PERFUMERY

The psychology and biology of fragrance

EDITED BY

Steve Van Toller and George H. Dodd

SPRINGER-SCIENCE+BUSINESS MEDIA, B.V.

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The cover illustration shows the Mensing colour/fragrance rosette used for testing perfume preference (discussed in Chapter 10).

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Contents

Colour plates appear between pages 144–145

Contributors x

Preface xii

Acknowledgements xvi

Foreword: Abnormalities of smell xvii
E. Douek

PART I THE BIOLOGICAL UNDERPINNINGS OF SCENTS

1 Human odour culture: a zoological perspective 3
D. M. Stoddart
1.1 Introduction 3
1.2 Man: the scented ape 4
1.3 Ecological and behavioural background to the evolution of modern man 5
1.4 Incense and perfume 12
1.5 The nose and emotion 15
1.6 Conclusion 16

2 The molecular dimension in perfumery 19
G. H. Dodd
2.1 Molecules and perfumes 19
2.2 Perfumery and the psychology of art 19
2.3 Perfumes and sensory processing 20
2.4 Perfumery and allied crafts 22
2.5 Perfume molecules 23
2.6 Perfume oils and aromatherapy 27
2.7 Synthetic odorants and the psychological frontiers of perfumery 30
2.8 Receptor events in perfumery 38
2.9 Conclusion 45

3 The significance of odorous steroids in axillary odour 47
D. B. Gower, A. Nixon and A. I. Mallet
3.1 Introduction 47
3.2 The human axilla 47
3.3 The apocrine glands 49
3.4 Composition of apocrine secretions 50
3.5 Microbiology of the axilla and its relationship to axillary odour 51
3.6 Odorous steroids present in apocrine sweat 54
3.7 Formation of odorous substances in the human axilla 60
3.8 Odour of 16-androstenes: psychology and significance 63
3.9 Sensitivity to musk odours 67
3.10 Psychological experiments using odorous steroids 68
3.11 Pheromonal aspects of odorous 16-androstenes in the pig 72
3.12 Mechanisms of perception of odorous steroids 73
3.13 Conclusion: perspectives for future studies 75

PART II DEVELOPMENTAL AND SOCIAL ASPECTS OF FRAGRANCE

4 The acquisition of odour hedonics 79
T. Engen
4.1 Introduction 79
4.2 Physiological and behavioural responses of prelingual infants 80
4.3 Related animal research 83
4.4 Postlingual children 84
4.5 Children's vocabulary for hedonic properties 89
4.6 Conclusion 90

5 Perfume as a tactic of impression management in social and organizational settings 91
R. A. Baron
5.1 Introduction 91
5.2 The impact of perfumes on first impressions 93
5.3 The impact of perfume during employment interviews 96
5.4 The 'sweet smell of success'? Sex of applicant and interviewer and perfume as determinants of ratings in simulated interviews 96
5.5 'Too much of a good thing'? Effects of scent and non-verbal cues on evaluations of job applicants 99
5.6 General discussion 103

PART III ODOUR PERCEPTION AND THE LANGUAGE OF THE BRAIN

6 Contingent negative variation (CNV) and the psychological effects of odour 107
S. Torii, H. Fukuda, H. Kanemoto, R. Miyanchi, Y. Hamauzu and M. Kawasaki
6.1 Introduction 107
6.2 The experiments 108
6.3 CNV amplitudes at different sites on the scalp 110
6.4 Effects of odours on CNV 112
6.5 Conclusion 118

7 Emotion and the brain 121
S. Van Toller
7.1 Introduction: *Homo sapiens*, the microsomatic smeller 121
7.2 The sense of smell 123
7.3 Emotion 124
7.4 The biosocial theory of emotion 127
7.5 Emotion and olfaction 130
7.6 Psychophysiology 132
7.7 Brain-evoked potentials 134
7.8 Brain electrical activity mapping 139
7.9 Conclusion 140

PART IV FRAGRANCE THERAPIES

8 Anxiety reduction using fragrances 147
J. R. King
8.1 Introduction 147
8.2 Stress: the vicious circle 148
8.3 Relaxation training 149
8.4 Problems with traditional relaxation techniques 152
8.5 Enhanced relaxation therapy: key features 152
8.6 Action of fragrance: a closer look 153
8.7 Odours and disease 156
8.8 Use of fragrance alone 157
8.9 Construction of the fragrance 158
8.10 Further refinements 161
8.11 Role of fragrance in enhanced relaxation: verification 162
8.12 Applications of enhanced relaxation therapy 164
8.13 Wider applicability 165

9 Essential oils as psychotherapeutic agents 167
R. Tisserand
9.1 Historical background 167
9.2 Twentieth-century aromatherapy 169
9.3 Effects of essential oils on emotional states 175
9.4 Concepts of mood evocation with essential oils 177
9.5 Conclusion 180

PART V THE CONSUMER AND PERFUME

10 The psychology of fragrance selection 185
J. Mensing and C. Beck
10.1 Is selection of a perfume a matter of chance? 185
10.2 The subjective experience 191
10.3 The desired life-style 191
10.4 Sociobiographical data and climatic factors 192
10.5 The Colour-Rosette Test 193
10.6 Trends in perfumery from a sociological point of view 195
10.7 A few basics about trends 195
10.8 Characteristic traits of a trend 196
10.9 Life cycles of aesthetic trends 197
10.10 Change of self-perception: the main perfume trends in recent years 199
10.11 The new world of fantasy and what it offers 200
10.12 The 'fun-type' 201
10.13 Magic fantasy: the view into the past 202

11 Perfume, people, perceptions and products 205
J. Byrne-Quinn
11.1 Introduction 205
11.2 Smell marks people 205
11.3 Smell marks brands 207
11.4 People do differ 208
11.5 Perception differences 211
11.6 Difficulty of explaining responses to perfume 214
11.7 Conclusion 215

12 Selling perfume: a technique or an art? 217
S. Le Norcy
12.1 Introduction 217
12.2 Selling a perfume 218

12.3 Training a perfume sales assistant 220
12.4 The customer's attitude 223
12.5 Conclusion 225

13 Fragrance education and the psychology of smell 227
A. Green
13.1 Introduction 227
13.2 The Fragrance Foundation 227
13.3 Fragrance education 228
13.4 Future developments in the fragrance field 230
13.5 Conclusion 232

References 235

Author Index 257

Subject Index 263

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Preface

THE SENSE OF SMELL

The nose is normally mistakenly assumed to be the organ of smell reception. It is not. The primary function of the nose is to regulate the temperature and humidity of inspired air, thereby protecting the delicate linings of the lungs. This is achieved by the breathed air passing through narrow passageways formed by three nasal turbinates in each nostril. The turbinates are covered by spongy vascular cells which can expand or contract to open or close the nasal pathways.

The olfactory receptors, innervated by the 1st cranial nerve, are located at the top of the nose. There are about 50 million smell receptors in the human olfactory epithelia, the total size of which, in humans, is about that of a small postage stamp, with half being at the top of the left and half at the top of the right nostril. The receptive surfaces of olfactory cells are ciliated and extend into a covering layer of mucus. There is a constant turnover of olfactory cells. Their average active life has been estimated to be about 28 days.

A major neurological feature of the sense of smell is the large number of receptor cells that converge upon a relatively small number of secondary cells, located in the olfactory bulbs which lie on the under surface of the brain. This convergence indicates that the sense has evolved in terms of sensitivity. It has been calculated that as few as seven or eight molecules striking an olfactory cell will produce a nerve impulse with about forty nerve cells needing to be stimulated before a smell sensation is reported. There have been numerous theories of olfaction, but all have failed to explain how we detect smells. A detailed account of olfactory processes can be found in the first chapter of *Ageing and the Sense of Smell* (Van Toller, Dodd and Billing, 1985).

In addition to smell receptors, the nose of humans contains another system, a touch system, which is often mistakenly assumed to be part of the sense of smell. This second system is the trigeminal system and it is part of the extensive 5th cranial nerve. Somatosensory or touch nerves detect pungent substances, such as ammonia, carbon dioxide and acetic acid. The

chemosensory system is best illustrated by the protecting head-averting reflex when a pungent substance, such as household ammonia, is inhaled.

THE PERFUME INDUSTRY

Perfumers have a low public profile. Whereas most people meet physicians, plumbers or bank managers, they will probably never meet a perfumer. Indeed, few of the enthusiastic readers of fashion magazines could name a perfumer. Perfumers learn their craft by joining manufacturing companies as apprentices. Perfumery is not encountered as a university course of study and, at present, there is very little communication between the perfume industry and the academic world. It is for this reason that we intend to have courses at the University of Warwick, designed to introduce people in the perfume industry to the sense of smell.

Human interest in pleasant smells is ancient. Aristotle noted the aesthetic aspect of the smell sense by pointing out that it could be pleasurable even when the source neither protected nor nourished. In addition, Aristotle argued that pleasant smells could contribute to the well-being of humans. Later, the Roman poet Lucretius wrote that pleasant smell particles were smooth and round whilst unpleasant smell particles were barbed and prickly and invaded the senses by intrusive actions.

The study of perfumery is a multidisciplinary activity which overlaps the molecular sciences – chemistry, plant biochemistry, biotechnology, with the humanistic fields – literature, advertising, fashion and aesthetics. The immensely successful and growing perfume industry has not, apparently, hitherto felt the need to examine the psychological phenomena underlying the effects of fragrance.

If we turn to consider the related pharmaceutical industry we find that it has evolved much more rapidly this century. Up until the end of the last century, there were many similarities between the activities of pharmacy and perfumery. Both chiefly used plant extracts and pharmacists formulated simple perfumes. Advances in biochemistry during this century have revolutionized our understanding of the ways in which drugs work. Unlike the perfumery field we find that academic study of pharmacology works in close conjunction with the pharmaceutical industry. It is not unusual to find a pharmacology department in a university taking the initiative and organizing a meeting on new areas of drug action.

THE PSYCHOLOGY OF PERFUMERY

Although an important book on the psychology of perfumery was published

in 1951 (Jellinek, 1951), until the conference held at the University of Warwick in 1986 there has previously never been a joint meeting of the industrial and academic disciplines relating to the sense of smell. Each year brings the launchings of many new perfumes; the respective national perfumery societies hold meetings; conferences on the sense of smell take place. These events involve the exchange of important knowledge relating to perfumes but the information remains largely isolated.

The Warwick Olfaction Research Group is unusual in that it is led by two people, one of whom is a practising perfumer with an understanding of what it means to be asked to create a perfume, and the other a psychologist with an expertise in the area of emotion. Our interaction (Dodd and Van Toller, 1983) was a potent stimulus to hold the First International Conference on the Psychology of Perfumery. The main purpose of the meeting was to see if there was a framework that would knit the area together into a coherent set of ideas and also to give new perspectives to the study of perfumes. We invited speakers from all areas of the discipline. Thus, the meeting brought together people from the fragrance industry, academics and aromatherapists into a forum for debate. Besides the scientific basis of smell and perfumery, other important topics, including the important one of educating the general public about olfaction and perfume, were discussed. Hopefully, the meeting brought fresh perspectives to current issues in perfumery. Following our meeting, Annette Green of the Fragrance Foundation in New York, coined the word 'Aromacology' to identify this new area.

PLAN OF THE BOOK

Anyone interested in the sense of smell must have some knowledge of the abnormalities of the sense and this important aspect is discussed by Douek in the foreword. The book is divided into five sections, each having an important bearing on any discussion concerning perfume and fragrances.

Part I relates to biological underpinnings. Stoddart, bringing a zoological perspective to the problem, presents *Homo sapiens* as the scented ape and suggests certain biosocial reasons for the use of perfumes in the female of the species. Dodd, a biochemist and perfumer, discusses the aromatic molecules and analyses their chemical, physiological and aesthetic roles in human behaviour. He also questions the basic tenets of the aromatherapists. Gower and his colleagues review and present new, fascinating findings about the role of the odorous steroids produced by the apocrine glands, which are located in certain areas of the skin.

Part II deals with the important developmental and social aspects of fragrances. Engen reviews earlier studies on how babies react to odours and points to the paramount importance of the learning processes in human

reaction to an odour. Baron has carried out a number of experiments on how a perfume wearer is perceived. He concludes that perfume can be used as a tactic of impression management, so long as a series of cautions is taken into account.

Part III is concerned with the electrical activity of the brain during odour perception. Torii and his colleagues present a series of studies that involve the measurement of the DC voltage activity of the brain during the smelling of odours. They report both psychological and electrical changes of the brain in response to odours. Van Toller discusses the similarities between emotion and the sense of smell before reporting two new techniques involving AC electrical activity of the brain.

Part IV concerns two authors from widely differing backgrounds who are, nevertheless, both interested in the role of fragrances in inducing mood and relaxation states. King, who is a psychiatrist, uses odours to help reduce stress in his patients. He analyses the precise role of the sea-shore or woodland fragrances used in his therapy techniques. Tisserand presents an historical and a contemporary account relating to the use of aromatic essential oils in aromatherapy.

The fifth and final section contains four chapters by authors who all deal with the perfume consumer. Mensing and Beck describe their personality test using a coloured rosette, which has a value for indicating the type of perfume the testee is likely to favour. Byrne-Quinn works in the fragrance industry and her job is to understand how a product's odour is perceived by customers of Quest International. She reports that it is possible to classify consumers into odour-perception types. Le Norcy, in the penultimate chapter, takes us to the perfume counter and discusses problems relating to the sale of perfume and the training of the perfume sales assistant. As Le Norcy points out, the selling of a perfume involves a complex interaction between the consumer and the representative of the perfume house. The final chapter, by Green, discusses the important role played by the Fragrance Foundation in educating public awareness of fragrance and perfume. The industry is moving away from the 'mysterious' to a more enlightened position, concerned with educating the public about the forgotten sense of smell.

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Finally, the Second International Conference on the Psychology of Perfumery will be held at the University of Warwick in July, 1991.

Foreword
Abnormalities of smell

E. DOUEK

When studying perception, it is always interesting to consider the abnormal. Observing what happens when things go wrong offers a new insight into forms which otherwise may be taken for granted. Deafness clearly defines the place that hearing has in human development, together with the function that sound has in communication and the elaboration of language and, more subtly, whether the higher concepts of human understanding that seem to depend on language can be found if hearing and language are absent.

The sense of smell, and therefore of taste and flavour, also invokes a system of communication. This sense has not been developed in humans to the point of a language or transduced to writing, it has therefore been more difficult to describe and define. Nevertheless, we are aware of its presence and uncertain role, and we therefore experience a certain unease when considering its possible influence. Newspapers abound with entertaining pieces on animal pheromones and their possible presence in humans. Behind it all is our sexual anxiety: is there a means of enhancing our attractiveness, and our influence, surreptitiously? Put very crudely in reproductive terms, 'can I aspire to the greatest choice in selecting the genes with which to mingle my own in the creation of my descendants?' Or in terms of power, 'could I become so irresistible that people will do what I want them to?'

The possible ways to a wide sexual choice and economic social power are documented in practically every history or novel ever written and humanity does not cease to reflect upon them, from beauty and techniques for its enhancement to intelligence and how it can be trained. Smell retains a mysterious element because its place is uncertain anyway, and because it offers tantalizing possibilities of a pathway which shortcuts beauty, intelligence, training and money. In this way, it lies closer to magic and its potions than to other aspects of human endeavour. More recently, it has been brought into psychological terminology – 'bonding' between mother and

baby, 'territorial marking', aggression, and so on. We should not forget that knowledge of psychology is often felt to represent the exercise of an 'underhand' power as it gives a technique for understanding, predicting and therefore countering other people's behaviour.

What, then, can abnormalities of smell teach us? The main problem that we come across is a decrease in the ability to smell. When it is total, it is referred to as anosmia but unfortunately the term is often extended to refer to any type of loss, even when it is partial. Clinically this is a serious mistake as the prognoses are totally different. Patients suffering from anosmia rarely get better, but when there is a diminution only, a high proportion have a chance of improvement, especially with treatment.

The causes of total anosmia fall into two main categories. The first is head injury and is probably the most common. In my experience road traffic accidents produce most cases and these are often associated with other neurological deficits, but from time to time we see other injuries such as those sustained in muggings or people who have slipped and fallen. The obvious injury is a blow to the forehead or face but not infrequently the patient has fallen on the back of the head producing a 'contre-coup' effect with the brain displaced from back to front. This displacement may tear the fine nerve fibres as they pass to the olfactory bulb.

The second main cause of anosmia seems to be a viral infection – *seems* because we have not isolated a specific virus on the one hand, and there is on the other a tendency to attribute all diseases of unknown aetiology to 'viruses'. In some ways, it is similar to possession by demons in medieval times and we could make a case for the virus as a 'demon'. However, in favour of an infective cause is the fact that patients describe an influenza-like illness with some fever, malaise and nasal obstruction during which the sense of smell disappears. At first they are not alarmed as they expect not to be able to smell properly in the circumstances. It is only when the illness improves and the nasal obstruction is cleared that they realize that olfaction does not return. There is one typical and specific system in such cases. Patients perceive from time to time a fleeting whiff of smell, but it is very brief and the sensation they experience although olfactory is the same whatever the actual smell. It is a single, non-discriminating response and invariably carries a bad prognosis. I have never seen anyone recover.

Complete anosmia results in serious problems. There is always an element of depression and this can often become severe and intractable. Patients will describe the world as dull and colourless, and it is difficult to decide whether this is simply a common feature of clinical depression or whether it is the direct, real effect of the loss of so many sensations. Perhaps there is no real dividing line between the one and the other?

To many patients the inability to taste food has been the major loss. A few who have managed to overcome their despondency have tried to devise

foodstuffs which produce some interest despite loss of flavour, but this has never been properly exploited. It is worth discussing in some detail possible further development. First, we should consider what residual experiences survive:

1. Taste for salt, sweet, sour and bitter.
2. Perception of burning such as that obtained from chilli, pepper or curry powder.
3. Perception of texture such as identifying differences between thick and thin sauces and recognition of what textures and surfaces are agreeable.
4. Vision, so that attractive preparations can arouse interest.
5. Audition, identifying the difference between crackly and soft sounds.

This, then, allows the possibility of elaborate permutations, and although there is no way in which the loss of flavour can be replaced, it does offer some chance of a greater interest in food. I should add, in this context, that there is a small group of patients who have lost the sense of smell completely, yet do not complain. All I can say is that perhaps these had in common a certain familiarity with repetitive and uninteresting food even before their injury.

I have two patients who appear never to have had a sense of smell. They are probably congenital anosmiaics; they were certainly not bothered by it, only curious about their missing sense.

When patients have a partial loss of smell which we should properly call hyposmia, or when the sense of smell comes and goes, the prognosis is totally different. Generally speaking, it is good because it suggests that the olfactory organ is normal and there is present some obstruction such as mucus or swelling. Surgery is sometimes helpful, but the main form of treatment is topical, intranasal steroids. Quite remarkable successes have been achieved by a combination of both with resulting exhilaration in the patient. One somewhat sophisticated woman of scientific bent described the wonderful sensation of the return of smell as being like 'making love again after a long interval'. This rather imaginative declaration from an articulate woman has certain implications regarding the emotional levels at which olfaction operates. One can only with difficulty imagine such a statement made when someone recovers the ability to see or hear. Certainly I have never come across this association following a successful operation for deafness.

A relatively common abnormality is the illusion or hallucination of smell. The term parosmia has been broadly associated with this symptom. In the most common category it is associated with loss of smell, often after head injury. The sensation consists almost invariably of a bad smell which is usually difficult to describe, but similar to that of drains or faecal matter. These poor people are not only deprived of their sense of smell, but have to experience these unpleasant sensations as well.

A second group of patients is more difficult to define. They have no loss of

smell, but they do have frequent experiences of a bad smell. This tends to be faint and not dramatic, but causes a good deal of concern. The personalities of these people have characteristics in common: they are shy and withdrawn and a subgroup feels that the unpleasant odour emanates from themselves. Here there are obvious associated problems and in rare cases the olfactory hallucination is associated with paranoid feelings. These generally do not develop into anything more florid. It is said that Louis IX, King of France, suffered from this complaint, and his skills in countering real or imagined plots gave him a reputation for cunning. The countermeasures he took could easily be looked upon as those of a paranoiac, but there is no doubt that as a king in those unstable times he was rather successful.

A third group of patients suffers from hallucinations of smell. In those cases there is an association with temporal lobe epilepsy and the olfactory sensation may be part of the aura which precedes the fit or, in rare cases, may represent the fit itself. The smell then is most often one of burning, but in view of these cases it is best to consider this possibility whenever a patient complains of parosmia.

Very occasionally we find people who complain of hyperosmia, or say that they are so susceptible to smells that it is indeed a disease. There are never any clinical findings and it is difficult to find an explanation. By analogy, it is not possible to see too well or to hear too well although excessive sensitivity to light occurs, and people with a cochlear type of hearing loss do suffer from over-sensitivity to loud sounds and distortion. The meaning of hyperosmia remains obscure.

Occasionally we see a patient where an olfactory sensation produces a sense of *déjà vu* or of true recall. This does not necessarily imply serious neurological disease and in some ways it may be a not unpleasant aspect of life. There is Marcel Proust's experience of how the smell/taste of a Madeleine biscuit dipped into tea began his recall, years later, of the summers of childhood spent at his aunt's house in the country, and ultimately inspired the writing of his great seven-part novel.

Abnormalities of smell are common and the sensations experienced often bizarre. Patients will describe them in detail and may become obsessed with the strange nature of the sensations they experience. In practice, these descriptions do not help much with diagnosis. In the end, we find that we must exclude serious lesions, such as intracranial tumours, but that after this we have to divide cases into those that will get better and those that will not. We are still looking for a clinical electro-physiological test to investigate the neuronal patterns, and we are always searching for better means of quantifying the abnormalities complained of.

PART I

The biological underpinnings of scents

1

Human odour culture: a zoological perspective

D. M. STODDART

1.1 INTRODUCTION

It has become fashionable in recent years to argue that the dichotomy between man and the animals is unreal, that man and the animals are both products of unifying processes of nature and all aspects of their biology are interpretable according to a small number of common theories. This is all to the good, but it should not blind us to such differences as do exist. Principal among these is that socially relevant instructions in animals are passed from generation to generation at the genetic level, while among humans social action is governed by culturally transmitted ideas and notions of how things ought to be done. Animal culture is not a strict parallel of human culture, though it shares the same social environment.

Comparative zoology received a considerable shot in the arm a decade and more ago when the theory of sociobiology was developed by Wilson (1975). Animal behaviour had by this time become the subject of respectable study and was used to help explain many mysteries of evolution. Behaviour was seen to be adaptive in an evolutionary sense, even if it resulted in such phenomena as infanticide and genocide. Sociobiology gained some notoriety when adherents of extreme political views tried to pervert the sound scientific arguments to their ends and show that extreme behaviour may be justified by the genes. Thankfully this era is now over, though the zoological community is more wary than before of arguing that the behaviour of modern-day humans and non-human animals is fashioned in the same way. That notwithstanding, the methods of comparative zoology have much to teach us about the *possible* evolution of some human behavioural traits. I believe that the use by humans of incense and perfumes is one such trait and that many of the enigmas inherent in our odour culture can be resolved by comparative zoological study. In this chapter I enquire why the human olfactory sense

should not have been the subject of culturally induced social gratification to the same extent as the visual and acoustic senses, and whether the repressed olfactory sense of modern man might have arisen in response to certain changes in the social environment of man's early ancestors.

1.2 MAN: THE SCENTED APE

In his review of the structure of the skin of non-human primates Montague (1972) states: 'one of the characteristics of human skin is the apparent useless abundance of sebaceous glands. Among the non-human primates we have studied, only the lemurs have as many sebaceous glands as man.' Sebaceous glands of the apocrine type are associated with hair follicles, and occur densely in humans in a few clearly marked anatomical sites. These are listed by Baker (1974) as primarily the axillae, the circumanal region, the anogenital region (scrotum and root of the penis in the male and labia majora and mons veneris in the female), around the nipples, on the skin of the chest and of the abdomen – both above and below the navel in Negroes – and on the face in front of the ear in Australids. Baker notes that apocrine scent glands are weakly developed in Mongolids to such an extent that the Korean Huanghoids may be regarded as having no axillary organ at all. Comparison of Caucasian man, at least, with gorillas and chimpanzees indicates a high level of similarity, despite man's relatively hairless body. All three anthropoids have well-developed axillary organs. A full discussion of sweat glands and their secretions is presented by Gower, Nixon and Mallet in Chapter 3.

From the point of view of the comparative zoologist, the species *Homo sapiens* exhibits many of the characteristics one would expect to find in a species which has an active olfactory communication system, namely the presence of dense aggregations of specialized scent-producing apocrine glands, and the retention of tufts of hair around those aggregations. In the social behaviour of modern man there is evidence of an enigmatic umbra surrounding man's olfactory world. Humans are acutely aware of body odour, removing it with lavish enthusiasm and high frequency. To refer to another's body odour in public – or indeed one's own body odour – is socially unacceptable; it is a behaviour which civilization has outgrown and outlawed. Yet there is abundant evidence that humans have a deep-felt need to smell of something, and to perceive an odour emanating from others – as long as the odour is not that of humans! Perfumes, after-shaves, toilet-waters and such concoctions contain a blend of fragrances of plant and animal origin. A striking feature about these mixtures, as was noted by Havelock Ellis half a century ago (1936), is that the perfumes of flowers, as well as the coveted animal products musk, civet and castoreum, are odours of a sexual

character. Daly and White, writing in 1930, noted that the functional significance of perfume may not be for the purposes of disguising or masking natural body odour, as is widely thought, but to heighten and fortify natural odour. As Pratt (1942) later put it, perfumes 'unconsciously reveal what consciously they aim to hide'.

The notion expressed by both Daly and White (1930) and Pratt (1942) is that any involvement of smell in human sexual biology is sufficiently repressed such that sexual odours can be used in perfumes without fear that they will elicit sexual behaviour. For this to be so, the human sense of smell must have undergone some radical changes during man's evolution, the most radical of all being the repression of its sensitivity to and recognition of sexual odours. I wish to examine this hypothesis in an attempt to identify whether there are ecological and behavioural reasons which might have led to olfactory repression.

1.3 ECOLOGICAL AND BEHAVIOURAL BACKGROUND TO THE EVOLUTION OF MODERN MAN

Unfortunately we have no certain way of knowing how man's ancestors organized their social lives. It is only by analogy with extant relatives – gibbons, orang-utans, gorillas and chimpanzees – that we can make intelligent guesses about whether these creatures lived in small family-based groups, or whether they lived in large, gregarious masses. A number of comparative features suggest that man's ancestors lived in small groups based around the family, as do present-day gibbons, orang-utans and gorillas. But at some point in the past – the precise timing is not crucial – man's ancestors became gregarious. The evolutionary pressure for this was most likely the drying of the equatorial regions of the earth during the Miocene period which was associated with the fragmentation of the once extensive forests leading to the development of grasslands. With the grasslands came the evolution of the large herbivorous ungulates. The only way in which man's ancestors could hunt and kill these large beasts was to operate collectively, a procedure which necessitated collective living. There are two main reasons why animals adopt a gregarious life-style. First, gregariousness provides protection against predators, and secondly, it allows for more efficient and effective resource exploitation. Although there are elements of both in all examples of gregariousness, it is reasonable to assume that the second, more than the first, applied to man's ancestors.

