 3). There were significant main effects of teas on bitterness and palatability ratings: *Th* was evaluated as more bitter and less palatable than *Ti* and *Th*.

Thus, participants preferred *Namacha* and *Iemon* equally to *Hajime* when they evaluate the teas based on their own taste, but they had a trend

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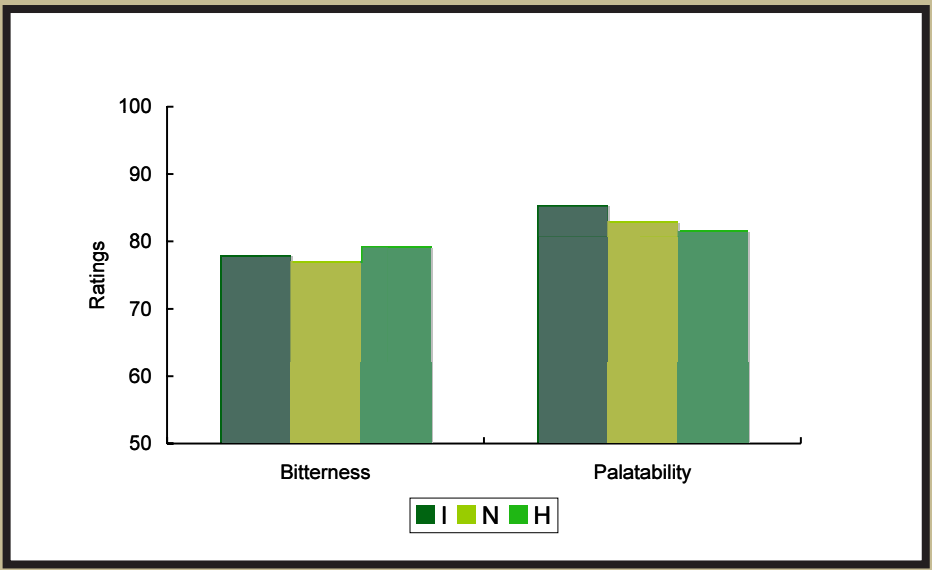

Figure 3. Bitterness and palatability ratings for teas after watching CMs.

to prefer CM of *lemon* to other two brands on their brand images. The sales of *lemon* in a market was better than that of *Namacha* and *Hajime* in the days when the experiments were done (November of 2005), so these results, to an extent, concurred with mass consumer behavior.

Results from these two experiment showed that the brand images evoked by watching CMs affected not only palatability of the tea stimuli that is results of cognitive and integrated information, but also taste intensities that were presumably the product of sensory information from peripheral receptors. Thus, it is suggested that our primary sensory processes, such as bitterness and flavor intensity, are affected by a top-down process of expectations to the brands. This phenomenon can be explained by results of McClure and his colleagues (2004). After watching most preferred CM, participants retrieve positive images for the product from their memories, which adjust sensory processing to match the expectation. As a result of this top-down processing, participants evaluated the stimulus as most preferable. This effect was also accessed in a recent study (Schemer, et al., 2008). In a series of experiments, the authors showed that the product placed in a video program of a rap star was evaluated more positively by participants who regard the rap star positively and explained this phenomenon in a context of evaluative conditioning: the participants' positive emotions evoked by watching favorable the video program were transferred into the images of the products placed in that video program.

There have been several studies reporting that expectation distorts sensory processing of the odor and flavor. Dalton (1996) reported that health-related information about an odor affected habituation for the odor: participants showed long-lasting intensity ratings for the odor described as having a risk for health. Sakai and colleagues also reported that participants who received negative information about the odor showed weak habituation for the odor and evaluated the odor as unpleasant (Sakai, Kobayakawa and Saito, 2004). Their brain responses for the odor, measured with functional MRI, also showed differences from those of positively informed participants (Sakai, et al., 2006). The authors also showed that expectation, developed after seeing pictures, distorted olfactory sensory processing. The participants presented with the odors and with congruent pictures showed stronger responses in intensity and hedonic ratings for the odor than the participants with incongruent pictures (Sakai, et al., 2005). Other studies showed that a word description of a stimulus also affects chemical perception of that stimulus (Distel and Hudson, 2001, Hoegg and Alba, 2007).