Before becoming gregarious, man's ancestors probably lived in family-based groups consisting of one adult male, one or a few adult females and their dependent young. The mating system adopted would have been monogamous, or at least sequentially polygynous (Short, 1980). Under such

conditions there would have been no strong selective pressure for the evolution of obvious oestrus advertising signals in the females, for the bonded mate of any female would always be close at hand and so not overlook the heat. Chance (1962) and others have remarked that under conditions of non-advertisement of female sexual status male reproductive success is best served by him maintaining close contact with his female(s) so as to be able to respond to subtle signals advertising oestrus. Among man's extant near-relatives only chimpanzees have evolved a markedly different mating strategy. In these gregarious apes there is no long-term pair bonding and females mate promiscuously (Short, 1977). Oestrus is advertised by a dramatic swelling of the anogenital region and by the development of white 'necklace' patches on the chest. It is understandable that a species which forms no pair bonds is best served by a pronounced advertisement of sexual status.

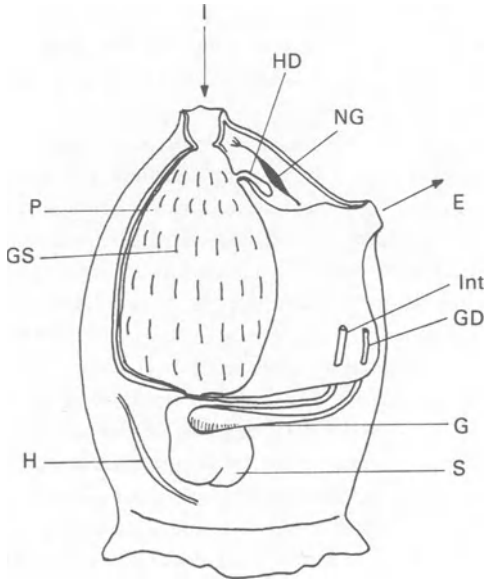

Fig. 1.1 Diagram of sea-squirt (after Grassé) showing position of hypophyseal duct with nerve ganglion.

I	inhalent siphon	G	gonad
E	exhalent siphon	S	stomach
HD	hypophyseal duct	H	heart
NG	nerve ganglion	P	pharynx
Int	intestine	GS	gill slits
GD	genital duct		

Modern man, then, is a product of an evolutionary process which saw his ancestors descend from the trees in small family groups and start aggregating in large assemblages to hunt prey on the grassy plains. But unlike the gregarious chimpanzees, modern man and his immediate ancestors are monogamous, or sequentially polygynous, thus preserving the family structure within the large crowd. For this reason, there has been little evolutionary pressure for the development of an overt visual oestrus advertisement. But anthropologists without a clear understanding of the role of odour in mammalian reproduction may have overlooked the likelihood of the existence of olfactory cues advertising sexual status in their consideration of the evolution of man's unique sexual biology. To develop this notion further it is necessary to consider some fundamental facts about sexual reproduction.

Studies of comparative zoology reveal that synchronous reproductive activity is found in many species of animal and that this synchrony is controlled by the release of advertisement cues by one organism which are taken up by another. Mostly, and exclusively among the lower animals, these cues are chemical. Thus the insignificant little sea-squirt – a creature beloved by comparative anatomists because of its phylogenetic relationships with the primitive vertebrates – will upon taking the sexual products of another individual into its pharynx in its feeding current, almost immediately respond by releasing its own sexual products into its exhalent current. Over three decades ago Carlisle (1951) showed that the neighbour's sexual products were identified as such by a structure at the side of the pharynx called the ciliated pit or hypophyseal duct (Fig. 1.1), which enlarged when thus stimulated and in so doing induced the nerve ganglion to fire the neural message to the gonads to release their charge. The action of this organ is broadly similar to that of the mammalian hypothalamopituitary region. As long ago as 1914 Wordemann showed in an elegant series of histological preparations that the anterior part of the pituitary organ of the lamprey – a primitive, jawless fish – arose from the same embryonic patch of ectoderm as the olfactory organ. In his authoritative monograph on the biology of lampreys and hagfishes, Hardisty (1979) examines the evidence of comparative anatomy and concludes that the close association between the pituitary and the olfactory organ may have meant that the function of the early precursor of the pituitary organ in animals may have been to detect the state of sexual ripeness in another, and to respond by secreting hormones to effect liberation of the gametes.

The naso-hypothalamopituitary-gonadal axis has long been recognized as a feature of mammalian biology. A number of congenital sexual defects in humans linked to olfactory system defects have been recognized since the time of Aristotle (Bieber, 1959; Males, Townsend and Schneider, 1973). Careful neurobiological research has revealed the pathways which comprise

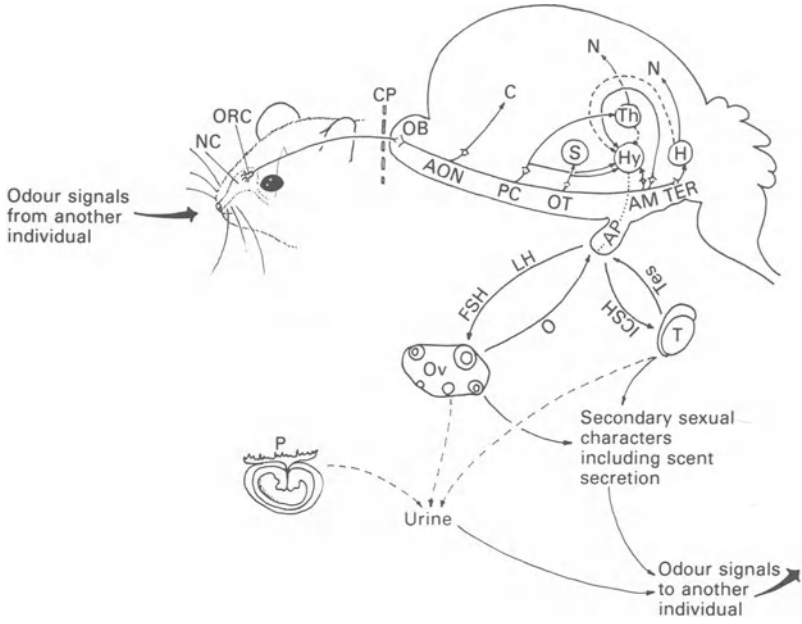

Fig. 1.2 Schematic representation of the major components of the naso-hypothalmopituitary-gonadal axis in a mammal.

AON	anterior olfactory nucleus	regions of olfactory cortex
PC	pyriform cortex	
OT	olfactory tubercle	
AM	amygdala	
TER	transitional entorhinal cortex	
CP	cribriform plate	
OB	olfactory bulb	
ORC	olfactory receptor cell	
NC	nasal cavity	
S	septal region	
Hy	hypothalamus	
H	hippocampus	
Th	thalamus	
N	neocortex	
C	central limbic system structures	
AP	anterior lobe of pituitary	
O	ovary	
T	testis	
P	placenta	
FSH	follicle stimulating hormone	

the axis, and these are shown schematically in Fig. 1.2. The hypothalamic region is a major receiver of olfactory neurones, and releases a variety of releasing hormones which pass to the anterior pituitary via the hypophyseal portal system and induce the pituitary to secrete the suite of hormones which governs and controls the mammalian sexual cycles. The great biologist J. B. S. Haldane noted that pheromones had steroidal structures, and suggested that the hormonal system of internal bodily messengers may have originated from the pheromonal system of external messengers (Shepherd, 1983). This suggestion appears not to have been examined further.

There is an abundance of experimental evidence indicating the fundamental role of odours and olfactory communication in the sexual biology of mammals. Studies performed on a wide range of mammalian orders, from insectivores to artiodactyls, indicate a greater or lesser reliance on scent cues. In the primates, Curtis and his colleagues (1971) noted the interest shown by male rhesus monkeys in the vaginal secretions of females, and introduced the term 'copulins' to refer to the active ingredients. These were various fatty acids produced by bacterial decay of pure vaginal secretions and their balance was controlled by the female's level of circulating oestrogens. Rodents rely quite heavily on odour cues, and Bronson (1976) has constructed a comprehensive overview of the pheromonal cueing system in the laboratory mouse. In many studies, including those on laboratory mice, the chemical nature of the active ingredient remains elusive, but in the pig, derivatives of the steroid sex hormones provide the activity. The odour of the testosterone metabolite 5α-androstenol initiates mating behaviour (Hafez and Signoret, 1969), and further primes the reproductive system to revert to normal oestrus following the birth of a litter (Hillyer, 1976). It will be recalled that this compound occurs in substantial amounts in the axillary organ of man, as well as in the salivary glands of the pig. (Readers interested in advancing

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LH luteinising hormone
O oestrogen
ICSH interstitial cell stimulating hormone
Tes testosterone
Inside brain: ———— centrifugal fibres of olfactory system
---------- fibres associated with hypothalamic activation following olfactory system stimulation
..... route of hypothalamic releasing hormones via hypothalamic system to anterior pituitary
Outside brain: ———— hormones and target organs
---------- steroid metabolites

their knowledge in this area are directed to the reviews of Brown and Macdonald, 1985; Stoddart, 1980; Vandenbergh, 1983.)

Against this physiological and zoological background it would be remarkable if man's ancestors in the pre-gregarious times did not make use of the odours of metabolites associated with ovum maturation and release processes which are largely controlled by steroid hormones. A number of reports published in the last fifteen years have suggested that some of the reproductive effects demonstrated to occur in laboratory rodents may also occur in humans. Thus McClintock (1971) presented evidence purporting to show that cycle length in women living in all-female university residences tended to increase when there was no contact with men, returning to normal when contact occurred. This effect is well documented in mice, known as the Lee–Boot effect (van der Lee and Boot, 1955). Russell, Switz and Thomson (1980) investigated a case of a woman who apparently drove the cycles of her room-mates, suggesting that the axillary gland steroid metabolite odours produced a measure of cycle synchrony among experimental subjects. These and other observations on humans must be interpreted with the utmost caution, for they do not conform to acceptable standards of experimental controls. A consideration of (a) man's phylogeny and taxonomy, (b) the demonstrated involvement – sometimes crucial – of odours in the orchestration of sexual physiology and behaviour of a wide range of mammals, (c) olfactory effects on cycle length reported in modern humans and (d) the known naso-hypothalamopituitary-gonadal link in man leaves a strong impression that odours most likely played a not insubstantial role in the sexual physiology of our ancestors.

Let me return once again to our early ancestor living in a small family group. I postulate a heavy dependence upon oestrus advertisement odour cues among our progenitors, for the overlooking of a single sexual cycle by a male would have been maladaptive. But I also postulate that these odour cues were strongly maladaptive when our ancestors evolved their gregarious life-styles. Gregariousness meant that each female was surrounded by many males, and the development of prolonged hunting trips, as proposed by some anthropologists (Reynolds, 1976), increased the chance that a female bonded to an absent hunter would sexually attract a male who was not her mate.

There is a very important biological reason why a female must remain faithful to her mate, and the key to its understanding may be found in the long period during which the young is dependent upon its parents, and particularly upon its mother. This simple and obvious fact necessitates a clearly structured division of labour between the sexes with the father providing food and protection and the mother maternal succour. The infant must be imagined as a genetic investment made by both parents, an investment which matures when the infant grows up and leaves offspring of its own. It will best do that if it has ample opportunity to learn the

intellectual and practical skills necessary for survival, and which demarcate man from non-human mammals. As with all investments, it follows that it is not in the best interests of either investor to do anything which will lessen the likelihood that their investment will mature. Seen from the male's viewpoint, he can justify exposing himself to some risk in order to provide food for his dependants since in so doing he is furthering the perpetuation of his own genetic line. Seen from the female's viewpoint, she must do nothing which might cause her mate to desert her, for both she and their shared infant depend upon him for food and protection. Thus the bond which binds the parents together is the absolute requirement for the species to reproduce itself. If a 'married' female in a gregarious group was to be impregnated by the first male which chanced by during her oestrus, the pair bond is immediately weakened, for now there is no justification for her 'husband' to put himself at risk for the genetic investment of another male. A female which remains faithful to its mate, and a male which does not philander, each demonstrate that they are effective parents through the enhanced survival possibilities of their offspring. The demonstration is not conscious of course, and is only observed by the forces of natural selection which continually seek out and encourage the survival of the best suited. The nuclear family which remains together for at least as long as the young are dependent upon their parents is clearly more suitable for the care and maintenance of slowly developing animals than any transient pairing arrangement (Lovejoy, 1981). It follows logically that natural selection will favour any development which reduces the chances that a female might cuckold her bonded mate, and which curbs a male's likelihood of philandering. I have hypothesized elsewhere (Stoddart, 1986) that the solution to the retention of the nuclear family within the framework of a gregarious life-style was found in an intense olfactory repression which served to make oestrus undetectable. Ovulation signals, presumably of steroid origin as in other mammals, were scrambled and rendered meaningless. To compensate for this important loss of cueing, strong epigamic selection enhanced visible anatomical characteristics, resulting in modern humans being the most epigamically adorned primate of all. Sexual physiology also underwent change enabling the female to remain receptive throughout the cycle and the male capable of arousal without the stimulation of ovulation-linked odours. The unique sexual biology of humans arose as a correlate of the necessity to privatize sexual advertisement, which itself was a *sine qua non* of gregariousness and the retention of the nuclear family.

This rather lengthy discourse provides a zoological explanation for human olfactory repression. It is now necessary to examine the biological basis for the human uses of incense and body perfume against this zoological backdrop; to define and investigate the reasons why odour culture is not well developed in modern humankind.

1.4 INCENSE AND PERFUME

Almost all human cultures since the beginning of recorded history have used incense in a number of social situations. What is remarkable is that only a small number of ingredients have been used in its manufacture. We are told that Moses took with him eight ingredients prior to the Exodus: styrax, ladanum, galbanum, frankincense, myrrh, sweet cinnamon, cassia and sweet cane. Today these still form the basis of many incense formulations, though such substances as gum benzoin, tragacanth, sandalwood and cedar may be added. The Ancient Egyptians used prodigious quantities of incense – it is said that in the three decades of his rule King Rameses III burned almost two million blocks of incense. Additionally the Assyrians burned almost 60 tonnes of incense during the great annual feast of Baal. The Ancient Greeks and Romans in their turn also consumed vast quantities of incense: large and important public gatherings were fêted with incense, and within private homes incense was burned on special occasions or when there were guests.

There is little doubt that the early Christians reviled incense because it was such an important part of Jewish religious culture. The Syrian scholar Arnobius questioned whether the gods needed smoke to placate them, asking:

> What is this sign of respect which comes from the smell of gum of a tree burning in a fire? Does this, do you suppose, give honour to the heavenly magnates? Or if their displeasure has been aroused at any time, is it really soothed and dissipated by incense smoke? But if it is smoke the gods want, why must it only be incense? If you answer that incense has a nice smell while other substances have not, tell me if the gods have nostrils and can smell with them? But if the gods are incorporeal, odours and perfumes can have no effect at all upon them, since corporeal substances cannot affect incorporeal beings. (Atchley, 1909)

The most parsimonious explanation for the use of incense is that people offer it to the deity because like music and fine art which fills and decorates churches and places of worship, its odour inspires them in a remarkable way. Most incense ingredients are the resinous or gummy exudates from the bark of trees and other plants, whose botanical function is to repair wounds to the bark. They contain volatile essential oils which evaporate on exposure to the air, leaving the resin to set hard in the wound. If the proportion of essential oil is high, the resin remains fluid and is termed 'balsam' or 'balm'. Resin contains three main types of compound. First, these are highly complex polymers of the higher isoprene–terpene sequence called resenes. Their molecules are so large and their internal linkage so complex that they are essentially colloidal in character and almost certainly non-volatile. Next there are acids of varying complexity. For example, in American rosin the

main acid is abietic acid, which has a structure based on three C_6 rings. Simple acids, such as benzoic acids, are more regularly found. Finally, there are a series of complex alcohols, called resin alcohols. A common resin alcohol is amyrin. Amyrin is thought to be formed from a group of plant substances called the phytosterols, and all phytosterols are structurally allied to the animal sterols. A particular form of sterol, with a structure composed of four C_6 rings, is the steroid configuration. It will be recalled that steroids form the base for animal sex hormones. A number of animal steroids have been found in plants – the male sex hormone testosterone and the related hormone androstenedione have been found in the Scots pine (*Pinus sylvestris*) (Bell and Charlwood, 1980); Fig. 1.3 shows the structure of two commic acids alongside that of certain other steroid alcohols from myrrh (*Commiphora abyssinica*) and testosterone and the similarity is striking. From what is known about the structural–activity relationships of odorant steroid molecules any compounds with a steroid-like shape elicits a steroid-like odour. Ohloff and co-workers (1983) showed that certain flexible synthetic monocyclic C_{16} molecules, which are quite unlike the tetracyclic steroids in structure, can be rotated into conformations which resemble the profiles of steroids. It seems perfectly possible therefore that the resin alcohols are able to elicit a steroid-like odour perception within the human brain. Further support that this may be so comes from Kloek's (1961) study of the odours of steroids. Using a large group of university students as his test panel, he noted that a great many steroid odours were described as being 'woody' or as 'like incense'. He added that this last description probably meant 'like sandalwood', as sandalwood is often compounded in incense. The odours of sandalwood and the pig mating pheromone and human axillary secretion 5α-androstenol are remarkably similar.

Before examining the biological basis for our use of incense further, I wish to consider the possible evolution of body perfumes. During the early days of gregariousness there would have been some division of labour between the sexes. Some anthropologists consider that females would have lived an existence as gatherers of plant materials, while the males hunted large prey. They would have gathered flowers, fruits, buds, nuts and seeds and dug up roots, rhizomes and tubers. During these tasks juices from these structures would have soaked the hands, and if juicy fruits were abundant, the arms and even more. I hypothesize that the odours of these natural products would have helped to mask ovulation advertisement odours at the same time as olfactory repression was effecting a central blockade to the recognition of these odours. Natural selection would tend to favour those females which more effectively masked their odours, for they would best maintain the bond of fidelity. There is no reason to suppose that these early females found the natural perfumes pleasurable; their value to human evolution was maintained by natural selection and not by hedonism. The protection that these females

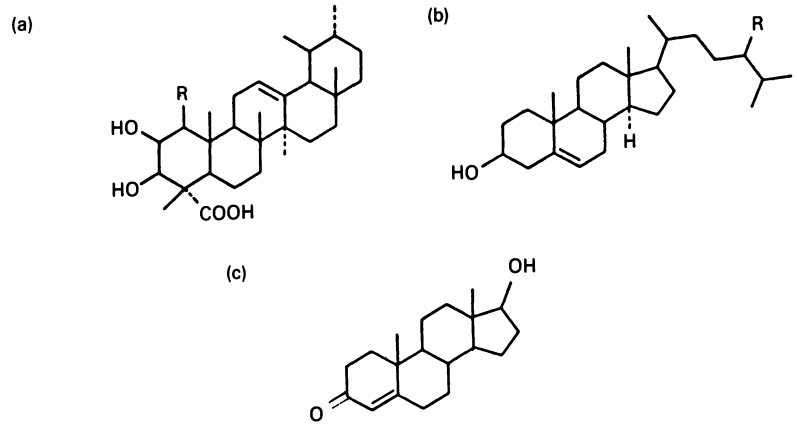


Fig. 1.3 The structure of some plant and animal steroids.

(a) R = H commic acid D
R = OH commic acid E
(from myrrh, *Commiphora abyssinica*).

(b) R = H cholest-5-en-3β-ol
R = CH_3 campest-5-en-3β-ol
R = C_2H_5 sitost-5-en-3β-ol.

(c) Male sex hormone testosterone.

gained for their genetic investment in the next generation was initially quite accidental, but as human consciousness developed the protective nature of these odorants was recognized and they would have been purposefully gathered and applied.

The most sought-after and expensive modern perfumes contain a number of mammalian sex attractants, as we have already noted. On the face of it, this would seem to run directly counter to the above hypothesis. If the function of perfumes is to mask oestrus advertising odours, it is hard to accept that important ingredients might be substances which serve to advertise oestrus and sexual status in wild mammals. Students of animal behaviour have long recognized the incorporation into a certain piece of behaviour an element which, in a different context, serves an entirely different function. As an example, consider the 'neck bite' in the mating behaviour of carnivores (Ewer, 1968). It is an element of mating behaviour commonly seen in cats and dogs, but it also occurs in a host of other mammals and even reptiles. Shortly before intromission, the male opens his jaws and takes the female's neck into his mouth. If this behaviour were not under the strictest of controls, the female could sustain serious and even fatal

injury, for in the context of killing prey precisely the same behaviour is exhibited, only without inhibition. It is able to form part of the mating ritual precisely because it has been brought under control and is now 'safe'. Ewer goes on to show that the neck-grip was originally used by the reptilian ancestors of mammals to enable the male to mount the female, and that as the killing apparatus became more efficient during mammalian evolution, the control over its action became more efficient too. I suggest that a similar process occurred with perfumes. Once the neural suppression was complete, there was no danger in adding sex attractants to perfumes, and here I assume that humans are as capable of responding to substances produced by other species as they are of producing shared odorants. Their effect is to jog the ancient memory traces in the brain – retained in our biology just as are other vestigial characteristics – and in a sublime and vicarious manner reveal precisely what the perfume helps to conceal. So deeply buried are the memory traces of long ago that the scent of a mammalian sex attractant is no longer capable of releasing the behaviour it would once have, but the traces are not so tightly entombed that the subconscious mind cannot be stirred to excitement and provide a mood of attentive satisfaction. The incorporation of sex attractants into human perfumes subconsciously provides a constant reminder that the action pathway they once paved is now firmly and irrevocably under control. Incense is widely used in social circumstances when it is advantageous that all minds think alike, for the mind is alert and open to suggestion. The odours of incense, reminiscent of sex attractant steroids, lift the repression a little to release some of the emotion but none of the act. Freud (1929) first proposed the notion of 'organic repression' of the sense of smell, linking it to an upright gait and the elevation of the nose from the ground and from where it had formerly found pleasurable sensations. Brill (1932) advanced Freud's ideas by suggesting that although the repression was deep and complete, sex-attractant odours were not totally inert as far as humans are concerned. Under certain conditions they could come to the surface and be titillated by appropriate aromas, but only in certain neurotics and psychotics could such aromas release any 'abnormal' behavioural act.

1.5 THE NOSE AND EMOTION

All this brings us to the essential subject of this book, to the relationship between the sense of smell and human emotion. My hypothesis is based on the fact that humans have developed incense culture and body perfume based on the odours reminiscent of sex attractants which played an adaptive role in man's pre-gregarious days, and which have their effect because they are able to penetrate to the deeper levels of the psyche to gently stimulate the

emotions. The philosopher Grant Allen who wrote in his book *Physiological Aesthetics* (1877), 'no fine art can be based upon odours, for the human race at least. There are no associated emotions upon which the art could play', could not have known that the neurones of the olfactory system terminate in that part of the brain which is now thought to be the seat of emotion. Hearing and vision are relatively newer senses than chemoreception (Stoddart, 1984) and are analysed by centres in the cerebral cortex. The chemical senses are, by contrast, handled by the part of the midbrain known as the limbic system, as we have seen. The limbic system comprises a series of structures extending from the midbrain through the hypothalamus and into the basal forebrain – a phylogenetically ancient core system concerned not only with visceral motor functions, but also with emotional expression. An important element in this system is a body called the amygdala. The cortical and medial nuclei of the amygdala receive information from the olfactory system. The basolateral group of nuclei is involved in the expression of emotion (Shepherd, 1983). In other words, odours are processed in the part of the brain which is thought to be the seat of emotional response. Outputs from the amygdala, both from the cortical and basolateral nuclei, travel to the hypothalamus which itself regulates pituitary function and the reproductive physiology (Shepherd, 1983). The amygdala has also been shown experimentally to control sexual behaviour in rodents via its connections with the preoptic/hypothalamic region (Yahr, 1981). There seems little doubt that the olfactory system has a direct input to that part of the brain concerned both with emotion and sex. Grant Allen could not have been further from the truth!

1.6 CONCLUSION

Consideration of these various facets of human response to and cultural use of odours suggests to me why it is that our species has not developed a mass odour culture paralleling those of the visual and acoustic senses. Put simply, odours were once too fundamental to our well-being for their relegation to hedonism. Despite the intense suppression of our olfactory sense, for reasons which I have explained, odours still have a strong and affective power. Daly and White (1930) quote from Marlitt's *Das Eulenhaus*: 'Nichts in der Welt macht Vergangenes so lebendig wie der Geruch' ('Nothing on earth makes the past so living as does odour'). We can all verify this from our own experience of life. The ambivalence of humankind towards the olfactory sense and odorous world results from this suppression – our memory traces, our olfactory vestiges, are an Achilles' heel, a soft spot overlying a key to our deeper personalities which natural selection has inexplicably failed to patch. In a few million years the rigour of natural selection might have effected a

patch, had our intellect and ability to control its powers not intervened. But we shall never know. Our lack of a mass odour culture is atavistic, reminding us of our evolutionary and biological relationships with our ancestors – creatures whose bones we can see in the museum cabinet but whose lives remain a mystery.

2

The molecular dimension in perfumery

G. H. DODD

> In the author's opinion the study of the influence of odours on the human senses, connected partly with physiology and partly with psychology, is at least as important for the perfumer as the study of any other subject treated by various authors, and considered to be the foundation of perfumery.
>
> Paul Jellinek, *The Practice of Modern Perfumery*, 1959

2.1 MOLECULES AND PERFUMES

The psychology of perfumery is concerned with a range of issues most of which centre on the perfume user and his or her reactions towards a perfume. Most of the other chapters in this book deal with these behavioural issues. In this chapter we focus on the molecular aspects of perfumery. Through an exploration both of the properties of perfume molecules and also of the mechanisms by which these molecules excite olfactory receptors we will be prompted to ask questions which are not dealt with elsewhere in this book. Do certain types of perfume molecules give specific types of smell? How do our smell receptors distinguish between different types of perfume molecule? Can we, in contrast to what Engen believes (Chapter 4), hope to design novel odorants which will elicit powerful moods, even if we have not previously smelt such odours?

2.2 PERFUMERY AND THE PSYCHOLOGY OF ART

One of the goals of aesthetics is to understand the relationship between the properties of the stimulus and the qualities of the work of art. Thus, in

painting, we are concerned with the properties of light. We know that as the wavelength of the waves of electromagnetic energy (light) increases, we traverse the visible spectrum of colours from violet to red. We can predict exactly what colour will be found for 'pure' light of a single wavelength. Of course, our predictions are valid only for those of us with 'normal' vision. Indeed the exactitude of our predictions allows us confidently to identify the tiny percentage of the population who are colour-blind.

Other properties of light are also useful in thinking about the psychological processes underlying our liking for a particular style of painting. The triangle of colours, and the laws of colour mixing, are useful tools for constructing interesting arrangements of paint. The vivid qualities of fluorescent light from synthetic pigments permit a new type of visual art, characteristic of our time.