These studies showed examples of a proverb "Half a word to a wise man is enough." We can imagine chemical sensations as if we actually experience it, when we see a word or sentences before smelling or tasting it.

There are further studies reporting that expectation has impact on palatability judgments for foods and beverages. Sakai and Morikawa (2006) reported that participants presented with fruit juices and congruent pictures evaluated the juice as more palatable compared with those of participants with incongruent pictures and without pictures. These studies suggest that expectations aroused by description and/or visual images affects sensory perceptual processing of olfaction, taste and flavor. The results of the study reported herein, suggested that expectations evoked by CMs affect the processing of flavor and palatability of Japanese green teas. Considering that CMs include descriptions and visual images about the product, the results reported in this study also support this suggestion.

The precise way in which expectation affects palatability of foods and beverages remains unclear. In an article published by Cardello and Sawyer (1992), expectations for edible film, tropical fruit juice and several kinds of cola distorted palatability to assimilate to the expectation. They called this phenomenon as an assimilation effect, and suggested the assimilation effect as a better concept to explain consumers' evaluation than the other concepts, which were explained later in this article. However, there are several reports in contrast to Cardello and Sawyer (1992). For example, Sakai, Kataoka and Imada (2001) found a positive contrasting effect in palatability evaluation for the beverages presented after being adapted by a positive (more palatable) or negative (less palatable) contextual stimulus (beverages). Recently, DiMarzo, Zoboli, Donnarummma and Artoni (2007) examined the effect of consumer expectations on preference ratings for cheeses, failed to replicate this phenomenon. Although

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continued

they used 16 kinds of "Crescenza" cheese as stimuli, an effect of expectation on their palatability was found only in two of them: an assimilation effect was found in a cheese and a contrast effect was found in another cheese. The contradiction between the results from DiMarzo et al. (2007) and from Cardello and Sawyer (1992) may be caused by the following: Cheeses were very popular with the Italian participants and had strong differences in their flavor and taste, thus the participants could easily discriminate one product from another. Hence, the participants evaluated the products based on their own knowledge, which constitute uncontrollable expectations, independent of the experimental settings. On the other hand, because the stimuli used in the latter study, such as edible film and tropical juice were not familiar to the participants, and some kinds of cola including local brands could not show their clear differences in their taste, participants did not perceive the differences between the stimuli and concentrated on evaluating taste and palatability for the stimuli without their intervening expectations.

The stimuli used in this study have merit to be used to investigate a role of expectation in evaluation of palatability. Bottled green tea is popular in Japan and differences between the brands are not remarkable. Thus, expectation evoked by CMs showed clear effects on palatability of the stimuli. Further study of effects of expectation on palatability of foods and beverages using the behavioral methods reported in this study, may illuminate why and how expectation alters the actual perceived qualities of chemical stimuli, and may shed light on why some commercial messages (CMs) are more effective than others ■

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A review of "The Neurology of Olfaction" Christopher H. Hawkes and Richard L Doty: Cambridge University Press, 2009