Music consists of waveforms, the sound-waves of air pressing on our ear-drums; and many people have seen films showing the shape of complex waveforms captured on an oscilloscope. There is an understanding of the relationship between the harmonic waves emitted by an instrument and the quality of the sound experienced. This understanding, together with developments in microelectronics, permits the construction of sophisticated synthesizers which mimic the instruments of the orchestra with acceptable fidelity.

2.3 PERFUMES AND SENSORY PROCESSING

In perfumery, in contrast to the visual and aural arts, we lack the convenience of being able to express the stimulus as a waveform which can be quantified in a convenient mathematical form. The older perfumery literature alludes to several hypotheses which envisage that certain types of vibration are responsible for the sensation of smell. Aromatherapists still believe that subtle vibrations are characteristic of essences extracted from plants (Tisserand, 1977). Later in this chapter it will be shown that modern explanations of olfactory mechanisms provide an explanation in terms of molecules rather than vibrations. Unless we seek an interpretation of the biochemical mechanisms at a subatomic level (usually exceeding the understanding of most who favour olfactory wave mechanisms and requiring an understanding of quantum (wave) mechanics), molecular properties account satisfactorily for most perfumery phenomena. The dictum of William of Occam, Bishop of Oxford, in the fourteenth century, favours molecular explanations. Occam's razor essentially states that of two competing hypotheses, the simpler should be accepted.

Thus when dealing with the problems of perfumery aesthetics, as discussed by Mensing in Chapter 10, we look for some features which are not found in the other arts. The general features of sensory processing, including

transduction steps in the sensory cells, signal processing in neural networks, and the culmination of the processing in an emotional experience, as discussed by Van Toller in Chapter 7, employ general mechanisms which are essentially common to most of the major senses (Uttal, 1973). Hence the central brain centres and mechanisms which handle the signals at higher levels are common to the senses.

The more significant differences for the senses lie in the receptor structures and in the stimuli. Perfumery is the art associated with the sense of smell. Olfaction is one of the chemical senses and deals with molecular stimuli. The molecular nature of the stimulus differs from the physical stimuli for vision and audition. So when I create a beautiful perfume, I look for an explanation in terms of the constituent molecules in the fragrance. And it is at this point that we are forced to recognize the relative backwardness of olfactory sciences. Our current methodology does not easily permit us to give an explanation of the 'form' of the molecular mixture which gives rise to agreeable smell sensations.

Visual stimuli can be categorized in a number of ways, including shape – lines, triangles, circles, etc. – shadows, and so on. This categorization facilitates the analysis of art and the aesthetics of pictures. New computer methods in the field of pattern recognition have provided a 'natural' language for describing the form of the objects we see. We still have great difficulties in creating 'natural' languages for describing perfumes. It will be necessary to fabricate a new mathematical language to describe the 'form' of the molecular stimuli in perfumes. Classical mathematical methods, such as Fourier analysis, have been the key to the waveform analysis of musical sounds. These methods use continuous mathematical functions, and they are useful for characterizing continuous stimuli such as light or sound. Molecules are discrete entities, and the appropriate mathematics for describing the properties of the molecular ensemble underlying perfumery aesthetics should use discrete functions. Until the recent advent of powerful computers it was not feasible to use this kind of mathematics. However, this kind of mathematics is now making rapid progress (Wolfram, 1984).

We face the mathematical problems directly in the design of 'electronic noses'. Our initial devices (Persaud and Dodd, 1982) used simple mathematics but the newer generation of multi-transduction devices requires the full application of mathematics (Barker, Bartlett and Dodd, 1988). This mathematics may be the most powerful way of describing interactions in the neural circuits and may possibly emerge as the most natural way of expressing the 'language of the brain'. Like quantum mechanics, it poses conceptual problems for those uninitiated in the mathematical language. But it is this very abstractness which may make it useful in analysing the inherently non-visualizable molecular 'form' which gives rise to a beautiful perfume.

2.4 PERFUMERY AND ALLIED CRAFTS

In the perfumery literature there is an understandable desire to compare perfumery phenomena, including the underlying psychological events, with comparable phenomena from the other arts. It is flattering for the perfumer to compare her 'creations' with the *oeuvre* of a musician or painter. This tendency is particularly noticeable in the French literature, and since modern classical perfumery has its roots in France, this viewpoint has been widely propagated. One consequence of this bias in the literature is to emphasize the supposed analogies between perfumes on the one hand, and music and painting on the other. Implicit in this viewpoint is an acknowledgement of a supposed equal complexity of the stimuli. But whereas other stimuli, e.g. music, as discussed above, can be quantitatively analysed, permitting further advances in our understanding of the psychology of the art, no such analysis is presently possible with odour stimuli.

The French tradition emphasizes the special role of the creator of the perfume. Analogies with that other craft in which the French tradition has been pre-eminent, namely gastronomy, are striking. The cook and the perfumer represent two distinctively French attempts to create an art form from the stimulation of the chemical senses – smell, taste and the trigeminal sense. Even here, we find more cultural idiosyncrasies. We have all heard of Monet, Renoir and other notable painters of the French School; Ravel, Gounod and Berlioz are famed worldwide as French musicians; while Bocusse is an example of the French gastronomic genius – but who has heard of Robert, Polge or Roudnitzska, the creators of famous perfumes? The fashion houses of Chanel, Rochas and Dior, who market the famous perfumes of these perfumers, are household names throughout the world. The creators of the 'art' remain obscure. How strange that this should be, if perfumery really is an art form comparable to painting and music!

There is an alternative view of perfumery which perhaps suits those of us reared in the more robust Anglo-Saxon tradition. This viewpoint notes that the quintessential experience of a perfume is an evocation of a mood. Moods are concomitants of activity in the limbic system of the brain, as is described by Van Toller (1978) (see also King in Chapter 8 and Van Toller in Chapter 7). Limbic activity can be elicited by a number of methods, including direct chemical stimulation of receptors in this region of the brain using certain classes of tranquillizer. Indeed members of an important class of tranquillizers, the benzodiazepines, have specific binding sites on the olfactory sensing cells (Anholt *et al.*, 1984). So from a molecular viewpoint we can regard perfume molecules as a special class of mood-modifying chemicals which act on the peripheral parts of the limbic system (Dodd and Van Toller, 1983).

The two viewpoints of perfumery represented above are not of course mutually exclusive. Both are necessary for a full understanding of the

psychology of perfumery. In this area of perfumery, as in the area of neurobiology, we confront the dilemma of mind–body interactions, the spirit–molecule interface. Since other chapters in this book deal with the behavioural aspects of perfumery, we will concentrate here on the molecular domain of perfumes.

2.5 PERFUME MOLECULES

The traditional materials in perfumery were fragrant oils and resins extracted from a variety of plants. Some of these are mentioned by Tisserand in Chapter 9. I belong to that school of perfumery which believes that the most exquisite perfumes are made by blending the finest flower oils. This was probably true for the perfumery mentioned in the Old Testament, and earlier; it is still true today. This continuity of olfactory sensation is perhaps a comforting experience in a time of rapid social change. The finest oils are very costly, and this is the principal reason why so few of us have had the opportunity to experience fragrances from the 'Golden Age' of perfumery.

A crucial temporal factor is involved in the smelling of these oils and this affects the aesthetics of a perfume; this factor, which is now less important for other art forms, is still troublesome for perfumery. If I am curious about, say, the rules of perspective or the use of colour which distinguishes the Pre-Raphaelite school from modern movements, there are relatively easy ways of resolving these issues. I can, for instance, visit art galleries possessing collections of works by the Pre-Raphaelite Brotherhood and contrast the richness of the paintings with the starkness of works by David Hockney, Francis Bacon and their contemporaries. Thanks to modern technology, I can even place side by side high-fidelity prints of paintings from each school for precise evaluation. Similarly, I can listen to recordings of the same piece of music by different orchestras. However, the sense of smell poses special problems. Because of rapid adaptation to smells, especially strong perfume oils, comparison of two oils is difficult. We must ensure a certain time to elapse between the evaluation of each sensation.

We must recognize that at least some of the aesthetic aspects of perfumery are circumscribed by the currently available perfumery oils. We can judge between the products on the market, but we should realize that most perfumery today is rather akin to commercial art. I create individual perfumes for my clients, but for most people that delightful time, described by Le Norcy in Chapter 12 when clients went to their perfumer for their own special perfume, has passed. The typical perfumer of today is an artisan employed by a commercial company, working to strict performance criteria. In addition, the cost of the product is a key point. Today's consumer has little opportunity to sample a fine perfume – sister of a fine vintage wine – constructed exclusively from the finest, fresh, natural flower oils.

For the reasons discussed below, I disavow the special role ascribed by Tisserand and other aromatherapists to natural essential oils when they are used for the creation of perfumes. However, I do share some of their nostalgia, together with a little alarm at what has happened to perfumery. Contrast the perfumery industry with the other industries which appeal to the chemical senses. For example, wine is a beverage that we know has been made from *natural juices*, not a concoction fabricated from synthetic alcohol, water and synthetic flavouring, however palatable that product might be. The same considerations apply to beer and more particularly to fine Scottish malt whiskys, such as the Jura malts – in the judgement of which the nose plays a pre-eminent part. All these fine beverages are natural products produced by companies with a prime regard for the customs and traditions of their industry. Up to about a hundred years ago the same considerations would have applied to perfume. Along with wine, beer and whisky, it too would have been made from natural substances. Unfortunately it is too late to resuscitate the noble term 'perfume'. It no longer refers to a natural product, but simply to a fragrant mixture of chemicals, and nowadays most are synthetic.

The technology permitting the use of single pure odorants in perfumes arose in the nineteenth century. William Henry Perkin, having studied under Hofmann at the Royal College of London, announced in 1868 the synthesis of coumarin, a natural perfume chemical with the delicious odour of newly mown grass. This was the first chemical synthesis of a natural odorant. By 1890 at least twenty synthetic odorants were commercially available to French perfumers. The modern trend towards the incorporation of synthetics into perfumes had begun. Notable among the first perfumes which capitalized upon the new olfactory possibilities of incorporating synthetic odorants into natural oils was Fougère Royale. Using the new coumarin, Paul Parquet, joint owner of the Parfumerie Houbigant, created this masterpiece of a perfume in 1882.

Here we may make a distinction between the types of stimulus of the sense of smell. If the stimulus contains only one type of molecule, we label it as 'simple'. Simplicity in the stimulus, it should be noted, does not necessarily betoken a correspondingly simple response or an easy odour description. For example, the powerful human odorant, androstenone, more fully described by Gower in Chapter 3, is not easily perceived by some people. For some it has a distinct urinous note and for others a musk note, while still other observers report other notes. This diversity of odour response is obtained with pure specimens of the odorant.

It is somewhat banal to refer to the question of purity, but this factor is still responsible for much mischief in odour science. Odour studies are, to a large extent, part of chemistry and the usual stringent chemical criteria of chemical purity should be applied. Any reader who has no personal

experience of olfactory experiments should be especially cautious in interpreting the olfactory literature, particularly that part dealing with human reactions to odours, and also when the stimuli are single chemicals. A striking example of impurity effects is found with another putative human pheromone, alpha-androstenol. We find that most samples of this odorant have a urinous note, but this disappears on extensive purification, leaving a material which has a sandalwood or a musk note depending on the observer; the importance of odorant purity for olfactory work is touched upon elsewhere (see Van Toller, Dodd and Billing, 1985).

If an odour stimulus contains more than one kind of molecule, then it is a 'complex' stimulus. These stimuli are odorant mixtures and may consist of natural odorants only, as in the case of flower oils, or mixtures of synthetic odorants with natural oils as occurs in most perfumes, or mixtures of wholly synthetic chemicals as are found in cheap perfumes. The complexity of these stimuli can vary from binary or ternary mixtures, such as are often used in experiments on human olfaction, to the bewildering complexity of flower oils which may contain over 400 different odorants.

Perfumes are invariably very complex olfactory stimuli. An example of a formula for a classical floral chypre perfume is shown in Table 2.1. For an

Table 2.1 A formula for a classical floral chypre perfume

Synthetic odorants		*Natural oils*	
1 Lilial (Givaudan)	3	18 Pimento oil	1
2 Aurantiol	2	19 Coriander oil, Russia	2
3 Terpineol extra	3	20 Nutmeg oil, East Indian	1
4 isoEugenol	5	21 Petitgrain oil, Paraguay	1
5 isoAmyl salicylate	3	22 Ylang-Ylang oil, premier	2
6 Ethyl acetoacetate	0.4	23 Lavender oil, English	4
7 isoButyl phenylacetate	4	24 Bergamot oil, Sicily	8
8 Phenylethyl acetate	4	25 Patchouli oil, Indonesia	3
9 Phenylethyl alcohol	3	26 Vetivert oil, Haiti	1
10 Anisaldehyde	1	27 Sandalwood oil, Mysore	1
11 Trimethylundecylenic aldehyde	0.5	28 Oakmoss resinoid	4
12 Civettone	2	29 Rose absolute, Grasse	16
13 Heliotropin	2	30 Jasmin absolute, Grasse	16
14 Vanillin	3	31 Immortelle absolute	0.5
15 Galaxolide (IFF)	1	32 Tuberose absolute	1
16 Androl (CPL)	1	33 Hyacinth absolute	0.5
17 Pyrolide (CPL)	0.1		100.00

This is a formula from the 'Golden Age' of Perfumery. Today, you would have to be rich to be able to afford such an abundance of natural oils, especially the absolutes. In most current perfumes these oils would be replaced by synthetic chemicals.

experienced perfumer this formula is as suggestive as is a score for a musician. With the exception of three new synthetic chemicals, this is a formula which could have been devised in the 1930s. The first seventeen items are synthetic odorants, but the normal perfumery grades of such materials are rarely pure and all of these items are likely to have significant amounts of impurities. The nature and power of these impurities usually vary from one manufacturer to another. In fact so much variation is possible with the synthetics alone that this factor, by itself, would cause considerable difficulty if a perfumer were trying to imitate a particular perfume effect. This formula demonstrates the difficulties which will be found in the future as academic psychologists begin systematically to explore reactions to perfumes with slight variations in the formula.

The perfume 'score' can be read only if the interpreter has an intimate knowledge of the ingredients, and especially their range of variation. Unfamiliarity with a single ingredient, particularly if it is a new and powerful synthetic odorant, means that a perfumer would be uncertain about a dominant note in the perfume. It would be like a master cook reading a recipe for a fruitcake which included nutmeg. If he were unfamiliar with this ingredient and it made a dominant contribution to the spiciness and 'bite' of the cake, he would have little hope of re-creating the saporous intentions of the recipe's inventor. With some modern perfumes which rely heavily on special impact synthetics, such as the damascenones, the main note may be supplied largely by a single odorant.

The remaining items in the formula are natural oils. The chemical composition of these materials have been investigated in detail and the analytical results are published in the literature (Lawrence, 1987). Many of the oils would contain ten to twenty major chemicals along with a diverse range of at least several tens of minor components. The variability in the quantitative chemical composition of the natural oils can be considerable, both from country to country, distillation company to distillation company and, of course, from year to year. The odour qualities of different batches of oils might differ so much that great variation in the smell of the final perfume can be found. Perfumers operate stringent olfactory quality-control procedures to ensure the replicability of the perfume 'score'.

In the final part of this chapter we will emphasize the biochemical unity between olfactory molecular mechanisms and the receptor mechanisms for drugs and hormones. We will see that it is legitimate to regard olfaction as part of molecular pharmacology. In this latter area drugs and hormones are usually presented as single types of molecule to the receptors. Simple mixtures are also used but mixtures with the complexity of perfumes are avoided: it would be difficult to untangle the multiplicity of molecular interactions. For the same reasons of simplicity, most experimental laboratory work on human olfactory mechanisms employs either pure

odorants or simple mixtures. As argued above and elsewhere (Van Toller, Dodd and Billing, 1985), the use of well-characterized, pure, single odorants enhances the likelihood of obtaining results which can be replicated in other laboratories. However, the approach to olfactory mechanisms using single odorants presents a stimulus to the system which is so much simpler than the molecular complexity of finished perfumes that it must raise doubts about the likelihood of obtaining significant information of interest for the psychological reactions to perfumes.

2.6 PERFUME OILS AND AROMATHERAPY

This book brings together, for the first time, the aromatherapy and perfumery communities. One of the differences between these two fraternities lies in their attitude towards the perfume stimuli. Aromatherapists ascribe a special role to natural oils, yet at the same time stress the potential toxicity of synthetic materials. The position of the aromatherapists is cogently summarized by Tisserand:

> Why natural oils? Why not anything that smells nice whether it is natural or synthetic? The answer is simply that synthetic or inorganic substances do not contain any 'life force'; they are not dynamic . . . Everything is made of chemicals, but organic substances like essential oils have a structure which only Mother Nature can put together. They have a life force, an additional impulse which can only be found in living things. (Tisserand, 1977)

This aromatherapeutic argument is faulty on a number of counts. The chief defect is that none of the aromatherapists seems willing to consider the chemical evidence and so they remain in ignorance about current concepts of molecular structure and their relationship to cellular dynamics. The statement by Tisserand, above, is an example of latter-day vitalism (Ihde, 1964). This belief impeded the development of biological chemistry until, beginning with Wohler's synthesis of urea in 1828 and continuing through the demonstration of enzymatic activity in a pure protein by Sumner and others in the 1920s, it became evident that the chemical substances of living tissue were in all physiological respects identical to the same molecules synthesized in the laboratory.

For the purposes of either perfumery or olfactory experiments it does not matter whether we use methoxy-isobutylpyrazine from a laboratory synthesis or a sample which has been isolated from galbanum oil, provided that sufficient attention is given to the effects of impurities. It is the natural, 'green' smell of this odorant which matters to the perfumer. As discussed above, the effects of impurities, which are more likely with the sample from

a natural oil, cannot be neglected. They can affect the odour of a perfume, but we do not expect them to contribute the 'vibrations' cited by Tisserand and which are alleged to produce the shape, odour, colour and sound of every object (Tisserand, 1977).

The aromatherapists are confused about another point which is explained in the biochemical literature (Zubay, 1983). The dynamic activity which is characteristic of cellular living processes and which is esteemed by practitioners of aromatherapy is not a property of the constituent molecules of the cell. The metabolic activity comes about from the specific organization of and specific interactions between these molecules both in time and space. The thermodynamic and physico-chemical principles involved in these interactions are well understood though a complete account cannot be given at this stage in the evolution of biochemistry. Our present understanding permits impressive technical developments such as the synthesis of novel enzymes, the fabrication of synthetic genes and the construction of active membrane systems. There is no feeling that future developments will be impeded through failure to take account of vitalistic principles such as those quoted. We should conclude perhaps that aromatherapists should use living plant tissues, since these have demonstrable dynamic and metabolic activities, rather than the oils extracted from the tissues.

A further misconception arises with the attribution to the natural flower oils of the term 'essential'. This word is often taken to denote some vitalistic property of the oils which is presumed to be lacking from synthetic materials. These oils contain secondary rather than primary metabolites and are not essential for the 'life' of living cells.

A point which should concern the aromatherapists is the 'naturalness' of the oils used. Two points need to be made here. First, there is the question of the authenticity of the oils. Most practising aromatherapists are not expert chemists and therefore may be over-optimistic about the 'naturalness' of the oils they purchase. Oils are frequently 'arranged' and blended and more care should be taken with this aspect of perfumery oils by aromatherapists. Secondly, there is the pivotal question of the 'naturalness' of any oil which has been removed from a plant. Every perfumer throughout the ages has, along with the philosopher, Francis Bacon, pondered on the flowers 'which perfume the air most delightfully'. Some of us have wondered how we can capture the radiance and diffusiveness of, say, a carpet of wild bluebells come upon in an English wood on a sunny May evening. The intoxicating beauty of the perfume, which for an instant can seem to pierce the soul, provides the perfumer with the ultimate challenge. Imitate that! Not that the consumers wish to smell like a flower; but they may aspire to partake of the feelings which such natural perfumes inspire.

The importance of this special quality of a 'living' perfume in the air has been recognized at the research front of chemical perfumery. Ira Hill of IFF

(International Flavors and Fragrances Inc.) has written: 'our belief that much of what we perceive as fragrance is affected by molecules which in and of themselves have little or no aroma. In fact, they may not be even volatile in the classic sense of the word' (Hill, 1977). This draws our attention to an aspect of perfumery stimuli which has received little attention. Recent work has demonstrated that olfactory receptors can be stimulated by non-volatile molecules presented as aerosols (Mather and Dodd, 1988). Effects of this kind may explain part of the special appeal of the perfume from the living flower.

Hill also wrote: 'more and more of our effort is being directed towards answering questions about such subjects as substantivity or diffusivity. We feel that this is the heart of why fragrances really work.' A decade later this effort has paid off in a way which illuminates the question of the authenticity of natural oils. The chemical composition of the oil emanating from living flowers has been shown to be different from the oil extracted from flowers which have been cut for a short time. A striking example is found with the exotic, heady and narcotic fragrance of gardenia. Methyl benzoate, found in the living flower, is rapidly converted to ethyl benzoate once the flower is cut. Shortly after this, odorants such as limonene which are not emitted by the living flower, appear in the oil.

These new results throw doubt on the 'naturalness' of any of the current aromatherapy oils. Conventional oils (even if they are extracted by expression or by the use of liquid carbon dioxide) are obtained from flowers and leaves severed from the plant. In the case of some oils, e.g. patchouli, the plant tissue is deliberately left for some time, so that the desired quality of the oil can be obtained. Possible procedures to arrest the chemical changes include inhibition of the enzymatic activities responsible or the use of plant cells grown in tissue culture. Until such time as these procedures are available we can conclude that the perfumery oils used in aromatherapy are, to varying extents, modified versions of the natural oils.

Another objection to aromatherapy lies in the name of the activity: it suggests a treatment using smells. Perusal of the standard books on the subject (cited by Tisserand in Chapter 9) shows that most of the treatments involve application of the oils to the skin with extensive use of massage. Some of the treatments involve ingestion of the oils; there is no section devoted to treatment by smells, though the pleasure of using fragrant oils is often noted.

Aromatherapy is on surer ground, and the name is more appropriate to the activity where it compares the medicinal quality of the oils to the properties of synthetic drugs. It has been demonstrated that the anti-inflammatory and other medicinal properties of some natural oils, many of which have been used since biblical times, are gentler and less toxic than the pure, active drugs isolated from the oil. Since aromatherapy like most branches of

alternative medicine is practised chiefly by people without formal medical qualifications, the safety of the oils is an important asset for the activity.

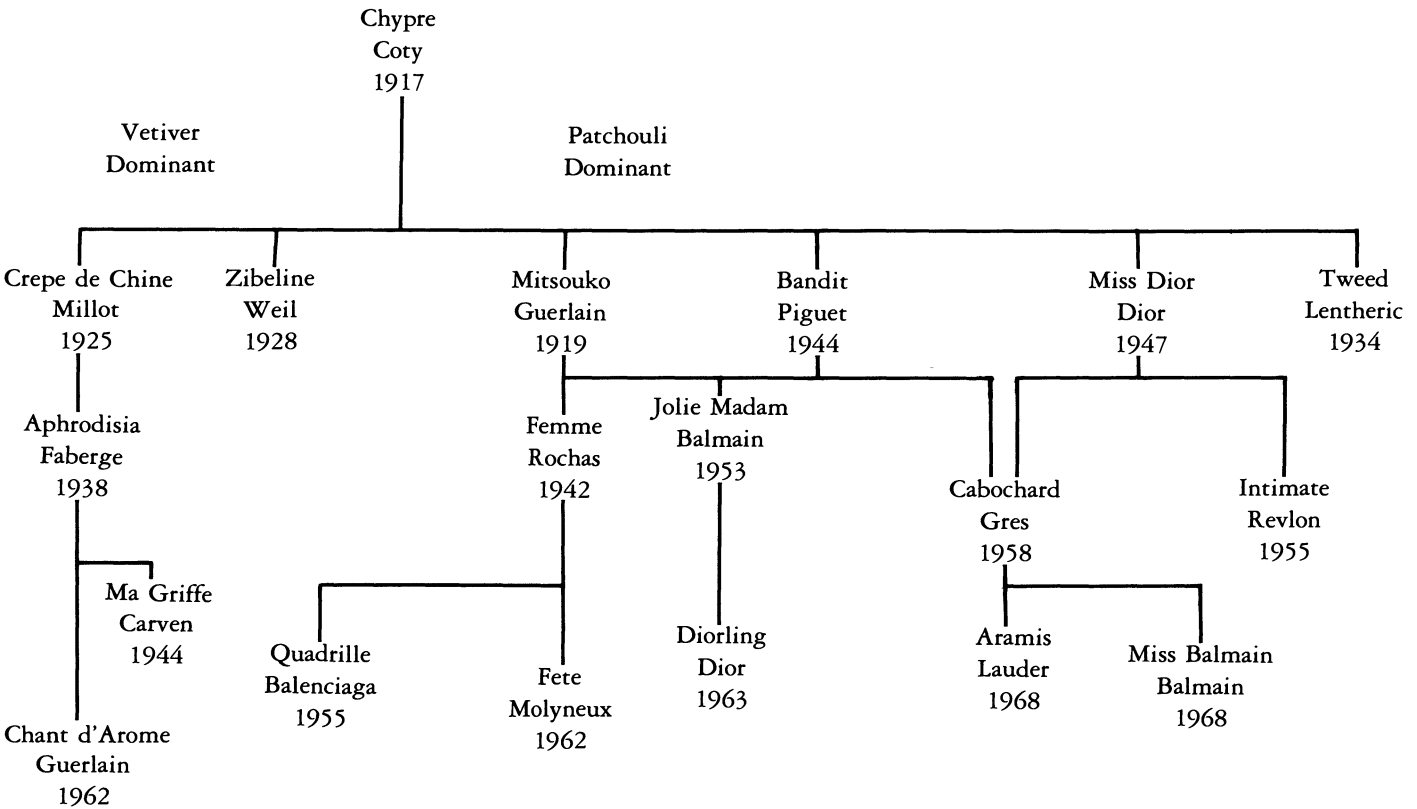
As pointed out by Tisserand in Chapter 9, aromatherapy is clearly a development of medical herbalism. It is undoubtedly an effective branch of alternative medicine. To criticize the inappropriate name of this type of holistic medicine is not to impugn its effectiveness; this is revealed in the increasing number of patients attending registered practitioners. For some years, inspired by the ideas of Montaigne (1580) and the pioneering experiments of Rovesti (1973), I have in my perfumery practice used the *odours* both of exotic natural perfume oils and new, unusual, synthetic materials in helping people to relax. I have coined the term Osmotherapy for this activity – treatment by smells – and it clearly differs from the main practices in aromatherapy; this term is discussed elsewhere (Van Toller, Dodd and Billing, 1985).

2.7 SYNTHETIC ODORANTS AND THE PSYCHOLOGICAL FRONTIERS OF PERFUMERY

By the end of the last century the gamut of perfumistic themes available from natural oils was fully explored. The development of the new families of perfumes which characterize the present century, such as the green family commencing with 'Vent Vert' (Balmain, in 1945) and the aldehydic floral family starting with 'Chanel No. 5' (1921), required the invention of new synthetic odorants. Our example of a classical chypre formulation (Table 2.1) helps us to understand the evolution of a perfume family (Table 2.2). The classic chypre was invented by François Coty in 1917. The mood appeal of this perfume, originally based on the types of natural oil shown in the formula, could not easily be extended in a novel direction without the help of the perfumery chemist.

An important advance for chypre perfumes was the incorporation of the synthetic peach-smelling gamma-undecalactone. This was a milestone in technical perfumery; it was one of the first powerful synthetic odorants to be blended with natural oils. Like other such impact odorants (for examples see Morris, 1977), this lactone requires a skilful, empirical blending into the oils lest it 'ride high' and so dominate the odour complex that the intended subtle, gentle effect is ruined. (This perhaps would be equivalent to Rossetti spoiling his *Proserpine* by re-painting the pomegranate with a vivid vermilion synthetic pigment.) The resulting perfume, Guerlain's Mitsouko, created in 1919, is a masterpiece among classical perfumes. This was the first member of a subdivision of the chypre family – the fruity chypres. Mitsouko and the other members of this family have a distinct appeal (see Mensing in Chapter 10). This perfume was interesting in terms of the psychology of perfumery.

Table 2.2 Some classical chypre perfumes



The soft, caressing fruitiness blends with the main chypre theme and captures the heart. Like other such developments of perfume psychology, it relies on subtle molecular interactions in the blend – interactions which have yet to be elucidated. The softness of this perfume contrasts with the aggressive, quasi-trigeminal qualities of some current American perfumes.

'Femme' (Rochas, 1942) accentuated the peach note and emphasized the distinctiveness of the subgroup. By incorporating a bouquet of aliphatic aldehydes into the basic chypre formulation 'Crêpe de Chine' (Millot, 1925) was created and formed another distinct grouping of the chypre family. 'Miss Dior' (Dior, 1947) was created by using a characteristic perky green top note using galbanum oil, an oil in which the key impact pyrazines play the leading role. Finally, we will mention 'Carbochard' (Gres, 1958) in which styrallyl acetate and the difficult to use isobutylquinoline play a key role in the formation of an erogenic perfume.

The generation of a perfume's 'psychological appeal' is still largely an intuitive action of the artist in the perfume studio. It is the perfumer who is called upon to realize the ambitions of the marketing manager. The most fragile or nebulous marketing idea must be expressed concretely in a collection of chemicals and oils. It falls to the perfumer, alone with his or her collection of favourite ingredients, and with a nose and brain sensitive to the expression of feeling in odours, to create the beautiful perfume which satisfies the marketer's dream. Diane Von Furstenberg asked the perfume company Roure Bertrand Dupont for 'a perfume that smells divine'. The result was the exquisite perfume 'Tatiana'. The perfumer can explore new domains in the psychology of fragrance only if there are new odorants. There are two main methods of obtaining such molecules. One is the traditional route of intensive analysis of natural oils in the hope of capturing key impact odorants. This approach is exemplified in the studies of rose oil undertaken by Firmenich et Cie, under the direction of Ohloff (Ohloff, 1978). Some results of this work are shown in Tables 2.3 and 2.4. The data in Table 2.3 illustrate the point that the bulk of an oil is made up from a small number of odorants. But analytical data of this kind must be interpreted in the light of the sensory properties of the odorants.

The data in Table 2.4 help us with this point. The sensory attribute of most interest here is the threshold value, the minimum amount of the chemical which can be detected; this attribute is explained in more detail elsewhere (Van Toller, Dodd and Billing, 1985). The threshold values, quoted in parts of odorant per billion parts of solvent (p.p.b.), show a 10 000-fold range for these odorants. Ohloff expresses the relative importance of the odorants in the construction of the rose oil odour by computing the odour value, expressed as odour units and defined as the ratio of the concentration of a constituent to its threshold value. We reach the valuable conclusion that the damascenone, despite being a minor component

Table 2.3 Major constituents of rose oil

Constituent	%
Citronellol	38
Paraffins	16
Geraniol	14
Nerol	7
β-Phenyl ethanol	3
Eugenol methyl ether	3
Linalool	2
Ethanol	2
Farnesol	1
	86%

Source: Ohloff, 1978.

Table 2.4 Data on some of the 275 known constituents of rose oil

Constituent	%	*Threshold ppB*	*Odour units*	*% of odour units*
Citronellol	38	40	950	4
Geraniol	14	75	186	0.8
Nerol	7	300	23.3	0.1
Rose oxide	0.46	0.5	920	4
β-Damascenone	0.14	0.009	15 555	69.9
β-Ionone	0.03	0.007	4286	19.3

Source: Ohloff, 1978.

The odour thresholds are expressed as parts per billion in water. An odour unit is defined as the ratio of the concentration of a constituent to its threshold concentration. Thus, in a crude sense, ignoring the intensity properties of the odorants, differences in the odour units between the constituents may be taken as a measure of their effective contribution to the odour of the oil. This kind of analysis shows how minor components may be the most important odorants in an oil.

of the oil (0.1 per cent), dominates the odour. It is almost as if the other constituents, though they are themselves odorants, are merely solvents for this archetypal key impact odorant.

Some other examples of odorants which are important building-blocks for contemporary perfumes are shown in Table 2.5. Compound 4 in the table is the key impact odorant of galbanum oil, one of the special ingredients of the perfume 'Miss Dior'. One of the strategies currently in use by the perfume industry is the chemical synthesis of these materials which are then claimed

to enjoy the special status of 'nature identical' materials. It is evident that these compounds would not find favour with aromatherapists though it is likely that at least some aromatherapy oils contain some 'nature identical' materials. The synthetic odorants may be distinguished from their natural counterparts by their different ratios of carbon isotopes. As explained above, when sufficient attention is paid to purity, there is no odour difference between synthetic and natural odorants. In the next decade biotechnology is expected to provide *in vitro* methods for obtaining large quantities of the natural key impact odorants. This will pose a dilemma of Jesuitical proportions for the aromatherapists! Some in the perfume industry will think that this development is apposite since much of the underlying philosophy of aromatherapy is still essentially theological in nature.

The second way in which the perfumer can get new molecules for extending the psychological appeal of his or her perfumes is by turning to the odour chemists, whose job it is to define the relationship between the structure of a molecule and its odour. The odour–structure relationships should then hopefully lead to the invention of novel odorants.

Odour–structure relationships play a vital role in the development of a systematic psychology of perfumes. Unfortunately this area of perfumery science is under-studied, and virtually all of the systematic data refer to single odorants rather than the mixtures of odorants which characterize perfumes. Surely, this is a field to challenge the ingenuity of future perfumery scientists? Apart from the important technical difficulties associated with purity of the stimuli, discussed above, there is the central difficulty of the mechanisms of *odour memory*. There is experimental evidence suggesting that odour memory is different from either sight or sound memory. In contrast to the highly organized spatially and temporally modulated visual scene, a perfume is an experience of the *moment* without the grain of time and space (Cain, 1984).

Odour–structure relationships were pleasingly simple in the early days of perfume chemistry when relatively few chemicals were available (Moncrieff, 1967). Unfortunately these relationships have become more diffuse as a greater range of odorants has been encompassed. For the most part, these relationships lack the predictive power that they have in many areas of medicinal chemistry. It is interesting to relate the diffuseness of the molecular structure–smell relationships to the mechanisms of odour memory. It has been suggested that odour memory is appropriately matched to the odour stimulus. For example, visual memory is good for highly structured stimuli, such as portraits, but poor for free-form shapes of the kind shown in Fig. 2.1 (Lawless, 1978). These shapes have spatial modulation but are difficult to encode. Our memory for them is similar to that for odours and different from memory for organized visual images, as shown in Fig. 2.2.

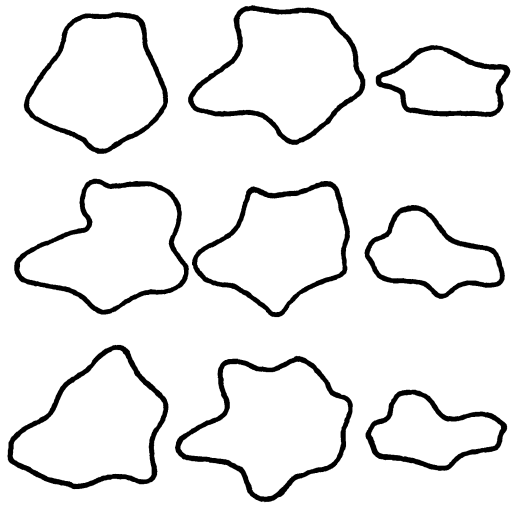


Fig. 2.1 Examples of free-form shapes that behave like odours in experiments on recognition memory.

Source: Lawless, 1978.

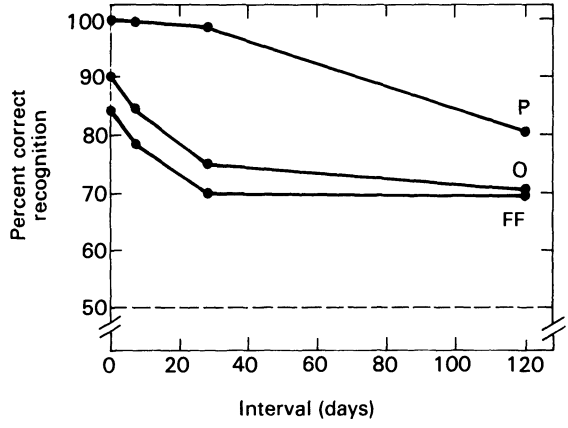


Fig. 2.2 Recognition memory, i.e., distinguishing an 'old' from a 'new' stimulus, for pictures from a travel magazine (P), common odours (O), and the 'free-forms' shown in Fig. 2.1.

Source: Lawless, 1978.

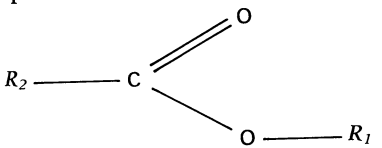
Experiments of this type are invariably flawed by contamination with the affective reaction to smells. As discussed elsewhere (Van Toller in Chapter 7), the hedonic reaction to a smell is an inescapable part of the smell

sensation. We can think of this as a kind of olfactory 'quantum'-effect. In quantum mechanics the act of observing affects what is observed. When we smell a perfume, the association triggered by the act of observation interferes with the 'objective' assessment of the odour quality. This effect is probably responsible for a lot of the 'noisiness' of smell–molecular structure data. Few experiments of this type have been carried out with perfumes and the affective reaction might be particularly strong with such complex, but emotionally meaningful, stimuli. Interestingly, the memory for free-form shapes shares a property with smell memory, which is of interest for the mechanism of durable perfume associations (cf. Engen in Chapter 4). Those special shapes or smells (musks may be an example of such an odour class) which are initially well remembered go on to form memories of almost legendary durability. As Le Norcy remarks in Chapter 12, a certain perfume may suddenly impart a vivid mental picture of an early childhood meeting with one's grandparents.

The fact that some classes of smell may 'imprint' more effectively than others is apposite to the psychology of perfumery. Here there is a clue for a research programme on the fundamental molecular mechanisms involved in the association of mood and odour. Intuitively perfumers – ever people with a developed practical sense – have perceived this phenomenon. It is difficult, for example, to think of a successful perfume which does not contain a musk molecule, or a comparable high-mass molecule, with a precious wood or ambergris note. Intriguingly, these molecules are similar to human odorants (Dodd and Van Toller, 1983; and see Gower in Chapter 3). Some of these human odorants may act as signalling odorants. It is tempting to speculate that the special olfactory properties of such molecules – low thresholds, high plasticity of odour description, defined conformations, ease of recognition and special role in perfumes – indicate specialized receptor sites for these molecules (Wood, Dodd and Van Toller, 1988).

The concept of 'relative imprinting ability' of odorant molecules may help to resolve the question of whether there are innate odour qualities in some molecules. There is a clear division of opinion on this topic reflecting the bias of different areas of science. Psychologists, most of whom have only a cursory acquaintance with molecular phenomena, tend to favour the view that all odour molecules are equi-potent in eliciting moods, the difference between one type of smell molecule and another being generated by our early life experiences. This viewpoint is argued cogently by Engen in Chapter 4. Chemists tend to support the view that specific receptor sites occur for classes of odorants (Amoore, 1970). There is evidence that there may be a specific odorant receptor site for some important perfumery chemicals, namely the musky/sandalwood/ambergris/urinous odorants (Wood, Dodd and Van Toller, 1988). This site may have special physiological properties, and this could include facilitation of odour associations such that literally one sniff

Table 2.5 The main odour found in simple aliphatic esters



	R_1									
R_2	*Methyl*	*Ethyl*	*Propyl*	*Butyl*	*Pentyl*	*i-Pentyl*	*i-Butyl*	*i-Propyl*	*S-Butyl*	*t-Butyl*
Formate	E	E/F	E/F	E/F	E/F	F/E	F/E	F/E	F/E	M/E
Acetate	F/E	F/E	F	F	F	F	F/E	F/E/M	F/M/E	M
Propionate	F/E	F/E	F	F	F	F	F/E	F/M/E	F/M	M
Butyrate	F/E	F/E	F	F	F	F	F	F	F	M/F
Pentanoate	F/E	F/E	F/E	F/E	F/E	F	F	F	F/M	M
i-Pentanoate	F/E	F	F	F	F	F	F	M/F	M	M
i-Butyrate	F/E	F	F	F	F	F/M	M/F	M	M	M
tri-Methyl Acetate	F/M	F/M	F/M	F/M	F/M	F/M	F/M	F/M	F/M	M

This is unpublished data of Squirrell and Dodd. Most of the esters were commercial samples; some were synthesized in our laboratory. The odours were evaluated by a small team which included a perfumer. The aim of the work was to discover the main odour notes. These were: E ethereal; F fruity; M minty. Where more than two descriptors are used, the dominant note is shown first. Many of the esters showed minor notes, e.g. humus, earthy; but these are not recorded here. One limitation of the study was the purity of the odorants. However, the study sufficed to show that within a class of simple odorants restricted to one functional group, the shape of the molecule determines the odour. This is seen most clearly with the isomers – t-butyl tri-methylacetate and butyl pentanoate. The first compound, the molecules of which are spherical, has a marked minty odour; in fact most chemists would not recognize the nature of the chemical from its odour. In contrast, the second compound, the molecules of which are almost linear, in a stretched conformation, show fruity notes with no minty notes.

It may be worthwhile carrying out a larger study of this series of molecules including many more samples, particularly higher members and alicyclic esters. All of the odorants should be purified by spinning-band distillation and any impurities should be identified by gc/ms. In addition, the odour evaluations should make use of more sophisticated sensory evaluation methods, e.g. multidimensional scaling, and should use large panels. A conceptually 'simple' study of this kind would require a large research team for its implementation.

may lead to a strong *imprint*. The cultural evidence on perfume preferences suggests that there is a universal liking for musk odours. This could arise because we experience this type of odour *in utero* (humans secrete musky molecules), or it might indicate a special type of binding site which results in an 'innate' preference for this odour type. Experiments on this topic might be a fruitful way of exploring some of the molecular aspects of the psychology of perfumery.

The breakdown of 'simple' odour–structure rules inferred from a small number of examples is illustrated by some findings (Squirrell and Dodd, 1988). Most of us were told in our elementary chemistry that esters have a 'fruity' smell. The data shown in Table 2.5 show that the story is more complex, even for simple esters.

2.8 RECEPTOR EVENTS IN PERFUMERY

Perfumery is one of the earliest recorded crafts and the basic techniques of today's perfumers are essentially the same as those of their Egyptian predecessors 4000 years ago. It is a matter of selecting fragrant oils and learning how to blend them. The aim is an *accord* of odours in which the specific odours and personalities of the individual odorants has been submerged, so that new and unsuspected odours can emerge. Despite the increasingly frenetic atmosphere of commercial perfume laboratories, the activity of blending perfumes has a distinctly spiritual element. Perfumes reach the recesses of our memory and unleash our unsuspected feelings. Those of us who are perfumers feel that there is no earthly substitute for the joy of a quiet afternoon in a perfume studio! It may be a surprise, therefore, to observe the ugly word 'receptor' making an appearance. It hints of drug mechanisms and the associated shape changes in membrane proteins. It appears to be a term shorn of spiritual insight. How can it justifiably make its appearance in a perfume studio?

The clue to the emergence of receptor studies in the perfumery industry lies in the history of scientific research. The earliest and still the most substantial area of research is concerned with odorants. As mentioned above, synthetic odorants allow the perfumer to explore odour effects unobtainable using only natural oils. Thus, in 1921, with 'Parfum No. 5' from the fashion house of Chanel, Ernest Beaux used the aliphatic aldehydes, whose odours when concentrated are often unpleasant, to create a new family of perfumes. More recently, research in the laboratories of Firmenich has given us the damascenones and other members of the highly esteemed family of 'nature identical' odorants. These odorants give us the several striking accords found in contemporary perfumes including 'Nahema', 'Poison' and 'Kouros'.

The dominant themes in the laboratories of perfume manufacturing

companies have been, first, the discovery of the chemical composition of natural flower oils, and secondly, the invention of new odorants with perfumery potential. The first goal has been very successful. The industry has pioneered new analytical methods, in particular the combination of gas–liquid chromatography with mass spectrometry. One of the spectacular findings in this research is the class of key perfumery materials designated as 'key impact' odorants (Ohloff, 1978); some of these chemicals are shown in Table 2.4. They have such astonishingly low threshold values that the merest trace of these odorants give an oil its characteristic odour nuance.

The discovery of the trace odorants presents to the industry a paradox. They give the perfumer the olfactory equivalent of the artist's laser-light. But the novelty of both the new light effects and the new odour effects can obscure the basic artistic techniques which have held in both domains during the past century. Compare the subtlety of a classical French perfume, 'Mitsouko', for instance, with the aggressive, almost trigeminal quality of some recent American perfumes which depend on the new key impact odorants. It is as if these novel, dazzling chiaroscuro olfactory effects have so seized the imagination of the perfumer that all classical considerations of the form of perfumes have been put aside. Perhaps it could be argued that they represent the olfactory equivalent of non-representational art, and that in time, our noses could be educated to the new perfumery forms?

A second paradox with the new materials is that it has become almost cost-ineffective to hunt for new materials present in even lesser amounts. The cost of identifying them might not be recouped by the sales of such powerful materials. This is especially so, given the increasing concerns about the safety of fragrance materials. The research pursued in the area of the first theme, the composition of oils, has been pure chemistry. To solve these problems it was not necessary to take an interest in olfactory mechanisms. Hence we find that the perfume industry has traditionally supported conferences such as those on essential oil chemistry.

The second theme, the invention of new odorants with novel perfumery effects, has brought the industry nearer to the community of olfactory scientists. In this area of research it has been necessary for the perfumery chemist to take an interest in structure–activity relationships. While these relationships assume an underlying pattern of receptors, an understanding of the receptors was not necessary for experimental work. The systematic synthesis of new families of odorants became particularly intensive during the 1950s and 1960s and led to many novel perfumery chemicals, notably the non-nitro musk families.

Clearly the stimulation of olfactory receptors by odorants is a branch of molecular pharmacology. Just as the mechanisms of mood changes induced by neuroactive drugs are usefully pursued at the receptor level, so we can presume that studies of olfactory mechanisms at this level will help explain

aspects of the action of perfumes. The biochemistry of smell receptors has lagged far behind that of the other neuroreceptors. It is important that the perfume industry realizes that the critical mass size of biochemistry research groups interested in olfactory mechanisms has now been achieved and rapid progress can be expected during the next few years.

The literature of perfumery gives little hint of the recent dramatic progress in our understanding of olfactory molecular mechanisms. A little history may help here. The first of the modern studies on olfactory mechanisms started in the 1950s. The competing hypotheses of this period were the vibrational hypothesis of Wright and the so-called stereochemical hypothesis of Amoore; the kernel concept of both owes much to earlier olfactory hypotheses (Moncrieff, 1967).

In the 1950s came the publication of the famous 'little blue book on smell' (SCI Monograph No. 1, 1957), where we saw a range of elegant odour–structure studies based on extensive experimental programmes. The authors tried to explain their results in terms of the properties of the supposed receptors. It is striking that one of the outstanding contributors, Leopold Ruzicka, was able to build on the concepts of molecular parameters he had outlined previously in 1918.

The first biochemical investigations on olfactory epithelia began in the 1960s (Ash, 1968; Dodd, 1971). Some of the major biochemical themes in that decade – cAMP, liquid crystalline properties of phospholipids and allosteric mechanisms – were to be proved as seminal developments for olfactory mechanisms. During the 1970s the number of biochemists interested in olfaction increased. In the UK, in 1973, the first symposium on molecular mechanisms in chemoreception was held (Poynder, 1974). International scientific bodies devoted to both smell and taste, such as the European Chemoreception Research Organization (ECRO) and American Chemoreception Society (ACHEMS), were both formed in that decade. By the end of the decade the role of cAMP in olfactory transduction had been recognized (Kurihara and Koyama, 1972; Minor and Sakina, 1973; Menevse, Dodd and Poynder, 1977); studies on the identification of olfactory receptor proteins had begun using a variety of chemical modification methods (Getchell and Gesteland, 1972; Menevse *et al.*, 1977); and there was a clear recognition that the emerging field of membrane biochemistry would provide the techniques necessary to solve the olfactory transduction problem.

Perhaps the most important development of the 1970s in the approach to receptor mechanisms was essentially a psychological one. Whereas up to the 1960s it was widely believed that olfaction could be explained only on the basis of unusual molecular mechanisms, found only in olfactory neurones, it was now clear that such esoteric explanations were no longer necessary.

The 1980s has seen a spectacular increase in experimental studies on olfactory mechanisms. New, large research groups specializing in olfaction

began to appear, associated with Pelosi in Italy, Polak in France, Anholt and Snyder in the USA and with Lancet in Israel. In 1981 a seminal book on the topic was published, *Biochemistry of Taste and Olfaction* (Cagan and Kare, 1981). In 1985 the critical mass size of biochemists necessary for such difficult work was achieved and, for the first time, a meeting of biochemists working on olfaction was held at the University of Warwick, sponsored by NATO.

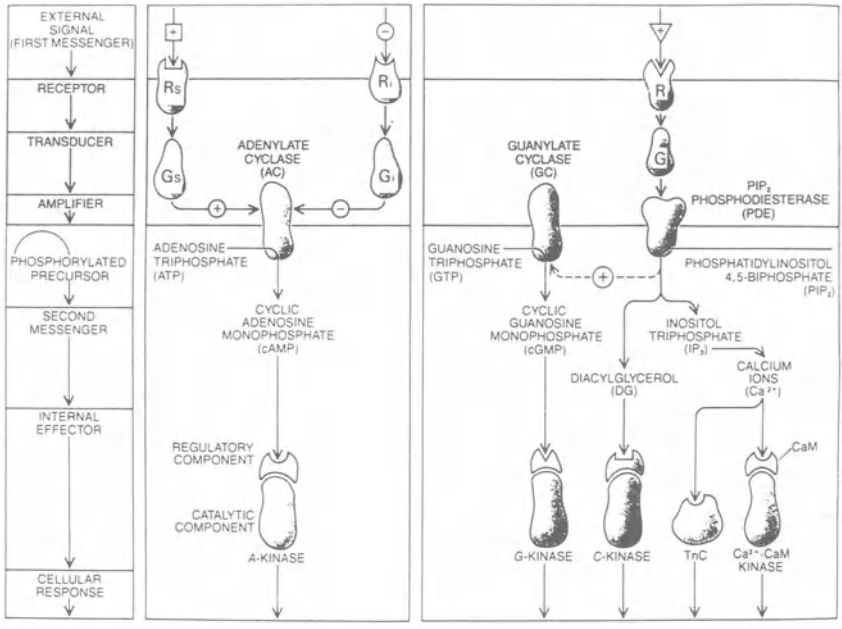
The general features of the vertebrate olfactory system have been described by Dodd and Squirrell (1980). Our current understanding of the receptor events in the detection of perfumes is summarized in Fig. 2.3. This scheme is essentially an updated version of the mechanisms previously proposed (Dodd and Persaud, 1981). Unlike most of the earlier proposals for olfactory stimulation which were purely speculative and lacked experimental support (Wright, 1964; Amoore, 1970, Moncrieff, 1967), the hypothesis outlined in Fig. 2.3 is supported by a variety of evidence from biochemical experiments with both rats and frogs.

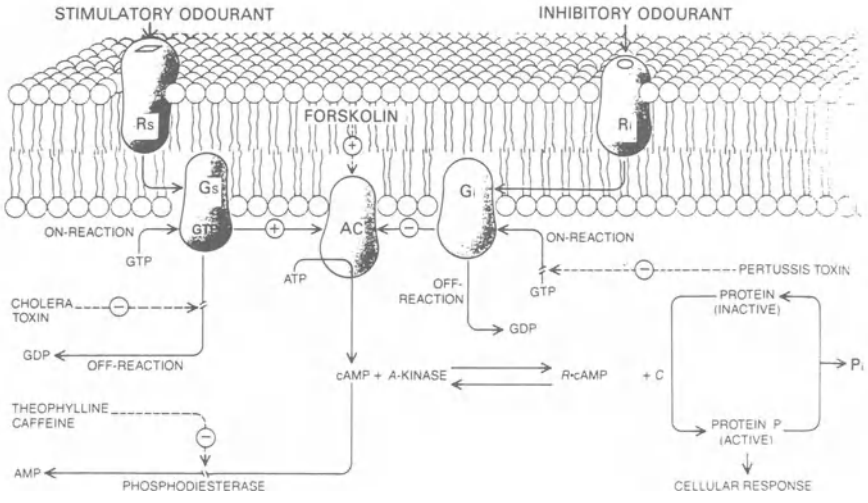
Biochemists currently approach the problem of olfactory molecular mechanisms by asking questions such as: are the well-known mechanisms involved in the detection of hormones by receptor cells actually operative in the olfactory sensory epithelia? This philosophy, though well understood by biochemists, is not fully appreciated by many olfactory scientists. This new approach is in marked contrast to the tendency of non-biochemists to look for esoteric biochemical mechanisms.

Biochemistry is one of the best-developed sciences involved in smell science. The great edifice of modern biochemical knowledge rests on a small number of fundamental, powerful general principles. In principle, this body of knowledge can be deduced from these principles. In practice, this is rarely possible since it is clear that there are still many fundamental biochemical phenomena which remain to be explained. However, given the uniformity, throughout the living world, of molecular structures; of metabolic cycles; of bioenergetic mechanisms; and of membrane–receptor events (Zubay, 1983), we can in the first instance reasonably anticipate that olfactory mechanisms share much of the molecular machinery found in other sensing cells.

The best-understood sensory receptor mechanism in vertebrates is that of vision, especially in the rod cells of the retina (Stieve, 1986). Using the principle of uniformity of molecular features outlined above, it was logical for biochemists to look for features in the rod transduction mechanisms which might be useful for olfactory mechanisms. The following features of retinal rod biochemistry are well established and they suggest points of interest for olfactory mechanisms.