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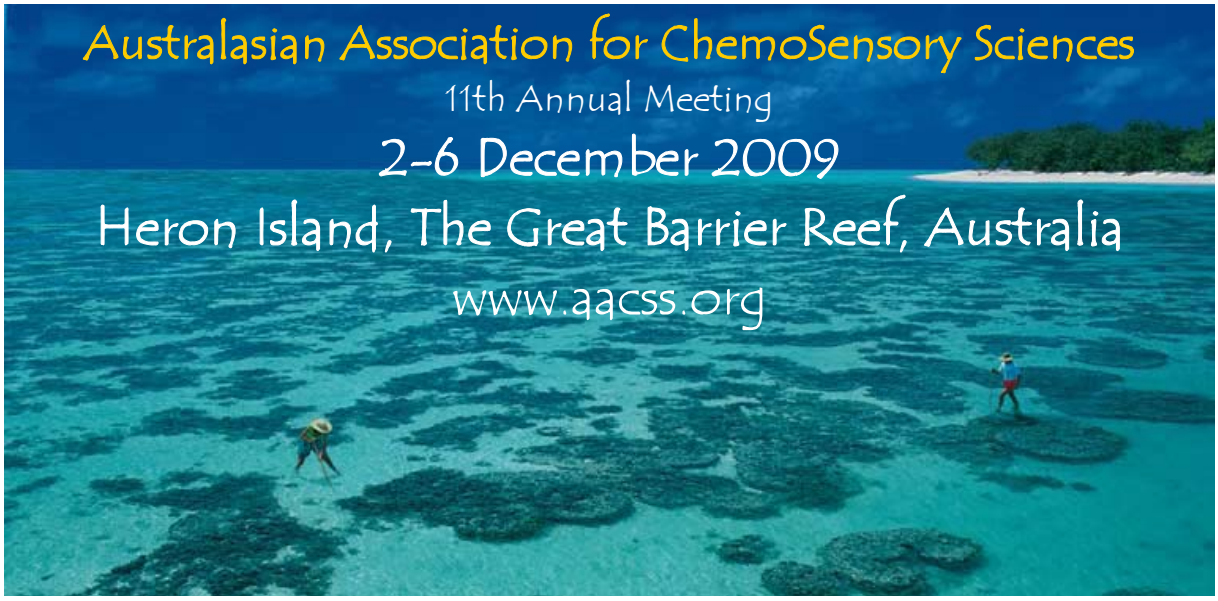
In my over 30 years of clinical practice as a physician, and almost as long as a teacher of medical students, I have often been concerned (and somewhat embarrassed) by how doctors largely ignore both taste and smell. This has always surprised me, as the nose is so much more accessible to the examiner than other less savoury, but often examined nether parts. Indeed, with respect to olfactory function, our physical examination is rather reminiscent of the description of Exeter in the 14th Century "when you draw close to the city you will see the great gatehouse... the high circling walls ... the great round towers... the immense cathedral ... and then you notice the smell."![1]

As such, I found the recently-published *The Neurology of Olfaction* by Christopher Hawkes and Richard Doty challenging, and extremely useful. The 43 page chapter on *Clinical Evaluation* increased my knowledge exponentially, and I intend to regularly quote the authors (with due credit) in my clinical tutorials.

However, what I personally found most fascinating was the detailed discussion of *Neurogenic Diseases that Affect Olfaction*: as a geriatrician, I spend much of my time trying to accurately diagnose and treat extremely common conditions, such as Dementia and Parkinson's Disease, and am only too aware of our deficiencies in this regard. There is ample evidence, for example, showing that busy General Practitioners under-diagnose dementia clinically, and despite advances in radiological scanning, and neuropsychological testing, geriatricians would agree that we diagnose affected people too late and too infrequently. Moreover, even the most experienced clinician is seriously challenged by the 'crossover" syndromes where Parkinson's and dementia co-exist in the same patient. Both are common in older people, but there is both diagnostic and therapeutic relevance in defining specific variants of the spectrum, such as Dementia with Lowy Bodies and Progressive Supranuclear Palsy, and differentiating people so affected from others in whom the two conditions exist coincidentally. This is not easy with the tools available, and I found it extremely hopeful to learn that in uncomplicated Parkinson's Disease, normal olfaction should be found on testing, and abnormal findings should prompt a search for an alternate diagnosis.

Clearly research and experience in this field is only just starting. The nasal passages, and the olfactory area of the brain lie close to the exterior, and at present one can only speculate as to how detailed olfactory assessment could contribute to clinical medicine and research. "Smell is a potent wizard that transports you across thousands of miles and all the years you have lived" said the famous Helen Keller. After reading this excellent book, one can only agree with her ■

[1] From *Thee Lonlie Plannete. The Time Travellers Guide to Mediaeval England: A Handbook for Visitors to the 14th Century* by Ian Mortimer. Literary Review, November 2008, p 24.



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19-25 July 2009	**Summer School on Human Olfaction** Dresden, Germany Registration deadline: 1 May 2009 Contact: thummel@mail.zih.tu-dresden.de Also: www.tu-dresden.de
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6-9 September 2009	**19th CASANZ Conference** "Air Quality and Economic Development" Perth Convention Centre Perth, Western Australia Contact: www.iceaustralia.com/casanz2009
2-6 December 2009	**Australasian Association for ChemoSensory Science (AACSS)** Annual Scientific Meeting Heron Island, Great Barrier Reef, Australia Contact: j.stjohn@griffith.edu.au

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