The sensing cell for night vision has a specialized feature, the rod, which is derived from a cilium. The receptors are localized in this region of the cell. The receptor is a special protein, rhodopsin, which lies deeply embedded in a


EXTERNAL SIGNAL (FIRST MESSENGER)
RECEPTOR
TRANSDUCER
AMPLIFIER
PHOSPHORYLATED PRECURSOR
SECOND MESSENGER
INTERNAL EFFECTOR
CELLULAR RESPONSE
Rs
Ri
Gs
Gi
ADENYLATE CYCLASE (AC)
ADENOSINE TRIPHOSPHATE (ATP)
CYCLIC ADENOSINE MONOPHOSPHATE (cAMP)
REGULATORY COMPONENT
CATALYTIC COMPONENT
A-KINASE
R
G
GUANYLATE CYCLASE (GC)
PIP2 PHOSPHODIESTERASE (PDE)
GUANOSINE TRIPHOSPHATE (GTP)
PHOSPHATIDYLINOSITOL 4,5-BIPHOSPHATE (PIP2)
CYCLIC GUANOSINE MONOPHOSPHATE (cGMP)
INOSITOL TRIPHOSPHATE (IP3)
DIACYLGLYCEROL (DG)
CALCIUM IONS (Ca2+)
CaM
G-KINASE
C-KINASE
TnC
Ca2+-CaM KINASE


STIMULATORY ODOURANT
INHIBITORY ODOURANT
Rs
Ri
FORSKOLIN
Gs
GTP
Gi
AC
ON-REACTION
GTP
ATP
ON-REACTION
PERTUSSIS TOXIN
CHOLERA TOXIN
OFF-REACTION
GTP
GDP
GDP
OFF-REACTION
PROTEIN (INACTIVE)
cAMP + A-KINASE
R•cAMP
+ C
Pi
THEOPHYLLINE CAFFEINE
PROTEIN P (ACTIVE)
AMP
PHOSPHODIESTERASE
CELLULAR RESPONSE

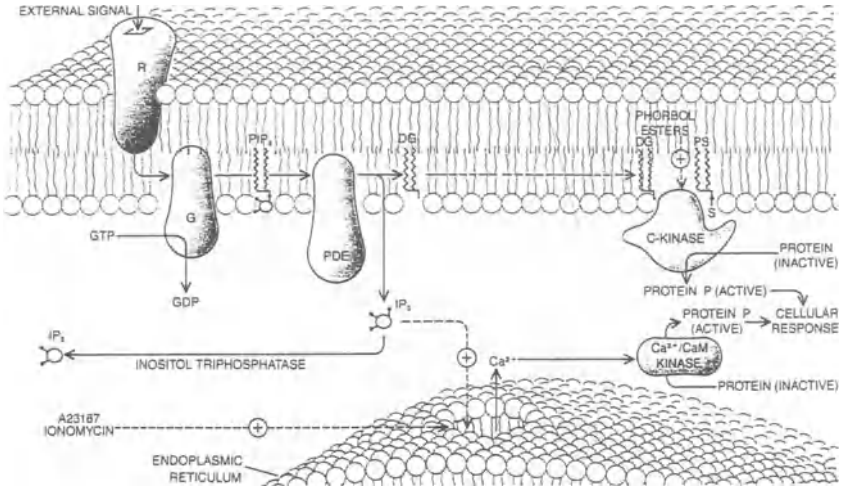


Fig. 2.3 A summary of the transduction steps currently believed to occur in olfactory sensing cells.

The format of the figure follows similar diagrams by Berridge (1986). The ideas summarized in the figure rely heavily on evidence from other types of receptor cells. The evidence for these mechanisms operating in olfactory cells is coming from recent experiments in the various groups of biochemists working on olfactory mechanisms.

membrane. The light we see is absorbed specifically by this protein and the absorption causes the protein to change its shape and thereby to become 'activated'. The activated protein, acting through a linkage called the G-protein, activates an enzyme system which changes the internal concentration of the universal second messenger molecule, cAMP. This messenger, possibly in combination with other messenger molecules, alters the amount of open pores in the membranes through which ions can flow. The consequent flow of ions changes the potential across the cell membrane.

The events described above are the main molecular events in the rod transduction scheme. They represent the results from over thirty years' intense study by a considerable body of scientists. A comparatively tiny band of biochemists has worked on olfaction during the past twenty years, but they have profited by the preceding work on rod mechanisms.

The olfactory sensing neurones also have specialized receptor membranes which occur in recognizable cilia protruding from the top of the cell into the nasal passage. These membranes have a very high density of proteins (Menco *et al.*, 1976; Kerjaschki and Horander, 1976). This is a feature which is welcome to a biochemist since it suggests mechanisms which will optimize the ability of the membrane to capture perfume molecules. The properties of

some of the membrane proteins have been investigated. These properties are, at the least, consistent with a role of a perfume receptor protein (Chen and Lancet, 1984).

The olfactory cells have a second messenger system which, in many respects, resembles that found in the retinal rod cells. The tissue contains a high level of the key enzyme, adenylate cyclase (Kurihara and Koyama, 1972). If the intracellular levels of the material produced by this enzyme, cAMP, are changed, the electrical signals produced by the cells when they detect perfume molecules are altered (Minor and Sakina, 1973; Menevse, Dodd and Poynder, 1977). Perfume molecules activate the cyclase enzyme (Pace *et al.*, 1985; Shirley *et al.*, 1986, 1987a, 1987b). There is also a G-protein which connects the receptor proteins to the enzyme system (Anholt *et al.*, 1987). The ion pores in the membrane which respond to the enzyme system, and are responsible for the electrical changes in the membrane, are beginning to be understood (Labarca, Simon and Anholt, 1988).

There are several points which should be borne in mind concerning the mechanisms outlined in Fig. 2.3. The experimental evidence still needs to be verified in several crucial respects. The biochemistry of the tissue is relatively unexplored and there may be many types of molecule present in the cells which would alter the picture we have presented. An additional point is crucial for perfumery. The biochemical evidence comes from experiments with rats and frogs; it is difficult to work with human olfactory tissue, but it is assumed that human olfactory cells have the same mechanisms.

Currently one of the central questions being asked about the transduction mechanisms is of particular relevance to perfumery: do different types of smell use different transduction channels? For example, it is known that some types of perfume molecule fail to stimulate the cyclase enzyme system. This has prompted the search for other types of second messenger systems. Two candidate systems are represented respectively by arachidonic acid (Piomelli *et al.*, 1987) and products of phosphoinositide metabolism (Berridge, 1986; Michell, 1986). Phosphoinositide metabolism has been found in rat olfactory mucosa (Russell *et al.*, 1988) but it has yet to be demonstrated that it is involved in the detection of perfumes. Interestingly, there is also phosphoinositide metabolism in invertebrate visual cells and its role there also remains unclear (Saibil, 1986). There might be a clear biochemical basis for striking perfumery phenomena such as the universal liking for musky molecules and the universal dislike of many thiols and amines. Perhaps the two classes of smell use different enzyme systems.

The central problem in relating receptor events to perfumery phenomena has to do with both the number and type of receptor proteins. The solution of this problem is the goal of biochemical studies. In a seminal paper, at a time when the concept of multiple receptors was relatively undeveloped, Polak (1973) proposed that the detection of perfumes involved multiple

receptors. It is thought that a perfume molecule may bind to several types of receptor proteins. This is the classical biochemical problem of multiple binding sites appearing in a new guise.

One experimental approach to the receptor problem lies in attempts to achieve a selective inhibition of receptors responding to different kinds of perfumes. A variety of methods have been used (Menevse *et al.*, 1977). The results from several such studies show evidence of selective effects (Squirrell and Dodd, 1988; Shirley, Polak and Dodd, 1983). However, to fully describe the pattern of results using even a single inhibitory reagent is a formidable task. For example, one of the most interesting inhibitions of olfactory responses was discovered in our laboratory by Ernest Polak. This was the selective blocking of some odour responses by the protein, concanavalin A (Shirley *et al.*, 1987b; 1987a). To date, over 120 odours and perfume molecules from several classes have been studied, but despite the large number of stimuli used and the obvious selectivity of the effect, it is clear that the mechanism of the effect is complex and that a full explanation will require much larger experiments.

Polak is now studying the receptors using monoclonal antibodies (Polak, 1988). These have proved to be powerful tools with other types of receptor. We also have, for the first time, smells which can completely abolish the sense of smell (Dodd, 1988). These may also prove to be useful molecular probes for dissecting the receptor membranes.

What happens to the perfume molecules after they have been detected by the receptor cells? This is a question for future biochemical work. It is particularly intriguing to know what happens to the nose of a perfumer who is working all day in the presence of high levels of perfume. What happens to all the perfume molecules which must saturate the cells? A possible answer lies in the discovery of enzyme systems in the olfactory tissue which can metabolize perfumes. We have recently discovered that a class of unusual perfume molecules, described by some people as having the most disagreeable smells they have ever encountered, interact with a P-450 enzyme system in olfactory mucosa (Jenner, Wood and Dodd, 1987). This enzyme system may possibly be involved with the clearance of perfume molecules from the sensing tissue.

2.9 CONCLUSION

One of the principal aims of my research is to provide explanations of perfumery phenomena in terms of the molecular events taking place in smell receptors. Clearly we are at the very beginning of what will be complex explanations. Such complexity is beginning to be a feature of all branches of molecular neurobiology. There are many intriguing issues to explore.

1. What is special about perfumes such as nicotine? It is now known that besides being a powerful drug, nicotine is an odorant (Edwards *et al.*, 1987; Edwards and Dodd, 1988). Will it be possible through a study of the underlying molecular mechanisms of this type of odorant to design novel and exceedingly powerful perfumes?
2. Will receptor studies assist in the discovery of new impact perfume molecules, perhaps primary odours, which will assist in the formulation of more beautiful 'accords'?
3. Is there a special set of receptors for pheromones? Can we through understanding the structure of such receptors design novel perfume effects?

Edmond Roudnitska, perhaps the master perfumer of this generation, has drawn attention to a problem which faces all who create perfumes. There are so many raw materials available that there is a temptation to go for complexity of composition. Roudnitska (1984) argues for the aesthetic superiority of simple compositions. Perhaps an understanding of the receptors and their interactions will provide a basis for 'simple' composition.

Finally, we must emphasize that we are on the threshold of new insights into the scientific basis of perfumery phenomena. It becomes more important than ever for non-technical people in the perfumery industry to have the opportunity to read about these developments in a simple format (e.g. Dodd, 1980). In the Warwick Olfaction Research Group we hope to combine the new brain-imaging methods, described by Van Toller in Chapter 7, with some of the biochemical methods. This will be a start on the long journey to explore the mind–body interactions in the sense of smell.

3

The significance of odorous steroids in axillary odour

D. B. GOWER, A. NIXON and A. I. MALLET

3.1 INTRODUCTION

For at least the past two decades many research groups have been interested in the glands that are involved in the odours emitted by humans, and the sources and composition of such odours and whether they provide olfactory cues which elicit responses in other humans. The apocrine glands, especially those in the axillae, are thought of as strong candidates for the source of some human odours. However, although the axillae and their role in human olfaction will be examined here, it is worth noting that apocrine glands are also found concentrated elsewhere in the body. For example, the mammary areolae contain these glands and it is conceivable that their secretions are involved in maternal–neonate interactions that have been discovered recently (MacFarlane, 1975; Russell, 1976; Schaal *et al.*, 1980). It has been shown clearly that the human neonate can distinguish between the smell of breast-pads taken from its mother and those taken from a strange mother. Furthermore, the infants became less restless when they smelled their mothers' odour (Schaal *et al.*, 1980). Schleidt and Hold (1982) sum up this behaviour in the words: 'die Mutter stillt das Kind.'

3.2 THE HUMAN AXILLA

The most numerous, and largest, human sweat glands are found in the axillae, where apocrine and eccrine glands occur in an approximate 1:1 ratio (Montagna and Parakkal, 1974). In addition to these, sebaceous glands are found connected to each of the hair follicles (as shown in Fig. 3.1). Apocrine

glands are tubular structures composed of a coiled secretory portion and a straight, narrow duct which runs parallel to the hair follicle and opens into the upper portion of the pilary canal, above the opening of the sebaceous gland. Thus both the apocrine and sebaceous secretions reach the skin surface via the hair follicle, whereas the eccrine glands open directly on to the surface, (see Fig. 3.1).

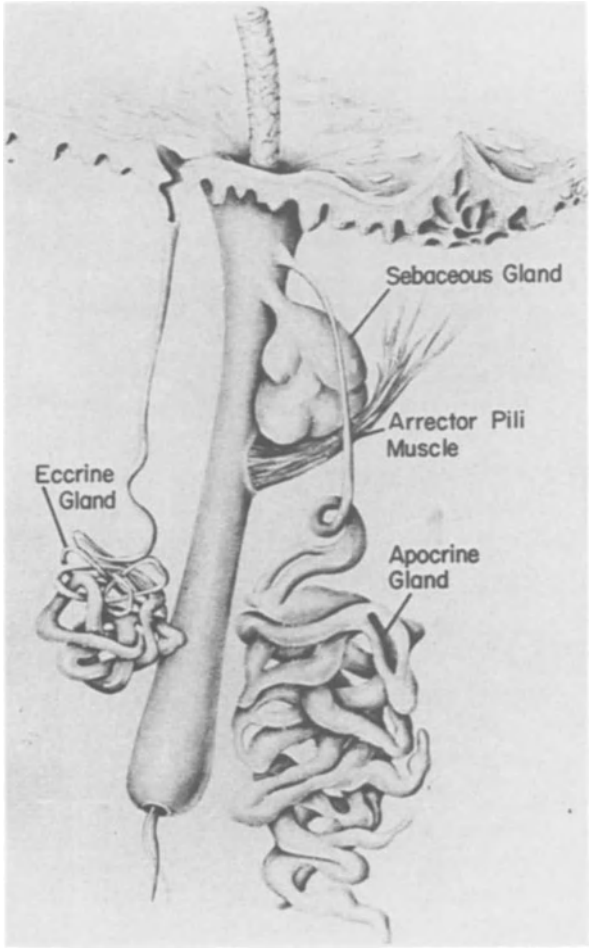


Fig. 3.1 Structure of axillary skin (from Montagna and Parakkal, 1974).

A number of factors make the axillae suitable for odour production: (a) the contents of the apocrine gland secretions may serve as bacterial substrates; (b) moisture is available from the eccrine glands; (c) there is a resident population of bacteria to transform non-odorous to odorous

substances; and (d) the presence of axillary hair may assist in odour dispersal. In view of this, the possible role of the axillae in human sexual relationships has been suggested (Brody, 1975). An unnamed writer in *New Scientist* (21 November 1985), comments on the two ways in which the axilla may be viewed:

> Many deem the human arm-pit a dank, unprepossessing corner of the body, fit only for frequent applications of soap and deodorant. Nevertheless, a dedicated few regard the axilla with mixed feelings, recognising that this charming grotto is full of intriguing odorous surprises.

3.3 THE APOCRINE GLANDS

The secretions of apocrine, sebaceous and eccrine glands are necessary for odour production, but the apocrine glands have been suggested as prime candidates for making a significant contribution to human odour. In early work Rothman (1954) drew attention to the strong axillary odour in adolescents which becomes less intense with maturity. Significantly, Mongolian races typically have very little or no axillary odour and possess small, relatively inactive apocrine glands (Hurley and Shelley, 1960). It seems that in Japanese societies (Bird, 1982) an individual who has any axillary odour is regarded as having bromidrosis, i.e. an abnormal or excessive odour of sweat.

Apocrine glands are stimulated by the 'flight and fight' reaction of adrenalin release from the adrenal medulla, so it is not surprising that the odour emitted from the axillae can provide information about an emotional state. Several workers (e.g. Schleidt and Hold, 1982) have shown that, after puberty, when the apocrine glands have begun to function, odour discrimination between genders becomes possible. The importance of olfactory cues in neonatal recognition of the mother was alluded to earlier, but it appears that this mother–neonate relationship is not lost as the age of the child increases. Schaal *et al.*, (1980) showed that 3–5-year-old children could correctly identify T-shirts which had been worn by their mothers. Conversely, mothers could correctly identify their own children (using the worn T-shirt method) and preferred their odours to those of strange children. In further experiments Yfrantis (1980, cited in Schleidt and Hold, 1982) showed that women were unable to distinguish between boys and girls before puberty, but in contrast gender discrimination becomes possible in adults, as shown in American (Russell, 1976) and in German, Italian and Japanese (Schleidt, Hold and Attili, 1981; Schleidt and Hold, 1982) individuals. Thus, taken together, these findings indicate that fully functioning apocrine glands are necessary to make discrimination possible between men and

women by olfactory means, and that the secretions of these glands may contribute markedly to human odour.

3.4 COMPOSITION OF APOCRINE SECRETIONS

Hurley and Shelley (1960) showed that intradermal injection of adrenalin (1:1000 in saline, 0.01–0.1 ml) into the axillary vault caused apocrine 'sweating'. The apocrine secretions so produced usually appear at the orifices of the hair follicles and form flat, globular droplets of turbid white fluid. In contrast, droplets of eccrine sweat are clear and spherical and emanate from pores, usually away from hair follicles. Apocrine secretions, collected by micropipette, dry rapidly to form a glistening, glue-like residue over the orifice of the follicles. Typically, approximately 1 μl quantities may be collected from Caucasian subjects, although Hurley and Shelley noted that greater volumes could be collected from Negroes.

Recently, the composition of apocrine secretions has been reviewed. (Gower *et al.*, 1985; Labows, 1988). In their early work Hurley and Shelley (1960) detected protein, carbohydrate and ammonia; the presence of lipids was suspected on the basis of histochemical studies, although the insensitivity of other methods utilized precluded the estimation of lipids. Later work has shown that approximately 10 per cent protein is present, and although the enzymic content of apocrine secretions has not been studied, excised apocrine glands contain a number of enzymes such as β-glucuronidase, 3-hydroxysteroid dehydrogenase, 4-ene-5α-reductase and esterase as well as lysozyme (see Labows, 1988).

Table 3.1 Lipid and cholesterol profiles from apocrine secretions, axillary sweat and sebum (from Labows, McGinley and Kligman, 1982; Bird and Gower, 1982)

	Percentage composition			
	Glandular secretion		*Skin surface extract*	
	apocrine[a]	*sebaceous*[b]	*axillae*	*facial*
Cholesterol	76.2	3.4	8.9	1.5
Cholesterol esters	0.9[c]	21.8	8.8	3.0
Wax esters	3.6[c]	–	21.2	26.0
Squalene	0.2[c]	19.0	13.4	12.0
Glycerides and fatty acids	19.2[c]	55.9	47.4	57.5
Total lipid	20 μg/μl	–	60 μg/cm^2	100 μg/cm^2

Notes:
[a] Stimulated and collected at skin surface.
[b] Collected from microdissection of gland (Puhwel, Reisner and Sakamoto, 1975, pp. 406–10).
[c] Probably of sebaceous origin.

The lipids consist of fatty acids and steroids, and of the former, propanoic and isovaleric seem to be implicated in the 'sweaty' odour which is produced on incubation of the freshly produced secretions. Of the steroids present, cholesterol makes up about 1 per cent by weight, and although the nature of the collection method results in contamination of apocrine secretion by sebum from sebaceous glands, the amount of cholesterol is greater than would be expected from these or from skin-surface lipid (Table 3.1). Labows *et al.* (1979) state that cholesterol is characteristic of apocrine secretions (see also Bird and Gower, 1982). Cholesterol esters are also present and are probably formed by bacterial (*Staphylococcus epidermidis*) hydrolysis of triglycerides and subsequent esterification of cholesterol with the released fatty acids (Puhwel, Reisner and Sakamoto, 1975). In addition to cholesterol and its esters, two C_{19} steroids and their sulphates have been identified in fresh apocrine secretions, namely androsterone and dehydroepiandrosterone (Table 3.2) (Labows *et al.*, 1979). These workers were unable to detect the odorous steroids, 5α-androst-16-en-3-one (5α-androstenone) and 5α-androst-16-en-3α-ol (3α-androstenol); the significance of this will be seen below.

Table 3.2 Steroids present in sterile apocrine secretions

Apocrine secretions[a]	*Method*	*Reference*
Cholesterol	g.c.–m.s.	Labows *et al.*, 1979
Androsterone (and sulphate)	g.c.–m.s.	Labows *et al.*, 1979
Dehydroepiandrosterone (and sulphate)	g.c.–m.s.	Labows *et al.*, 1979

Notes:
g.c./m.s. – gas chromatography/mass spectrometry.
[a] Stimulated with intradermal injection of adrenalin (0.05 ml, 1 in 1000).

3.5 MICROBIOLOGY OF THE AXILLA AND ITS RELATIONSHIP TO AXILLARY ODOUR

In their early experiments with apocrine secretions Shelley, Hurley and Nichols (1953) showed that freshly produced secretions (using intra-dermal adrenalin injections) were odourless. These workers found that when apocrine sweat from axillae (without ethanol washing) was incubated at room temperature, the characteristic axillary odour was produced after six hours. Odour did not develop if incubations were carried out at 0°C or if the sweat was treated with hexachloraphane, an anti-bacterial. Shelley, Hurley and Nichols concluded that axillary odour was produced *in vivo* by bacterial action on substrate(s) present in the apocrine secretions. Numerous researchers have provided results amply confirming this notion, and the

bacteria associated with apocrine odour have also been studied extensively. Strauss and Kligman (1965) inoculated sterile apocrine sweat with various species of bacteria and suggested that *Proteus vulgaris*, coagulase positive micrococci and coryneforms were largely responsible for odour production during 24 hours at 37°C. Shehadeh and Kligman (1963) showed that only coagulase positive cocci and coryneforms were associated with odour production, and that loss of the Gram positive strains was associated with loss of odour. Since that time numerous studies of human axillary microflora have been undertaken and reviews have been published (Leyden *et al.*, 1981; Labows, McGinley and Kligman, 1982; Jackman, 1982; Jackman and Noble, 1983; McGinley *et al.*, 1985; Gower *et al.*, 1985). In general, recent studies indicate that 70–80 per cent of the axillary flora are coryneforms (predominantly *Corynebacterium* spp). In a large study of 163 males and 122 female subjects (Jackman and Noble, 1983) 360 coryneform isolates were identified to generic level by cell-wall type. Axillary coryneforms were shown to comprise 83 per cent, Corynebacterium 5 per cent, Brevibacterium and other coryneforms 12 per cent. Jackman and Noble (1983) showed that nearly all of their subjects possessed axillary microflora that were either coryneform or micrococcal dominated. For example, in men 64 per cent had a coryneform-dominated flora and 27 per cent had a coccal-dominated flora,

Table 3.3 Mean counts of axillary bacteria in nineteen men, aged 18–45: effects of deodorant use

Coryneform dominated		*Micrococcal dominated*	
Deodorant	*No deodorant*	*Deodorant*	*No deodorant*
3.205×10^6	3.372×10^7	3.384×10^5	6.09×10^6

Ratios for:	Coryneform dominated / Micrococcal dominated	Deodorant	9.47
for:	Coryneform dominated / Micrococcal dominated	No deodorant	5.5
for:	Coryneform dominated	No deodorant / Deodorant	10.52
for:	Micrococcal dominated	No deodorant / Deodorant	18.0

whereas in women the reverse ratio was noted. This important finding confirms earlier work of Shehadeh and Kligman (1963), Marples and Williamson (1969) and Leyden *et al.* (1981).

Jackman (1982) refers to the fact that the mean aerobic count of $1.26 \times 10^6/cm^2$ in coryneform individuals was some five times higher than in coccal subjects. In our current work (Table 3.3), 19 men (aged 18–45) were studied. Microflora from left and right axillae were collected by the cup-scrubbing technique of Williamson and Kligman (1965) and the number and type of bacteria was determined. We wished to study the possible effects of deodorants or combined deodorants/anti-perspirants on both number and type of axillary microflora. The mean values (Table 3.3) show that deodorant treatment reduces by more than 10-fold the bacterial count in coryneform-dominated individuals and as much as by 18-fold in the case of micrococcal-dominated subjects. Further, the use of deodorants markedly affected the bacterial count in coryneform- as compared with micrococcal-dominated axillae. Without deodorants, the mean count was 5.5-fold higher in coryneform than coccal subjects, and this compares favourably with the data of Jackman (1982) and other workers. It should be noted that in calculating the means in Table 3.3 no account has been taken of the frequency of washing. In fact this varied markedly from once per week to three times per day (average 9.6 times per week). Only one subject routinely shaved his axillae. We found no obvious correlation between washing frequency and magnitude of axillary bacterial count or type, but the use of deodorants appeared to select for a coryneform-dominated as opposed to a micrococcal-dominated microflora. This is in conflict with other reports (Jackman, 1982); however, in this small study the effect did not achieve significance.

These non-correlations between washing frequency and bacterial count and type highlight the problems involved in this kind of study. Jackman (1982) has pointed out that the smaller number of axillary micrococci present relative to those of coryneforms might be due to a lack of appropriate bacterial nutrients on the skin surface which, in turn, could be related to the level of personal hygiene – 'a factor virtually impossible to assess accurately in surveys of this type'.

In the study of Jackman and Noble (1983) an attempt was made to monitor two related factors – those of absence of axillary hair and use of deodorants. In this connection it is noteworthy that nine out of eleven male factory workers, who did not use deodorants, had the highest proportion of 'coryneform' individuals. In contrast, a group of 32 female office workers, who all used deodorants and lacked axillary hair, had the highest proportion of 'coccal' individuals. However, in the current small study, in male subjects, there seemed to be no striking correlations between lack of deodorants and increase in coryneform-dominated individuals. If anything, there was a slight increase in micrococcal-type subjects if no deodorants were

used. As Jackman (1982) points out, it is very difficult, in essentially uncontrolled studies, to separate out other factors such as socioeconomic status. Since our subjects were drawn largely from academic and technical staff in higher education establishments, whereas those in the study of Jackman and Noble (1983) were factory operatives, this might be a possible explanation for the discrepant findings.

3.6 ODOROUS STEROIDS PRESENT IN APOCRINE SWEAT

Since freshly produced apocrine sweat is odourless until incubated with bacteria (as indicated above), it strongly suggested that non-odorous bacterial substrates were secreted, which were then modified to mixtures of odorous substances. Thus research efforts have been made, first, to identify such odorous substances, and secondly, to elucidate the pathways by which the non-odorous substances are metabolized by axillary bacteria.

We know now that some of the odorous substances present in apocrine sweat occur at extremely low picogram (10^{-12} g) levels, and sophisticated techniques, such as combined capillary gas chromatography/mass spectrometry are necessary for detection. Another problem in this type of research has been that of separating out the very small quantities of odorous substance from relatively massive amounts of other, often non-odorous, materials. This problem has been highlighted recently by Gower *et al.* (1985) and is also evident from current work reported here, in which we have measured small quantitites of odorous steroids in extracts of apocrine sweat or hair, against a 'background' of cholesterol, cholesterol esters, fatty acids, etc. Elaborate 'clean-up' procedures must be utilized (see also Bird and Gower, 1981).

However, despite these problems it has been possible to quantify odorous substances in axillary secretions. Labows (1988) has reviewed some of the earlier methods in which the axillae or even entire body were swept with an inert gas. The volatile substances were then collected in polymer traps and attempts made at identification. Other methods, probably more appropriate for identification of volatile substances in the axillae, have consisted of extracts of axillary hair or collection of apocrine secretion in axillary pads (Gower, 1972; Brooksbank, Brown and Gustafsson, 1974; Bird and Gower, 1981, 1982; Gower *et al.*, 1985; Tóth and Faredin, 1983, 1985).

Gower (1972) reported that the urinous-smelling steroid, 5α-androstenone (Fig. 3.2), could be identified by mass spectrometry in extracts of axillary pads worn by a male subject. Later work, using radioimmunoassay (RIA) (Claus and Alsing, 1976; Bird and Gower, 1981; Gower *et al.*, 1985) and gas chromatography/mass spectrometry with specific ion monitoring (Labows, 1988), has confirmed and extended this early observation. Men have significantly greater axillary 5α-androstenone levels than women (Fig. 3.3),

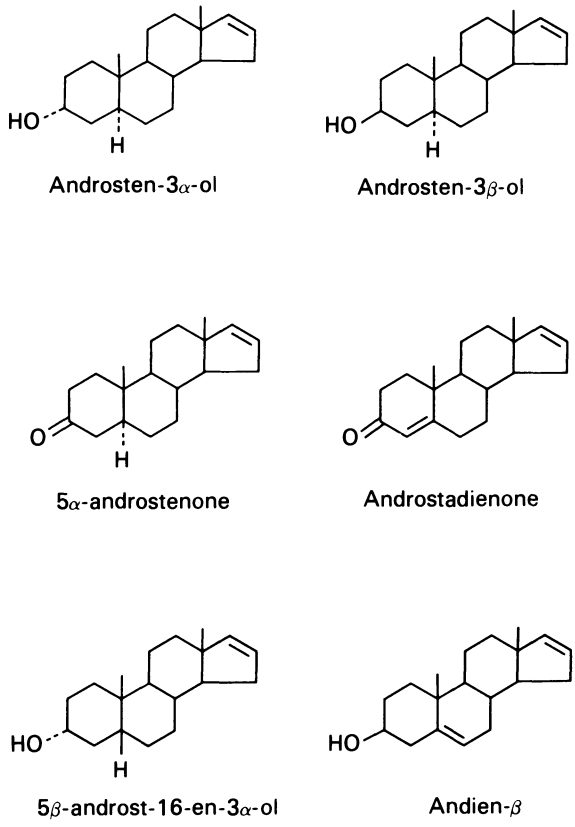


Fig. 3.2 Structures of some commonly occurring 16-androstenes. 5α-androstenone, 5α-androst-16-en-3-one; androstadienone, 4,16-androstadien-3-one; and andien-β, 5,16-androstadien-3β-ol.

the ranges being 12–1134 pmol/24 h and 13–39 pmol/24 h respectively. The geometric means were 51 and 9.5 pmol/24 h from men and women respectively, showing a highly significant difference (Gower *et al.*, 1985). Only one of the female subjects in the study of Bird and Gower (1981) has a 5α-androstenone level well into the male range, but this subject has not been further investigated with respect to type of axillary microflora present.

The range of 12–1134 pmol/24 h in men is very wide, and there are also considerable variations within individuals who were tested every two or three days. This is clearly shown by data for six men in Fig. 3.4. These data formed part of a study of effects of the general bacteriocidal agent, Povidone-iodine, on axillary 5α-androstenone. After treatment of one axilla with this solution, the 5α-androstenone concentration was very significantly reduced ($p < 0.001$) (Bird and Gower, 1982), and is in keeping with the suggestion

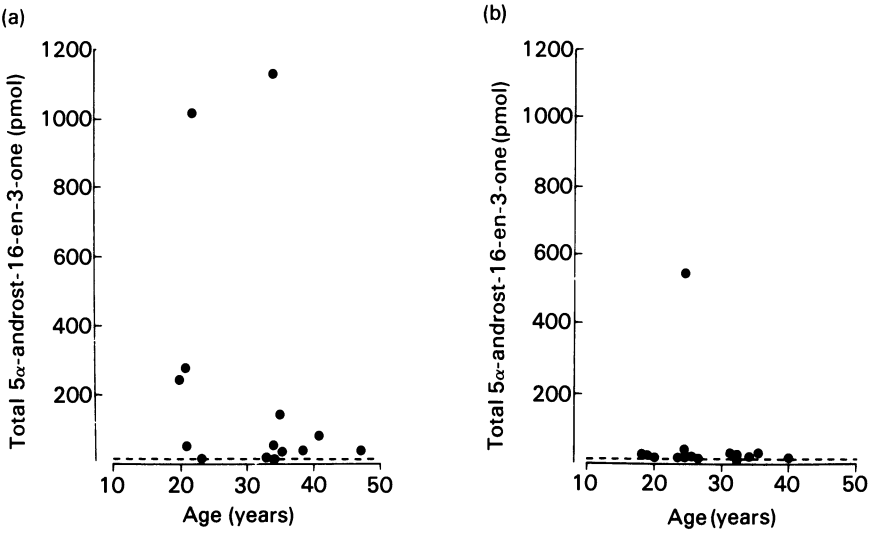


Fig. 3.3 Total 24-hour content of 5α-androst-16-en-3-one in collections from both axillae of (a) 14 healthy men, and (b) 15 healthy women. The lower limit of detection of the method (10 pmol) is indicated by broken line. (From Bird and Gower, 1981.)

that this odorous steroid is formed by bacterial action. In contrast, axillary cholesterol and squalene were not affected by Povidone-iodine.

Further studies of axillary 5α-androstenone (Gower *et al.*, 1985) showed that this was not related to age (18–41 years), degree of hirsutism (in women) or preferred hand of the subjects. This latter parameter was investigated because an earlier study (Bird and Gower, 1982) had shown that, in men, the level of 5α-androstenone from one axilla ('superior') was significantly higher than from the other ('inferior'). However, levels were linearly related to those of cholesterol in men but not to squalene (Gower *et al.*, 1985). As squalene is not found in apocrine secretions, but in sebum (Downing and Strauss, 1974; Leyden *et al.*, 1981) (see also Table 3.1), this suggests that 5α-androstenone does not correlate with sebaceous gland activity, as indicated also in earlier work (Bird and Gower, 1982). The relationship of axillary 5α-androstenone to testosterone was studied by Claus and Alsing (1976). Ten times more of the odorous steroid was shown to occur, even though the ratio of the two steroid concentrations in the peripheral blood plasma was 1:1.4. A number of other odorous steroids have been identified in axillary secretions, including 3α-androstenol (Brooksbank, Brown and Gustafsson, 1974), 3β-androstenol, 5,16-androstadien-3β-ol and 4,16-androstadien-3-one (Labows, 1988; see also Fig. 3.2).

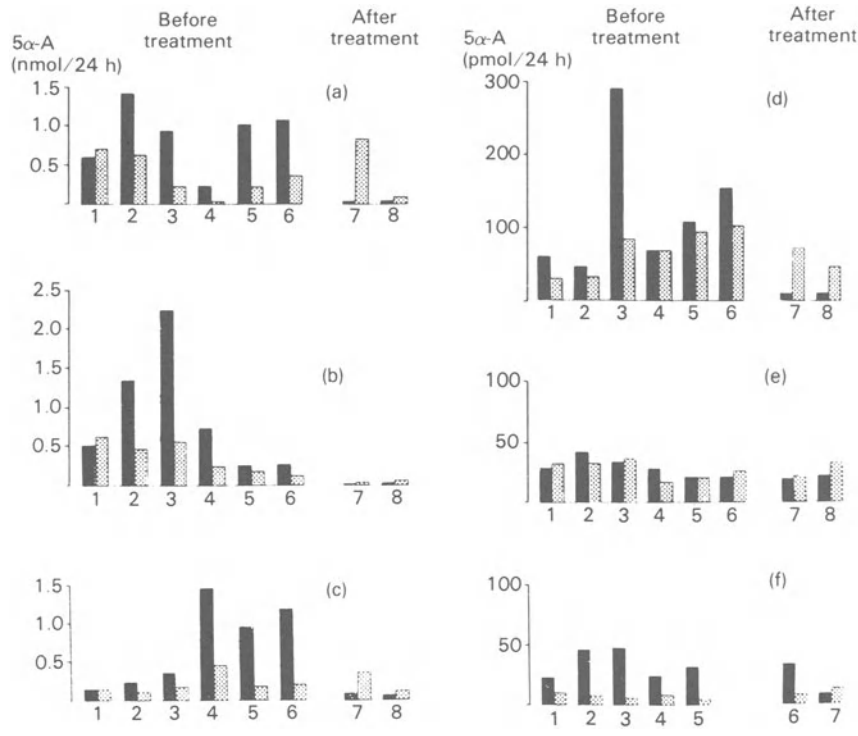


Fig. 3.4 The effect of Povidone-iodine on the human axillary area. The 5α-androstenone content of the 'superior' (■) and 'inferior' (▨) axillae of 6 adult male subjects (a)–(f) was measured by radioimmunoassay on five or six occasions. The 'superior' axilla for each subject was treated with the general germicidal agent, Povidone-iodine and the levels of 5α-androstenone measured on two further occasions. Note the difference in scales for subjects who were low secretors of 5α-androstenone. (From Bird and Gower, 1982.)

In some of our current studies we have exploited gas chromatography/mass spectrometry with specific ion monitoring. Earlier work from our group utilized radioimmunoassay (RIA), which although very sensitive (Bird and Gower, 1981, 1982), requires time-consuming chromatographic steps to separate 5α-androstenone because the method was not specific (Andresen, 1974). In the present work weighed quantities of axillary hair were taken from human subjects who had washed their axillae 24 hours previously with soap and water. The axillary hair (or sweat, in some experiments) was extracted with ethyl acetate, the extract dried and cleaned up with Florisil Sep-paks (Nixon *et al.*, 1986b) and then subjected to high-performance liquid chromatography (HPLC), utilizing a C_{18} (ODS) column. These

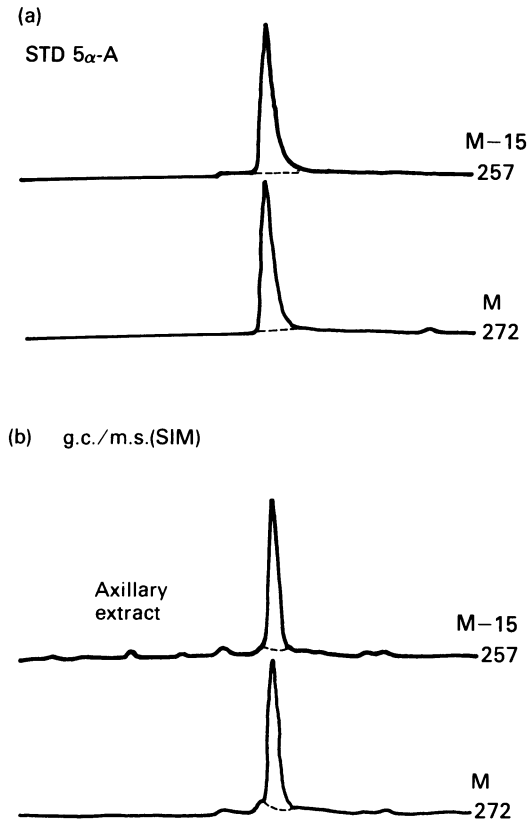


Fig. 3.5 Characterization of 5α-androstenone (5α-A) in an axillary extract from a male subject. After clean-up with Florisil Sep-paks (Nixon *et al.*, 1986b) and HPLC, the extract was subjected to capillary gas chromatography/mass spectrometry with specific ion monitoring. Retention times were 5 min 50 s and 5 min 50 s for the standard (272 and 257 respectively) and 5 min 52 s and 5 min 51 s for the extract (272 and 257 respectively). The mass spectra (not shown) were identical.

procedures were found to be an absolute requirement if minute quantities of odorous steroids were to be purified from extracts which originally contained large amounts of other lipid-type materials. After HPLC, the appropriate fraction was subjected to gas chromatography/mass spectrometry either as free steroid (monitored at the molecular ion 272 and 272–15, i.e. loss of a methyl group) or as the pentafluorobenzyloxime derivative (monitored at 467, the molecular ion, and 467–15, i.e. loss of a methyl group). Results obtained for the underivatized 5α-androstenone, which is eluted from the gas chromatography column at the same time as the authentic material are

Table 3.4 16-Androstenes present in axillary sweat and hair

	Method	*Reference*
Sweat		
5α-androst-16-en-3β-ol	g.c./m.s.	a,b
5,16-androstadien-3β-ol	g.c./m.s.	b
5α-androst-16-en-3-one	g.c./m.s.	c–i
4,16-androstadien-3-one	g.c./m.s.	b
Hair		
5α-androst-16-en-3α(β)-ol	g.c./m.s.	Gower *et al.*, 1985
5,16-androstadien-3α(β)-ol	g.c./m.s.	(reported here)
5α-androst-16-en-3-one	g.c./m.s.	(reported here)
4,16-androstadien-3-one	g.c./m.s.	(reported here)

Note:
g.c./m.s. – gas chromatography/mass spectrometry.
Sources:
[a] Brooksbank, Brown and Gustafsson, 1974, p. 864.
[b] Labows, 1988.
[c] Gower, 1972 p. 45.
[d] Claus and Alsing, 1976, p. 483
[e,f] Bird and Gower, 1981, and 1982, pp. 213, 517.
[g] Gower *et al.*, 1985, p. 1134.
[h] Dravnieks *et al.*, 1968, p. 611.
[i] Labows *et al.*, 1979, p. 294.

shown in Fig. 3.5; correspondence was obtained at 272 and 272–15. We were especially pleased that the baseline for the axillary extract showed no other peaks, indicating that our 'clean-up' procedures were adequate.

Using the powerful technique of gas chromatography/mass spectrometry with specific ion monitoring, the 5α-androstenone content of axillary hair was found to be in the range 0.1–100 ng/mg (10^{-9} gram). The large range is reminiscent of the levels in axillary extracts, above. The method provides a relatively rapid estimation of 5α-androstenone in axillary hair, and extensions to the method are now being used, so that other 16-androstenes may also be quantified using gas chromatography/mass spectrometry with specific ion monitoring. Thus far, 3α- and 3β-androstenols, 5,16-androstadien-3β-ol and 4,16-androstadienone (Fig. 3.2 and Table 3.4) have been detected with the latter urinous-smelling compound being present generally in greater quantities than 5α-androstenone.

We appreciate that reliable information as to how much steroid is produced in unit time requires a collection method as used by Claus and Alsing (1976), Bird and Gower (1981) and Tóth and Faredin (1985). Nevertheless, our current results prove that odorous (possibly pheromonal)

substances are present in axillary hair which, as noted above, may be involved in odour dispersal.

3.7 FORMATION OF ODOROUS SUBSTANCES IN THE HUMAN AXILLA

In recent work we have attempted to identify the non-odorous substrates which may give rise to 5α-androstenone and related compounds through bacterial action. These odorous materials are well known in pigs and will be discussed below in the context of effects on behaviour. Therefore, by analogy it was worthwhile to utilize pregnenolone as a putative substrate because its importance in porcine testis as a precursor for 16-androstenes is well documented (for review see Gower, 1984). Testosterone, which is known to occur in the human axilla (Claus and Alsing, 1976), and 5α-dihydrotestosterone were also utilized as putative substrates in three-week incubations with isolated *Corynebacterium* spp. The metabolites were separated, purified and identified using gas chromatography/mass spectrometry. A very large number of metabolic transformations of the added steroids was achieved by the bacteria including side-chain cleavage, 3α(β)-reduction, 4-ene-5α(β)-reduction, 17-oxido-reduction and 17-isomerization (Nixon *et al.*, 1984a,b; Gower *et al.*, 1986; Nixon *et al.*, 1986a). So far, we have only tentative evidence for the formation of 5α-androstenone from testosterone. We considered the possibility that mixtures of coryneforms should be used rather than single, isolated species, but although different metabolic profiles were obtained with mixtures consisting of three or more pure strains (Nixon *et al.*, 1986a), no further evidence for 5α-androstenone formation has been forthcoming.

A second consideration is the use of substrates other than pregnenolone, testosterone or 5α-dihydrotestosterone. Apocrine secretions contain the steroids dehydroepiandrosterone (DHA), androsterone and their sulphates (Labows *et al.*, 1979) and it is especially interesting that when the extracts were injected into the gas chromatograph at an elevated temperature, androsterone, DHA and thermal breakdown products of what proved to be their sulphates were observed. Further, the breakdown products, including 5α-androst-2-en-17-one, 3,5-androstadien-17-one and 2,4-androstadien-17-one (Fig. 3.6) had a strong axillary odour at the raised temperature used. Whether axillary bacteria modify DHA and androsterone into 16-androstenes has not been demonstrated to our knowledge, but these steroids do not serve as substrates for odorous compounds in porcine testis (see Gower, 1984). Another intriguing possibility for future research is whether the sulphates of DHA and androsterone would need to be de-sulphated first by bacterial sulphatases, before any further microbial transformations, or whether the sulphates in apocrine sweat could be converted directly into 16-androstene sulphates (cf. pregnenolone sulphate being converted into 5,16-androstadien-

3β-yl sulphate in porcine testis, Gasparini, Hochberg and Lieberman, 1976).

Under the conditions we used, it is not possible for any 5α-androstenone to have been lost through its volatility (Nixon *et al.*, 1986b). However, it is conceivable that it is formed in such small quantities in our incubations so as to be detectable by smell (by virtue of its very low olfactory threshold) (see below) but undetectable by the methods we used. These possibilities require further consideration in future research.

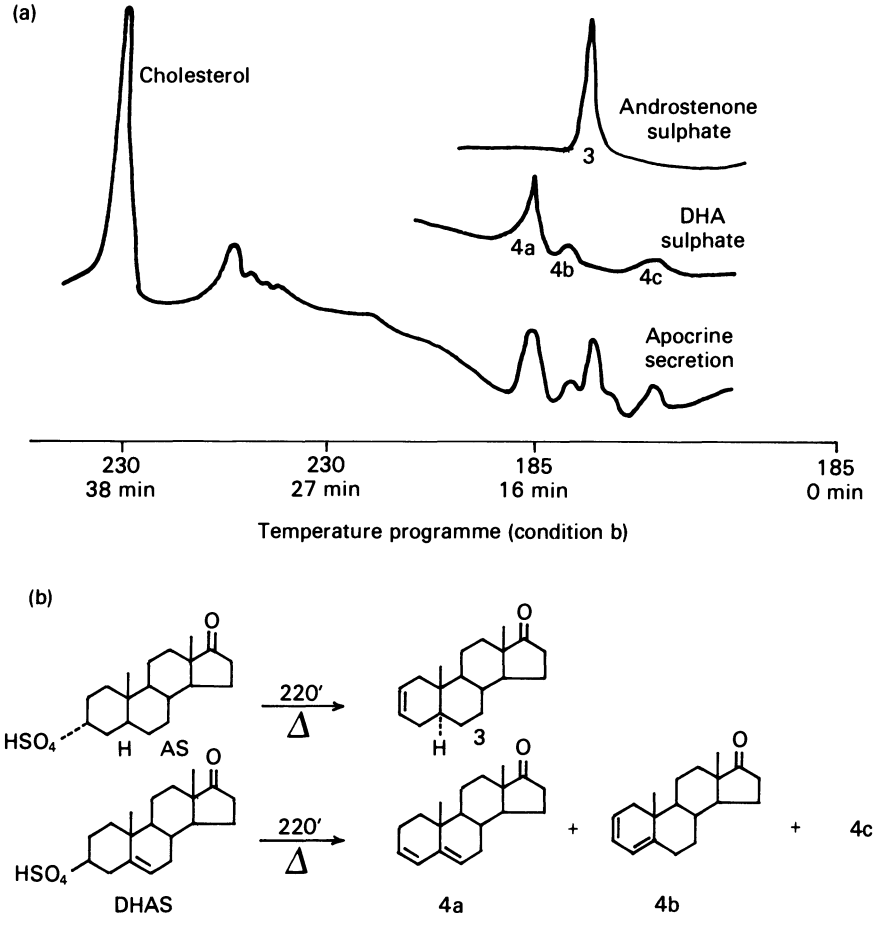


Fig. 3.6 (a) Comparison of C_{19} steroid sulphates and apocrine secretions by direct injection into the gas chromatograph. Conditions were: 10 ft × 2 mm Pyrex 3% XE-60 on 80/100 Gas Chrom Q; initial temperature, 185° (16 min), followed by programming to 230° at 4°/min. (b) Products observed from direct injection of steroid sulphates into the gas chromatograph (from Labows *et al.*, 1979).

In a pilot study we have classified the axillary microflora of five subjects as coryneform or micrococci dominated or mixed. Portions of the bacteria from each subject were incubated with ^{14}C-testosterone in three-week incubations, as described by Nixon *et al.*, (1986b). After extraction, the metabolites were separated by thin-layer chromatography and a radioautogram obtained (Fig. 3.7). Some radioactive material ran with the mobility of the very non-polar 16-androstenes, but this has not yet been characterized. As anticipated from earlier studies (Gower *et al.*, 1986; Nixon *et al.*, 1986b), the control lane shows breakdown products of testosterone which were formed in the absence of bacteria. Allowing for this, the other lanes show evidence of testosterone metabolism, most of the metabolites having been characterized in previous studies (Nixon *et al.*, 1986b). As a coryneform-dominated axillary microflora

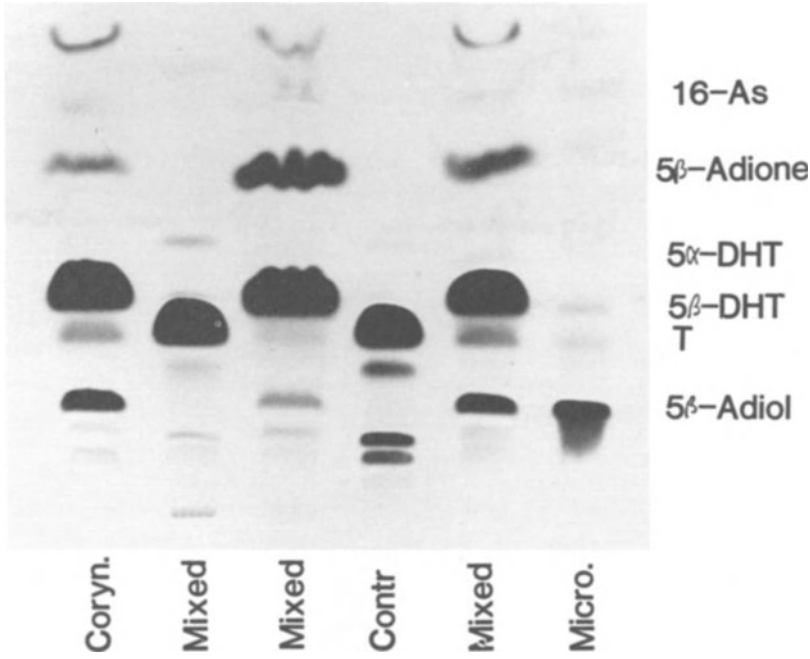


Fig. 3.7 Radioautograph of thin-layer chromatographic separation of metabolites of ^{14}C-testosterone formed after incubation (21 days) of axillary bacteria taken from 5 men (see Nixon *et al.*, 1986b). Axillary microflora were previously characterized as coryneform dominated (Coryn.), micrococci dominated (micro.) or mixed. Control indicates breakdown products of testosterone formed in the absence of bacteria. 16-As, 16-androstenes; 5β-Adione, 5β-androstane-3, 17-dione; 5α(β)-DHT, 5α(β)-dihydrotestosterone; T, testosterone; and 5β-Adiol, 5β-androstane-3α,17α-diol.

is usually associated with odour, we thought that those individuals in our small study might have produced non-polar 16-androstenes; Fig. 3.7 shows that there does not appear to be any correlation between bacterial type and metabolic 'profile'.

3.8 ODOUR OF 16-ANDROSTENES: PSYCHOLOGY AND SIGNIFICANCE

When 5α-androstenone and the related alcohols were discovered in boar testes, Prelog and Ruzicka (1944) and Prelog *et al.* (1945) commented on the marked odour of these steroids; 5α-Androstenone and androstadienone (Fig. 3.2) were considered to have a urine-like, pungent odour, whereas the alcohols, such as 3α-androstenol, were said to have a musk-like odour. In the four decades since those early studies numerous trials have been undertaken to investigate the way in which the odours of 5α-androstenone and other 16-androstenes is perceived by men and women (Griffiths and Patterson, 1970; Beets and Theimer, 1970; Amoore, Pelosi and Forrester, 1977; Theimer, Yoshida and Klaiber, 1977; Doty, 1981; Ohloff *et al.*, 1983; Wysocki and Beauchamp, 1984; Gower *et al.*, 1985; for review see Gower, 1981).

Some studies (e.g. Griffiths and Patterson, 1970) indicated a marked sex difference in the ability of individuals to detect the odour of 5α-androstenone, approximately 56 per cent of men and 93 per cent of women being osmatic. The data indicated that a high proportion of the female subjects were extremely sensitive to the odour, which they found most unpleasant. In a similar way, Koelega (1980) reported that women found the odour of 5α-A significantly ($p < 0.001$) more unpleasant than did men, although men also rated the odour as unpleasant. Approximately 10 per cent of the subjects were unable to detect the odour, but there were more specific anosmics among the male subjects (especially smokers) than among women. In contrast, a recent study (Wysocki and Beauchamp, 1984) using serial dilutions of 5α-androstenone in mineral oil failed to show any significant sex, race or smoker vs non-smoker differences in mean detection thresholds. A similar conclusion was drawn by Gower *et al.* (1985); olfactory thresholds were found to vary widely, from as low as 0.2 parts per billion (p.p.b.) (also noted by Amoore, Pelosi and Forrester, 1977) to 0.2 parts in 100 million; no significant difference in thresholds was recorded between men and women.

In these studies (Gower *et al.*, 1985) male and female subjects were invited to describe the odour of 5α-androstenone and were asked to use one or more adjectives provided – 'pleasant', 'floral', 'fruity', 'urinous', 'sweaty', etc. The men tested preferred to use a single adjective: none found the smell 'pleasant', 15 per cent 'unpleasant', 23 per cent 'musky', 23 per cent 'urinous', 9 per cent 'sweat-like' and 30 per cent 'strong'. The female

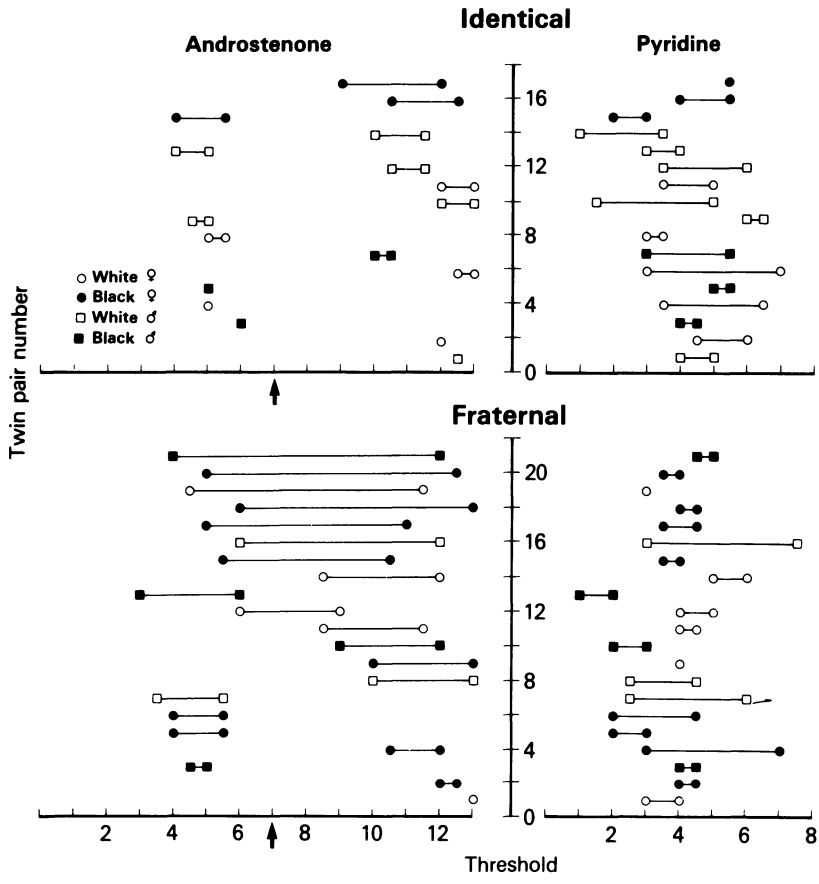


Fig. 3.8 5α-Androstenone and pyridine thresholds for each member of 17 identical and 21 fraternal twin pairs. The data are plotted by decreasing threshold and increasing discordance for 5α-androstenone. The concentration for step 12 of 5α-androstenone was 3.67 mM in mineral oil and that for step 8 of pyridine was 0.372 mM. For each odorant decreasing concentration series were prepared by serial binary dilutions. The concentration of 5α-androstenone indicated by the arrow was chosen to dichotomize subjects into 5α-androstenone sensitive or insensitive groups. (From Wysocki and Beauchamp, 1984.)

subjects utilized two adjectives: 70 per cent found the odour 'repellent' and a further 20 per cent recorded 'unpleasant'; the most used adjectives were 'urinous' and 'musky'.

The smell of the axillary extracts collected from the subjects in this study was also recorded by the female analyst. For the male subjects she recorded 'musky' and 'strong' (50 per cent) with only 20 per cent as 'sweet'. For the

women far more extracts (57 per cent) were judged to be 'sweet', with only 11 per cent 'musky' and 21 per cent 'strong'. Perhaps significant is the fact that one of these 'strong' extracts was subsequently shown by analysis to possess a content for 5α-androstenone of 550 pmol/24 h, well into the male range (Fig. 3.3).

Amoore, Pelosi and Forrester (1977) believe that 5α-androstenone is the primary urinous odour; 46 per cent of their subjects could not smell the odour, indicating that this is the most common form of anosmia so far encountered. Pollack *et al.* (1982) suggested that the extreme variation in sensitivity had a significant genetic component (although the trait was not correlated with HLA haplotype). That the ability to smell 5α-androstenone is genetically determined has been the subject of a recent study in fraternal and identical twins (Wysocki and Beauchamp, 1984). These workers tested adult twins for their ability to smell 5α-androstenone and pyridine (an odorant that is readily perceived by most adults); Fig. 3.8 shows that detection thresholds for pyridine were not significantly different between fraternal and identical twins, and the data therefore provide no evidence for a genetic component in variation of sensitivity in this case. The figure also shows that some subjects failed to detect 5α-androstenone, even when presented with the highest concentration (1.79 μM in 10 ml mineral oil). Identical twin pairs were more similar in 5α-androstenone sensitivity than were fraternal twin pairs ($p < 0.0001$), indicating a significant genetic component. However, in contrast to some earlier observations Wysocki and Beauchamp (1984) found no significant sex, race, smoker vs non-smoker differences in thresholds both for pyridine and 5α-androstenone.

The distribution of detection thresholds for 5α-androstenone (Fig. 3.9) shows that individuals who smell the steroid fall into one of two groups: (a) a very sensitive group, at the low end of the concentration series, who can detect less than 10 parts per trillion in air – at higher concentrations these people find the urine-like odour extremely unpleasant; and (b) a group who are not only less sensitive, but perceive the odour in different ways such as 'sweet', 'musky', 'perfume-like'. A third group of individuals is shown in Fig. 3.9, who fail to detect an odour at the highest concentration or even when presented with the crystalline material.

Dodd and Van Toller (1983) have made detailed studies of odour preference for 5α-androstenone and how the odour is perceived by individuals. Two groups of subjects were used, one osmatic and one anosmic to 5α-androstenone; each subject was presented with a perfume on smelling-strips, containing increasing concentrations of the steroid. The rationale of this approach was that, at some level of 5α-androstenone, the perceiver might detect it as an 'off-note' (not necessarily being aware of this) and thus give rise to a preference difference. Specific anosmics, however, would not detect the androstenone 'off-note' and would therefore not exhibit

a preference difference. The results of some of the studies are shown in Table 3.5; no effect was found with subjects who were anosmic to 5α-androstenone, whereas at the highest level added a significant effect ($p < 0.001$) was observed for the osmatic individuals. In this study the subjects had no prior knowledge of the experiment and were unaware that the differences detected were due to the odour of 5α-androstenone. This could be especially significant in the context of axillary odour in which 5α-androstenone and several other odorous steroids may be involved (see above). Although 5α-androstenone by itself may be a non-preferred odour, when blended with numerous other substances, it could be perceived in a different way.

Other odorous ketones may play a part in axillary odour, androstadienone being an example. It will be recalled that, in early studies, this was noted as smelling 'urinous' (Prelog *et al.*, 1945). Other groups, including Beets and Theimer (1970) and Ohloff and co-workers (1983), have confirmed this and have shown that generally approximately 50 per cent of subjects perceive the smell as 'urinous'. Androstadienone has a fairly low olfactory threshold (0.98 p.p.b.), but about five times higher than for 5α-androstenone (Amoore, Pelosi and Forrester, 1977). It may be significant, however, that this ketone is present in axillary sweat (Labows, 1988) and in axillary hair (see Table 3.4). Our current data indicate that androstadienone generally occurs at

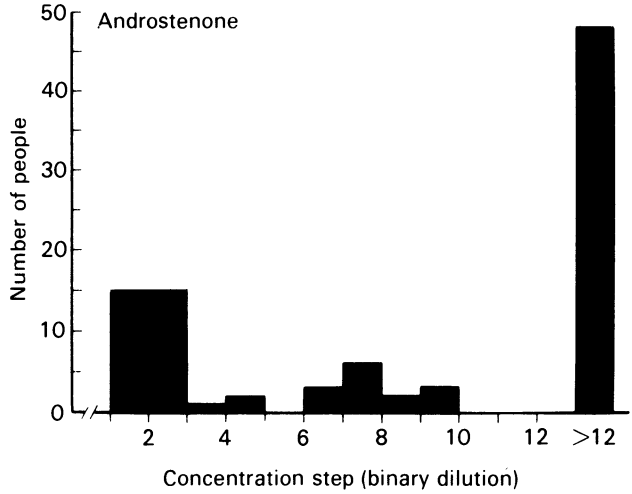


Fig. 3.9 Distribution of detection thresholds for a group of people tested with 5α-androstenone. Step 12 represents a concentration of the steroid of 0.1% (w/v) in light mineral oil; each dilution step is one-half of the previous concentration. The total range of the concentration series exceeds 4000-fold. (From Labows and Wysocki, 1984.)

greater concentrations than 5α-androstenone. Bearing in mind the relatively low olfactory threshold of 0.98 p.p.b., this could well make androstadienone of significance in the context of axillary odour.

Table 3.5 Rank totals of odours in a preference experiment

Odour	*Group*	*5α-androstenone added to perfume (%)*				
		0	0.1	1.0	10.0	
Oeillet	Osmic	156	160	156	196	< 0.001
	Anosmic	147	142	152	151	n.s.

Note:
Subjects were asked to rank the perfume on four smelling-strips in order of their preference on a scale of 1–4; the lower the rank total, the more the odour was preferred, a significant non-preference was noted for osmatic subjects at the highest concentration of 5α-androstenone added.
Source:
Dodd and Van Toller, 1983, 1–14.

3.9 SENSITIVITY TO MUSK ODOURS

It will be recalled that one of the components of axillary sweat is 3α-androstenol (Fig. 3.2). This compound is also excreted in human urine, with a sex difference of some three-fold in favour of men (Brooksbank and Haslewood, 1961; Brooksbank and Gower, 1970). Sensitivity to the odour of 3α-androstenol, which is said to be 'musky', has been studied by numerous groups. A recent structure–odour correlation survey (Ohloff *et al.*, 1983a,b) has revealed that certain structural features of the 16-androstene group of steroids (see Fig. 3.2 for structures) are correlated with odour. The double bond at C-16,17 seems to be unimportant with regard to the urine-like smell of 5α-androstenone or 5α-androstanone, whereas changing the configuration of 3α- to 3β-androstenol results in a diminution of the musk-like intensity.

In early studies Guillot (1948) reported that specific anosmias occur in humans to the odour of 3α-androstenol, while Kloek (1961) showed that 38 per cent of men and 22 per cent of women were anosmic. Synthetic musks such as exaltolide (ω-pentadecalactone) have also been utilized. Guillot (1948, 1958) originally reported that olfactory acuity of female subjects was greater than that of males; the sensitivity was alleged to vary with the phase of the menstrual cycle (Le Magnen, 1952). Vierling and Rock (1967) detected two peaks of olfactory acuity, one at seventeen days (just prior to ovulation) and the other in the luteal phase, eight days prior to

menstruation. Doty (1981) has similarly reported variations in olfactory sensitivity to musky and other odours during the cycle.

Amoore, Pelosi and Forrester (1977) consider exaltolide as the primary musky odour, with olfactory thresholds for this and 3α-androstenol of 1.8 and 6.2 p.p.b. respectively. Whissell-Buechy and Amoore (1973) showed that anosmia to exaltolide occurred in 8–9 per cent of humans and that the defect was a genetic one, inherited as a simple recessive autosomal characteristic. In contrast to the results mentioned above, Amoore, Popplewell and Whissell-Buechy (1975) could find no menstrual variation with regard to olfactory sensitivity to the odour of exaltolide.

Hendriks and Punter (1980) measured thresholds for exaltolide in 134 subjects on two occasions. The distributions were not found to be normal, but neither were they clearly bimodal. Half of the individuals who were classified as anosmics in the first test were not so classified in the second, and this has prompted Hendriks and Punter to recommend that caution be exercised when interpreting results of sensitivity studies. Further, in a second study these authors used exaltolide and hexanol, each on two occasions; hexanol was utilized to detect general anosmics. In this experiment all exaltolide threshold measurements correlated moderately well, as did all hexanol measurements. However, as anticipated if exaltolide is a primary odour, the correlation between this and hexanol thresholds was very low. In a third experiment Hendriks and Punter made eight repeated threshold measurements for exaltolide in thirteen normal and twelve anosmic individuals. Only four in the anosmic group showed a mean threshold value that was different from that of the normals. The clear conclusion is that anosmics to exaltolide can only be selected reliably by a great number of repeated experiments; the final percentage, so selected, may be lower than was documented on the basis of earlier studies.

Another musk-smelling substance, Musk R-1 (11-oxohexadecanolide) was used in the olfactory testing of 207 students (Koelega, 1980). The odour was primarily described as 'floral' and no sex difference in preference for the smell was demonstrated. In non-smokers a sex difference in sensitivity was just significant ($p = 0.05$) but not in smokers, who generally gave very poor performances in the tests. However, the standard deviations of the thresholds measured were very large, especially for female subjects.

3.10 PSYCHOLOGICAL EXPERIMENTS USING ODOROUS STEROIDS

With the finding of odorous steroids in human urine (e.g. Brooksbank and Haslewood, 1961); testis (Gower and Bicknell, 1972); axillary secretions (see above); and saliva (Bird and Gower, 1983), it was almost inevitable that speculation should arise as to the possible effects of such compounds in

human social interactions. In a number of studies (see Gower, 1981; Doty, 1981; Labows, 1988) attempts have been made to investigate the effects of odour on judgements, choice of location in others' presence, menstrual cycle length, and so on. Although some of these studies are of considerable interest, others may be criticized because of inadequate controls (Labows, 1986).

Some experiments to detect behavioural changes in response to odours have involved the subjects wearing face-masks, previously impregnated with the appropriate test substance, or with a control such as ethanol. In a study by Cowley, Johnson and Brooksbank (1977) the judgements of female interviewers of men who were applying for a position of responsibility were modified while being exposed to the odour of 3α-androstenol. Kirk-Smith *et al.* (1978) asked their subjects to give opinions about photographs of normally clothed people, animals and buildings. The odour of 3α-androstenol seemed to influence both men and women, so that they judged the photographed women as more attractive; the effect on judgements of the photographed men was weaker. In the first half of the session of exposure to the odour women judged the photographed women to be more 'defensive', while in the second half men judged them to be more 'aggressive'.

Benton (1982) exposed women to the odour of 3α-androstenol throughout the menstrual cycle; the subjects rated their moods as more submissive at mid-cycle. However, in contrast to these results, Black and Biron (1982) found no differences in physical attractiveness with a musk perfume as compared with a control odour.

5α-Androstenone has also been studied in the context of human social interaction. Kirk-Smith and Booth (1980) sprayed the steroid on the chairs in a dental waiting-room; three levels, 3.2, 16 and 32 μg, were used. Significantly more women used the odorized seats when they had been sprayed at the 3.2 and 32 μg level, and fewer men at the 32 μg level. Rather similar results had been obtained by Clark (1978) in a 'theatre situation', where some seats (all unreserved) had been sprayed previously with 5α-androstenone. These seats were occupied mainly by women. Also of interest was the finding that the programmes left behind after the performance were all found to be non-sprayed controls.

Kirk-Smith and Booth (1980) explain their results by suggesting that women might be attracted to the odour of 5α-androstenone, possibly because they associate it with men (it will be recalled that this compound is found in axillary sweat and axillary hair of men, as we have seen). Another possible explanation is that women perceive a similarity between the smell of 5α-androstenone and certain notes in perfumes that they have experienced. The non-preference of men for the seats sprayed with the highest concentration of steroid might be explained because the odour reminded them of another man and made them feel uncomfortable (is there a slight

aggressive feeling here, reminiscent of the effects of 5α-androstenone in the pig?).

In the 'theatre experiment' of Clark (1978) it was significant that the periods of five of the girls who worked there were disrupted because of the experiments; normally their cycles were synchronized. This phenomenon of menstrual synchrony is well known and has been studied by McClintock (1983). Women who live together in a hall of residence often come into phase with each other's cycles. It is generally thought that this is a pheromonal phenomenon. If the odour of 5α-androstenone can disrupt such synchrony (as in the example noted above), it is of special interest in the context of human social interactions and is reminiscent of the 'strange male' effect in mice.

Studies have been described by Russell, Switz and Thomson (1980) and Russell (1983) in which ethanolic extracts of collected axillary secretions from women were applied to the upper lips of female subjects. A control group had only ethanol applied. In one experiment four of the five subjects had synchronized their cycles to within one day of that of the donor in four months' treatment. Similar studies (Preti *et al.*, 1984) have confirmed that a synchrony effect could be caused by axillary secretions.

It is tempting to speculate that one or more of the odorous steroids found in axillary secretions may be important in these effects. Generally women have rather small quantities of 5α-androstenone (Fig. 3.3), but undoubtedly there are some women who have increased quantities. Whether such amounts in female axillary sweat or in men could control the cycles of women is still unknown, but it could possibly form the basis of important future studies.

In some of the above studies the subjects were asked to describe their feelings towards men and women, or towards photographs, or in some cases to describe their moods – submissive, aggressive, etc. An alternative method has been discussed by Van Toller *et al.* (1983) in which use is made of subvert psychophysiological responses recorded during the exposure of the subject to an odour. In this context measurement of electrodermal response (EDR) has been utilized extensively and the numerous documented recordings have been reviewed by Christie (1976) and Van Toller *et al.* (1983).

A number of problems have been noted with the use of EDR as an index of olfactory stimulation, and not least that in most studies the subjects were not isolated preceptually and may have failed to concentrate on the odour presented. Further, the odour presentation should be unsignalled and as silent as possible; it should be made at a standard point on the inspiration part of the breathing cycle. In the study by Van Toller *et al.* (1983) the subject's breathing cycle was monitored to ensure that their inspiration rate did not change on presentation of an odour, as this could itself produce changes in skin vasoconstriction, hence on conductance. Auditory cues were

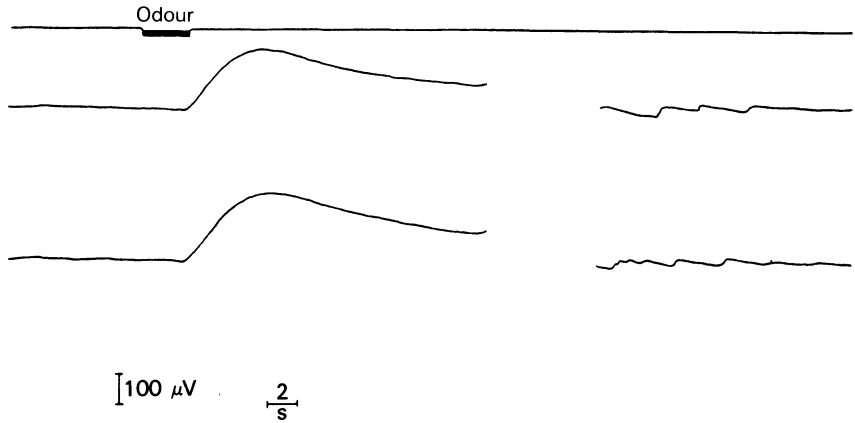


Fig. 3.10 Typical skin conductance changes obtained from both wrists of a single subject in response to an odorant. Note the steady baseline before the stimulus and the gradual decline of the signal from the maximum amplitude. (From Van Toller *et al.*, 1983.)

prevented by playing 'white noise' (at a tolerable level) to the subjects through headphones, and visual cues were prevented by having the subjects wear blacked-out goggles. As specific anosmia to the urinous smell of 5α-androstanone is documented, aurantiol (hydroxycitronellal-methylanthranilate) was used as a control odour in these studies.

Odours were presented to subjects from two parallel smelling-strips, clipped to a modified Anglepoise lamp-stand. This arrangement allowed for rapid location below the subjects' nostrils. A microswitch placed beneath one of the feet of the subject allowed an indication to be made that an odour was perceived; the slight foot movement however had no effect on skin conductance.

Using these carefully controlled conditions, Van Toller *et al.* (1983) measured skin conductance changes in men and women who had previously rated the odour of 5α-androstanone as 'pleasant' (a minority of subjects) or 'unpleasant'; all subjects perceived aurantiol as 'pleasant'. The numerous data obtained have been discussed and summarized by Dodd and Van Toller (1983); the amplitude (Fig. 3.10) of the responses to 5α-androstanone were approximately one to five times that for aurantiol, the effects being stronger for subjects who perceived a hedonic difference between the odours.

Two other points of considerable interest emerged from this work. It was noticed that some subjects who had previously been designated as anosmic to 5α-androstanone in trial experiments could nevertheless detect the odour under the conditions used later for skin conductance measurements. This phenomenon could explain why the percentage anosmia data, cited in the research literature, varies so markedly, and suggests that the ways in which

specific anosmia is determined need to be re-evaluated. Secondly, some subjects gave a skin conductance response but failed to give a behavioural response. It was shown subsequently that these individuals were able to perceive the odour but had no verbal label with which to describe it. It was not that they were detecting the odour unconsciously.

Unconscious odour conditioning in human subjects has been the subject of a further study by Kirk-Smith, Van Toller and Dodd (1983). In the first session of experiments two groups of male and female subjects had to complete a design using blocks in a pre-assigned time; this was designed to induce stress. For half of the subjects a low intensity of trimethylundecylenic aldehyde (TUA) was present. In the second session subjects completed mood-scoring scales and then judged photographs of people, plus completing a second mood-rating scale in a room where TUA was present. Some interesting results emerged from these studies. Female subjects were found to complete fewer block patterns in the first session; those who were subjected to TUA at that time showed an increase in 'anxiety' ratings in the second sessions. In contrast, subjects who were not subjected to odour in the stressed situation became calmer in the scoring and photograph-judging sessions. These data suggest that associations of an unfamiliar odour with a stressful situation may later elicit changes in mood and judgement, even though the subject may not actually perceive the odour (as was the case in the female subjects).

3.11 PHEROMONAL ASPECTS OF ODOROUS 16-ANDROSTENES IN THE PIG

The word *pheromone* was suggested in 1959 by Karlson and Lüscher to describe a substance (usually volatile) that is produced by a male or female member of a species and carried over to another member of the same, or a different, species where responses may be elicited. Wilson and Bossert (1963) further classified pheromones into two types: (a) primer and (b) releaser or signalling pheromones. Primer effects bring about a delayed response to prolonged stimulation, which is mediated through the neuroendocrine system, with pituitary gland involvement. Acceleration of puberty in the immature animal is a good example of this type. In contrast, releaser pheromones are those which cause an immediate behavioural response as a result of direct action on the central nervous system. Such responses include those of sex attraction and recognition of a receptive female by a male.

Although some of the 16-androstene steroids were isolated from boar testis as long ago as 1944 by Prelog and Ruzicka, it was not for many years that any behavioural effects in response to these compounds were

documented. Patterson and co-workers were the first to show that a sow, in oestrus, will respond to the odour of 5α-androstenone by adopting the mating stance, i.e. by standing immobile with back arched (Melrose, Reed and Patterson, 1971). Further work (Reed, Melrose and Patterson, 1974) involved a study of structure–activity correlates, and clearly showed that the structure of the compound used was important. For example, although the saturated compound 5α-androstanone has a similar urinous smell to 5α-androstenone, it was found to be only 10 per cent as efficient in pheromonal effect. Androstadienone is also effective, as is 5β-androstenone, even though this is reported as having no odour (Ohloff *et al.*, 1983); 3α-Androstenol is as efficient as 5α-androstenone but 3β-androstenol, an isomer with a less intense musky odour, is about 50 per cent as effective in producing the response. The signalling pheromonal effect has become of particular importance as a means of detecting when a sow is in oestrus, and a spray-can containing 5α-androstenone for this purpose has been patented (Melrose, Patterson and Reed, 1968).

More recently, Kirkwood, Hughes and Booth (1983) and Booth (1984a) have provided evidence for primer pheromonal effects, in that the presence of a boar or exposure to the odour of 5α-androstenone or 3α-androstenol results in acceleration of puberty. These steroids, which are formed in the boar testis (Cooke *et al.*, 1983; Gower, 1984) also occur in the submaxillary salivary glands where they are associated with a binding protein, called pheromaxein (Booth, 1984b; Gower and Booth, 1986). This acts as a storage centre with subsequent transport of the very non-polar odorous steroids to the saliva and thence to the environment, when the salivation reflex is stimulated by, for example, sexual arousal or aggression.

3.12 MECHANISMS OF PERCEPTION OF ODOROUS STEROIDS

It is thought that when an odorant impinges on the olfactory epithelium, it dissolves first in the overlying mucus layer, after which binding to specific receptors occurs. This process is thought to elicit electrical changes in the neuronal cells which can be recorded as the electro-olfactogram (EOG). Both porcine (Poynder *et al.*, 1978; Booth *et al.*, 1981) and ovine (Dodd and Persaud, 1981) olfactory tissue can be dissected out and perfused, so that EOG signals can be measured. Our results showed that although butyl acetate gave rise to EOGs of initial amplitude 4–5 mV (even after 24 h perfusion), no signal could be detected after 5α-androstenone (Poynder *et al.*, 1978). Conceivably this lack of response was because this steroid is so hydrophobic and sticks avidly to the glassware and tubing of the olfactometer used. Dodd and Persaud (1981), however, were successful in

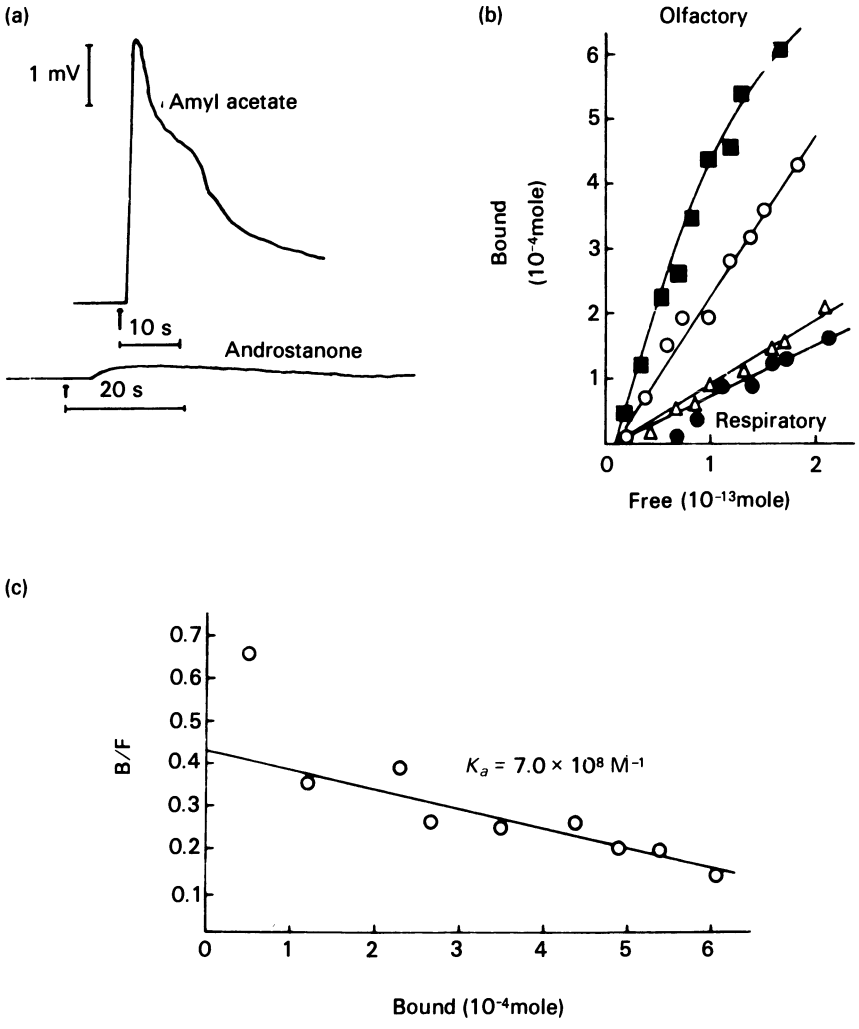


Fig. 3.11 Binding of 5α-[16,17-^{3}H] androstan-3-one to sheep olfactory epithelium. (a) EOG from intact sheep olfactory epithelium in response to stimulation by 5α-androstanone and amyl acetate. (b) Binding of 5α-androstanone to supernatant fractions of sheep olfactory and respiratory epithelia, following centrifugation at 12 000 g for 15 min. The non-specific binding (○, ●) was determined by adding excess unlabelled 5α-androstanone to the tissue plus labelled steroid. The free and bound ligands were separated using the standard charcoal method. (c) Scatchard plot of binding data shown in (b). (From Dodd and Persaud, 1981.)

detecting a small but significant EOG from the urinous 5α-androstanone (Fig. 3.11).

Although EOGs in response to the odour of 5α-androstenone have been difficult to record (as noted above), MacLeod, Reinhardt and Ellendorf (1979) succeeded in showing alterations of action potential activity in olfactory bulb neurons of miniature pigs. Twenty-five out of thirty-seven cells tested showed responses to either testosterone or 5α-androstenone. However, several cells could clearly discriminate between the two steroids since four neurones were excited by the odour of 5α-androstenone and unaffected by testosterone, whereas eight cells were excited by testosterone with no response to 5α-androstenone.

The extreme hydrophobicity of 5α-androstenone has also made receptor studies difficult and results obtained are often non-reproducible (Table 3.6). Despite many detailed attempts in our own laboratories, we have been unable to provide clear, unequivocal evidence for saturable binding against a background of non-specific binding (Hancock, Gennings and Gower, 1985). Dodd and Persaud (1981) have been more successful in this regard. While recognizing and sharing the same problems of hydrophobicity of 5α-androstanone and non-specific binding, the authors have nevertheless provided evidence for specific binding in sheep olfactory epithelium, with a binding constant of 7×10^8 M^{-1} (Fig. 3.11). At least part of the non-specific binding encountered in these experiments may be due to reductases which can rapidly catalyse the conversion of 5α-androstenone to 3α-androstenol and (at a slower rate) to 3β-androstenol (Gower and Hancock, 1982; Hancock and Gower, 1986). Whether these reductions are really involved in the transduction mechanism is open to question, although since 3β-androstenol in the pig is less pheromonally active than 5α-androstenone or 3α-androstenol, it is tempting to speculate that reduction might be a means of modifying the signal. Modification of reductive enzyme activity by circulating androgens, such as testosterone and 5α-dihydrotestosterone in the pig, present further intriguing possibilities for future research (Hancock and Gower, 1986).

3.13 CONCLUSION: PERSPECTIVES FOR FUTURE STUDIES

This chapter has focused on the evidence available for odorous steroids playing a role in axillary odour. Clearly these steroids, such as 3α(β)-androstenol, 5α-androstenone and perhaps especially androstadienone, are present in axillary secretions and in axillary hair. Bearing in mind the low olfactory threshold of 5α-androstenone and androstadienone, it is conceivable that they may be somehow involved. The way in which these odours are perceived is also of crucial importance in the context of human social

Table 3.6 Adsorption of ^{3}H-5α-androstenone to various surfaces

Test-tube material	*Percentage ^{3}H-5α-androstenone in solution after 180 min*	*s.d.* (n = 4)
Polyethylene	40.4	4.8
Pyrex glass	86.5	15.3
'Repelcoted' pyrex glass	73.0	14.8

Source: Gower and Hancock, 1982.

communication, particularly since axillary secretions contain a complex blend of odorous substances. The experiments reviewed here in which responses to an odour may differ, depending on whether the compound is pure or mixed with others, are obviously of considerable importance. Further work needs to be done on the microbiological aspects of axillary odour and especially on the mechanisms which occur in the formation of a mixture of numerous substances. For example, we know little or nothing at present as to whether the quantities of odorous steroids in the axilla vary with the emotional state of the individual concerned, although some studies to investigate this question are planned for our own laboratories.

The possibility that odorous 16-androstenes, such as 3α-androstenol and 5α-androstenone, can act as human pheromones causing changes in judgement or mood is still controversial and is disputed by some workers. None the less, the possibility still remains that we may be subjected, even at a subconscious level, to odours that may condition us and thus alter our responses at a later stage. If the axilla is a 'charming grotto, full of intriguing odorous surprises', perhaps future research will help to elucidate some of them.

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PART II

Developmental and social aspects of fragrance

4

The acquisition of odour hedonics

T. ENGEN

4.1 INTRODUCTION

The following is a true story about affective responses to odour. A newlywed couple had checked into an hotel the evening before. In the morning the smell of bacon drifted into their room from the kitchen below. She had grown up in a kosher home and woke up feeling sick, but he who was from a different religious background woke up hungry, urging her 'let's go for breakfast'.

Pleasure or displeasure is not in the odour stimulus *per se*, but is part of an ecological situation involving an interaction of the individual and the odour. This is what is so well described by Proust in the episode about the Madeleine biscuits. Odour hedonics, in my view, is a matter of learning by association in a Pavlovian sense and through modelling the modes of one's culture. Because of these factors, there will be general agreement about the location of a certain odour on the hedonic scale ranging from unpleasant at one extreme through neutral to pleasant at the other extreme. However, special individual experience will play a role such that an odour which is pleasant to most may be extremely unpleasant to an individual who has had a different experience with it. This applies to children as well as to adults. Aversion to certain food odours is one example.

The odour of skunk may illustrate the effect of culture and learning through the method of modelling. I first learned about skunks from a movie by Abbot and Costello, as I recall, in which there was a comic scene involving their encountering a skunk and the facial expressions and other behaviour caused by malodour. This was long before 'odourama' movies, and thus I did not experience any odour then, and because I have had no unfortunate encounters with it since, my hedonic rating of skunk odour is a purely cultural one. However, I do know people who like the odour because

of special fond childhood memories of places in the country, but they hesitate to show a reaction which may be considered psychologically strange.

Although it is conceivable that some odours have inherent power of repulsion and others of attraction, this remains to be demonstrated. For all the reports of such evidence, the learning hypothesis provides an alternative, competing interpretation. Perhaps there are certain salient odours the meaning of which are easy to acquire? This hypothesis remains to be investigated. However, in this chapter, I will try to show that there is convincing evidence supporting the hypothesis that hedonic responses to odours are learned.

The significance of the study of the responses of children regarding this issue is obvious, as they have had little or no opportunity to learn about odours. If odour responses are innate, children should respond to them as adults do. As will be shown, the evidence is very clear that they do not. A common clinical test of olfaction for adults involves discrimination of odour qualities, but such a test is not appropriate with children because they tend to respond mainly to the intensities of odours. Olfactory testing of children must rely on tests of intensity discrimination and detection of odour rather than quality discrimination and naming of different kinds of odour (Engen, 1986). It is important to use proper tests, because the normal behaviour of a child is correlated with olfactory functions (Cheal, 1975).

The following discussion is divided into four parts. The first presents observations of very young infants and their reactions to odours using physiological and behavioural indices such as change in respiration and facial expression. The second part briefly presents characterizing related research with animals. The third section presents results from children of 3 years or older who can be tested with psychophysical procedures similar to those used with adults. The final section discusses the nature of children's vocabulary for likes and dislikes. A comparison will also be made of odour and taste perception, which, though intimately related in some ways, do differ.

4.2 PHYSIOLOGICAL AND BEHAVIOURAL RESPONSES OF PRELINGUAL INFANTS

At Brown University a large number of new-born babies have been tested only 50 hours after birth. There is no doubt that these newborns sense odours. What is known about the maturity of olfactory systems and their responses to odours, both motoric and from physiological indices such as changes in respiration, confirm this. Yet at this early age one sees no evidence of hedonic discrimination of odours, for example, a differential reaction to anise vs asafoetida. Both odours seem to elicit the same kind of mild startlement. Most adults find one very pleasant, the other unpleasant.

Perception of smell, like taste, is characterized by plasticity. However, one can make certain predictions about food intake knowing the taste quality. Thus sweet tastes will affect the amount ingested and other characteristics of the sucking behaviour (Crook and Lipsitt, 1976). Salty tastes also affect the sucking behaviour in predictable ways (Crook, 1987). But one cannot depend on taste sensations to control food selection. There is, on the one hand, the famous clinical case of the boy who craved salt because of a thyroid condition and died when put on a normal salt-intake diet. There are, on the other hand, clinical cases of infants who died from drinking a bottle mistakenly filled with saline solution rather than water.

It has been assumed since the cafeteria feeding experiments of Davis (1928), which showed that 7–9-month-old babies left to their own devices selected a reasonable varied diet, that bodily needs control this selection through the hedonic values of food flavours. However, the results have been generalized too greatly. It was not a valid test of the underlying hypothesis that bodily needs control the hedonic value of taste sensations, which in turn control food intake, because the selection of stimuli only included edible substances. There was in the sample no salt solution, paint chips, philadendron, dirt or other harmful substances that children have been discovered to eat, nor 'junk food'.

In particular, Davis's study fails to consider the plasticity of the chemical senses demonstrated in another experiment by Gauger (1929) at about the same time but subsequently ignored. She showed that children ranging in age from 18 months to 3 years would give raw egg whites, vinegar (50 per cent) and a strong salt solution (two tablespoons of salt in a cup of water) higher and higher ratings as they were rewarded for eating them. It is important to recall here a fundamental point made by P. T. Young (1957) that 'new habits tend to form in agreement with body needs but established habits tend to persist as regulators of food selection even when the selections are out of line with (present) bodily needs.'

Olfaction is even more plastic than taste. According to the present theory, an odour is a non-functional environmental cue, a secondary factor, which plays no role in bodily need. An odour may be an integral part of the perception of a situation, eliciting its memory later but without causing any need as does food, which in that way involves the gut. Unfamiliar odours will arouse babies because of their novelty and startle-value but have no other hedonic properties. Thus the odour is an epiphenomenon of other biological processes such as feeding and interpersonal relations.

In one study (1980, unpublished) Barbara Weston and I attempted to determine whether or not 2- and 3-year-old babies would show evidence of familiarity to the perfume the mother wore during regular feedings. She would wear her own perfume and the same one each time. The perfumes included 'L'Air du Temps', 'Jontu' and 'Maximi'. After a few such

exposures – limited because of the usual short hospital stay – we tested the babies in the laboratory. The perfume was presented to the infant on a cotton swab and the babies' sucking, respiration, general activity and heart rate were recorded on a polygraph. There were two control groups: a test with an odourless cotton swab, and a test with another perfume, 'Cachet', which was not worn by any of the mothers in the experimental group. The results for 15 infants, 8 girls and 7 boys, showed 80 per cent response on trials with the perfume vs virtually zero with the odourless control. However, the infants responded about equally to mothers' perfume and the control perfume, 'Cachet'. It is clear, then, that new-born infants do respond to perfume, but they do not distinguish between them hedonically.

Others, beginning with MacFarlane (1975), have shown such affective responses to odour. After about a week or so, the baby discriminates between the gauze pad worn by his or her own breast-feeding mother and the one worn by another mother used as control. Balogh and Porter (1986) obtained evidence of odour discrimination even earlier by babies 2 days old for cherry and ginger odours. They had been exposed to them for a 24-hour duration, beginning 12 hours after birth. Breast-fed babies show greater evidence of recognizing mother by the odour than do bottle-fed babies (Cernoch and Porter, 1985). In a related study (Porter, Cernoch and McLaughlin, 1983) mothers have been shown to be able to select better than chance the clothes worn by their babies from a bunch of such clothing.

One may be inclined to think that the reason for these more positive results with body odour than with perfume is that they are more 'biologically significant' in some sense and may involve a shared phenotype. However, the carefully controlled similar research with animals, described below, strongly support the hypothesis that the nature of the odour is arbitrary and that the significant condition is the mother–child interaction. There have been a number of human studies also providing evidence of the role of odour perception in mother–child attachment (see Montagner, 1982; Schaal, 1985). This attachment is acquired over time in association with odour perception, but it is not caused by the odour but rather by the positive and rewarding nature of the association.

It seems difficult for most people to accept the hypothesis that infants should be non-responsive to hedonic odour differences perceived by adults, but it is a fact that infants show little evidence of such discrimination. The following provides another illustration.

Sucking by the infants is an example of highly organized behaviour. It can be described precisely in quantitative terms, and it has therefore been possible to show that the natural sucking rhythm of an infant to a passifier may be influenced by the presentation of various stimuli (Crook, 1987). Sounds and pictures tend to increase the amount of sucking when first presented, but with repeated presentation there will be less and less change

in this behaviour. This is described as habituation (Engen and Lipsitt, 1965). To observe the initial effect of odour stimulation on sucking behaviour we presented amyl acetate and lavender (pleasant to adults) and butyric acid and dimethyl disulphide (unpleasant) to infants on cotton swabs. All four odours were matched in perceived intensity by adult psychophysical observers. There were two interesting aspects of the results. No evidence was obtained regarding differences between the odours which to adults are extremely different on the hedonic scale. In a related experiment, also with negative results and thus not published (see Engen, 1982), infants' facial expressions were photographed and subsequently rated blind by independent observers, no evidence of differences elicited by these odours was found. These data thus fail to support Steiner and colleagues' (see Steiner and Finnegan, 1975) conclusions that odours have innate motivational properties. These investigators presented photographs of young infants showing characteristic facial expressions to sour, bitter, salty and sweet tastes, and also to the presumably pleasant odour of banana and the unpleasant odour of fish and others (Steiner, 1974; Steiner and Finnegan, 1975; Steiner, 1977). Two observations about these data seem valid. First, there is a clear indication of a difference between taste and smell. The facial expressions vary as expected for taste but not at all for smell. The interobserver reliability of the ratings is marginal and varies for different odours (Steiner, 1977, p. 182). Secondly, Crook (1981) has pointed out that the hedonic interpretation is equivocal: the facial expressions may reflect the effect of differences in intensity rather than quality for both smell and taste. In addition, a strong olfactory stimulus may also affect the trigeminal nerve and cause irritation (Engen, 1986). Finally, the rationale for the selection of the odours is debatable – e.g. that a 'fishy' odour of shrimp should be innately unpleasant? There is reliable evidence that the infants detect the odours, but not that they have significant effects on the sucking behaviour.

4.3 RELATED ANIMAL RESEARCH

There is now a growing interest and active research with a variety of animal subjects on the plasticity of odour perception (see *Experientia*, March 1986). Odour perception has been shown to be related to maternal behaviour by the mother towards the offspring. Merely washing the nipple of the mother will eliminate the attachment by the rat pup (Teichner and Blass, 1977). Disruption of this bonding, which clearly involves odour perception, is a detriment to their later sexual development (Fillion and Blass, 1986). Rat puppies will also come to associate the nipple providing milk with its odour. An artificial odour, such as orange, which has been shown in control experiments to be slightly aversive to the baby rat, may be substituted for

the natural body odour and acquire a positive hedonic value (Brake, 1981). Such associative learning is even evident in butterflies, which have been shown to remember flowers which rewarded them with nectar, as Darwin had speculated they might (Lewis, 1986). Finally, studies of squirrel monkeys and their infants have also shown that olfaction is an important factor in their relationship (Kaplan, Cibicciotti and Redican, 1977).

These rather diverse examples demonstrate the role of odour perception in mother–infant relationship. However, it should be stressed that the quality of the odour is arbitrary rather than special (Alberts, 1981). A perfume serves as well as mother's own odour. It is an open question whether or not this might have significant effects on later development in the case of humans. One should be on guard against zoomorphism.

The fact that certain body odours are naturally present during significant episodes, such as between mother and infant and between sexual partners, has led to the erroneous hypothesis that these odours have certain inherent powers over people. They do not. They are an integral part of coding of the episode and play a significant role in its memory, but do not cause the behaviour involved. One may substitute any odour and accomplish the same hedonic association.

4.4 POSTLINGUAL CHILDREN

When children are 3 years old, one can test them with standard psychophysical methods as used with adults. We have performed a number of such experiments which show how odour preferences develop. The method we used most often with these older children was pair comparisons (see Engen, 1974). The task for the child is to choose between two odours which differ in some respect stated in language appropriate to its age. In studying hedonic differences the problem is to decide which of two odours he or she likes better, and in case of odour strength which of two odours smells stronger. These judgements are transformed into scale values for each odour using standard pair-comparison techniques. Typically we used 25–35 children for each age and condition. A child was tested only once, with one exception noted below (see Fig. 4.4).

Such hedonic scales for 4-, 5-, 6-, and 7-year-olds and adults are depicted in Fig. 4.1. Five odours were compared, two at a time and all subjects agreed that the hedonic ordering from least to most pleasant was: butyric acid, rapeseed oil, diethyl phthalate, neroli oil and safrol. However, the quantitative characteristics of the scales differ according to age in two respects. First, the adult scale is steeper than the children's because the hedonic differences between the odours is more reliable for adults than for children. Secondly, the older the children, the steeper the function. Here the

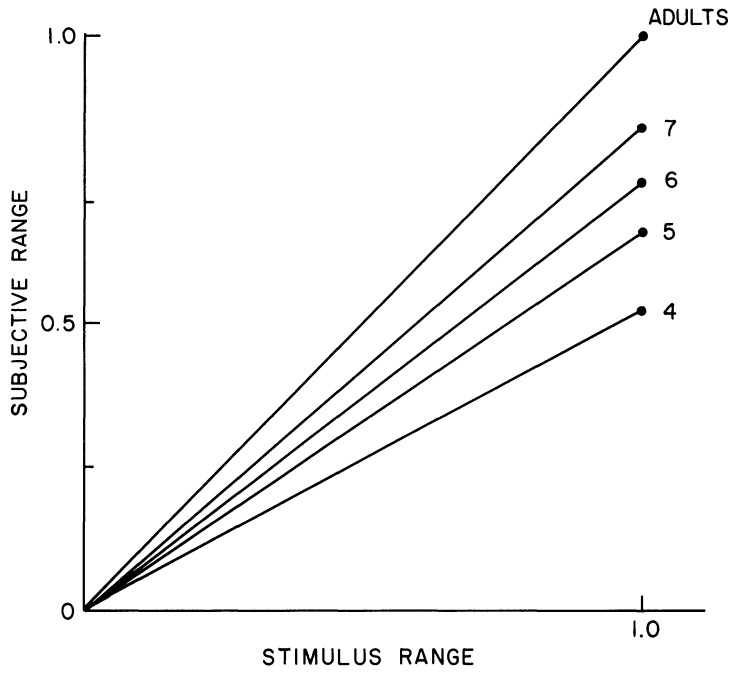

Fig. 4.1 The slope and range of hedonic scales obtained with the odours of butyric acid, rapeseed oil, diethyl phthalate, neroli oil and safrole as a function of the age of children. The scale for the adult has been anchored between butyric acid (0) and safrole (1) and arbitrarily given a slope of 1.0.

reason is that preference develops with age and becomes closer and closer to the cultural norm. To look at it from the opposite perceptive the younger the child, the flatter the function. A young child has no strong preference and may say that safrol over butyric acid is preferred on one trial but butyric acid over safrol on another trial. The older the child, the less likely is it that this will happen because the hedonic scale is now more firmly established. For an adult it almost never happens that he or she favours butyric acid over safrol. To put it still differently, the younger the child, the less accurate is the prediction of preference knowing only the odour stimulus. This supports Moncrieff's (1966) conclusion, based on an extensive investigation of odour preference, that children generally are quite tolerant of odours.

The changes with age for the hedonic values of two representative odours, amyl acetate and butyric acid, are shown in Fig. 4.2, in an opinion poll on whether the odours were liked or disliked. At age 4 the hedonic values of both odours are located somewhat below neutral (50 per cent). Novel odours are then all viewed cautiously and usually categorized as disliked – reminiscent of the orange odour mentioned in the case of animal research

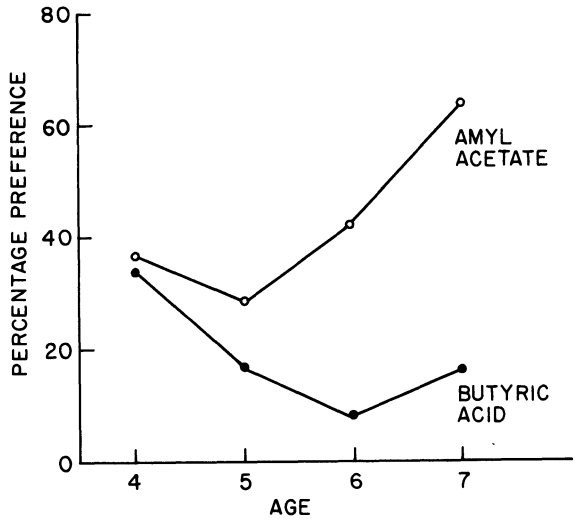

Fig. 4.2 The percentage of children indicating they liked the odour of amyl acetate and butyric acid as a function of age.

above – but with increasing age, the scale values separate as one would expect from adult values.

One must be careful in phrasing such opinion-poll questions to young children (as we were in the experiment shown in Fig. 4.2). The younger the child, the more likely he or she is to answer 'yes' to the question, 'Do you like this smell?' It is a response bias which seriously affects the oft-quoted data by Stein, Ottenberg and Roulet (1958), which they believed showed evidence of repression of the pleasure of body odours in Freud's theory of the psychosexual development. Accordingly, body odours are really preferred throughout, but the response of saying so is repressed at about age 5. However, the study did not control for the response bias and cannot be said to have any bearing on either Freudian or odour preference theory.

The distribution of the responses to the odour of butyric acid to two different questions, 'Does it smell good' and 'Does it smell bad?', is shown in Fig. 4.3. The results demonstrate that the form of the question is significant. The younger the child, the more likely one is to obtain an affirmative response to one question than the other. To avoid this pitfall in such experiments we attempted to ask questions in different ways and appropriately for the age, but generally by using a pair-comparison method (Figs 4.1 and 4.4). Linguistic problems are considered further below.

The next experiment compares the judgements of intensity and preference for the same odours and the same pair-comparison method. The odours were neroli oil at different concentrations, 100, 50 and 20 per cent in diethyl

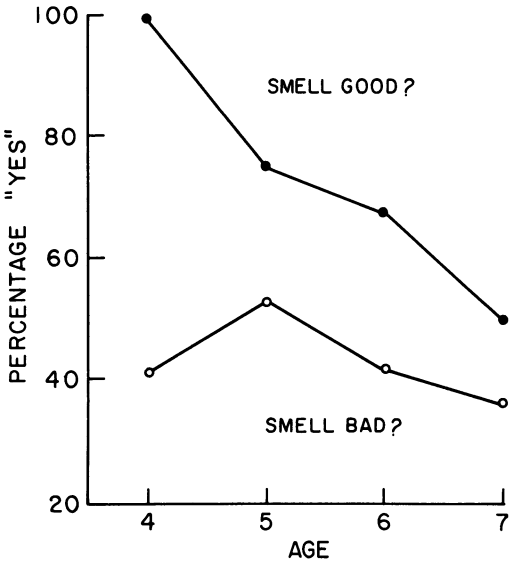

Fig. 4.3 The percentage of children giving an affirmative response to two questions about the odour of butyric acid as a function of age.

phthalate. The children were all 7 years old. Half of them were first asked to judge the odours hedonically and, on a later occasion, to judge them in terms of perceived intensity. The order was reversed for the other half of subjects. The relationship between the hedonic scale values and the intensity scale values derived from the judgements are shown in Fig. 4.4. It is clear that the hedonic value tends to be inversely proportional to intensity, that the most preferred odour was the weakest and that the differences in perceived intensity and preference is greatest for the strongest stimulus.

But the main point here is that the range of values, which are comparable for the two axes of the graph, shows that perceived intensity varies more than the hedonic values of the odours: the difference is about 2:1 in these standard deviation units derived from the pair-comparison judgements. At this stage of development children are more responsive to differences in intensity than hedonics. By contrast, the reverse is true for adults. For them the range of hedonic values obtained for different odours is approximately ten times that of perceived intensity differences of any one odour (e.g. amyl acetate), varying from 100 per cent down to threshold concentration (Engen and McBurney, 1964). (See Moskowitz, 1977, for a general discussion of the relationship between intensity and hedonics for initially unpleasant, neutral and pleasant odours.)

In addition to the odours tested above, one would be interested in results with more personally significant odours. Food odours have been studied for

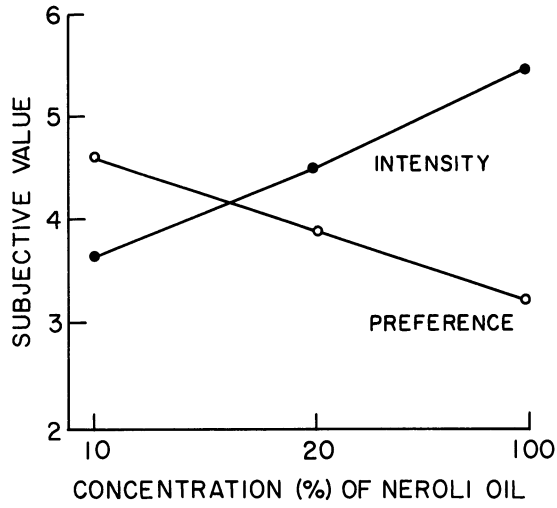

Fig. 4.4 Subjective scale values of preference vs perceived intensity as a function of the concentration of neroli oil diluted in diethyl phthalate by children aged 7. The concentrations are spaced logarithmically.

this purpose by Laing and Clark (1983). They obtained data from over 300 boys aged 8–16, and attempted to relate preference judgements to hormonal changes during puberty. Their test stimuli were common foods like meat, fish, onion and cheese. The children rated them on a hedonic scale with the following steps: 'like extremely', 'like moderately', 'like slightly', 'dislike slightly', 'dislike moderately' and 'dislike extremely'. Although there were significant differences in the ratings of certain odours, for example, that of coffee changed from 'dislike' to 'like' with age, there were overall no age changes, thus presumably no evidence of hormonal changes on the hedonic ratings of the odour. Related findings have been reported by Koelega and Koster (1974). Our data (Fig. 4.1) would lead us to think that at the age of 8 and older one would expect hedonic ratings to be closer to the adult norm than at a younger age.

Peto (1936), who probably first observed that the hedonic scale is a function of age, tested younger children. He was interested in how a child might 'behave towards a smell which is called disgusting or at least disagreeable by grown-up people' (p. 316). He tested 293 children: 92 under 5 years; 39 5–6 years; and 127 over 6. The odours, selected to represent Henning's categories, were anise, lemon oil, camphor, pine, tar, horn oil of oxen, carbol, kenopodium, trimethylamine, asafoetida, moleleuka, valerian, polysulphides and various perfumes. Peto presented them in sniff bottles and asked the children to smell each, and noted their reaction. He concluded that

for children under 5 there was virtually 'no reaction whether by crying, gestures, or words, by which we would detect that they experienced disgust or disagreeable feeling' (p. 317). Only 2 of the 92 children in that group gave any such indication. The percentage increased to about 50 per cent for the 5 and 6-year-old group and 80 per cent for children over 6.

4.5 CHILDREN'S VOCABULARY FOR HEDONIC PROPERTIES

In a recent study of disgust, Fallon, Rozin and Pliner (1984) observed the effect of various forms of contamination on the hedonic rating of food by children aged 3½–12. Their hedonic rating scale consisted of a series of faces which ranged from a happy one drawn with 'U'-shaped mouth to an unhappy one, indicated by an inverted 'U'. The stimulus was milk into which had fallen (it was suggested to the children) a leaf, a grasshopper, poison or dog faeces. The results indicate that children of about 6 or younger had no clearly differentiated notion regarding what might be acceptable and unacceptable categories of rejection. The authors conclude that contamination sensitivity only develops gradually with age. They also state that the results raise the problem of how cognitive and affective systems are related. There is an unjustified tendency to assume and take for granted that the cognitive factors which are involved in making hedonic judgements are the same for children and adults.

Although there is ample evidence in the linguistic literature that children younger than 3 years form cognitive categories of visual and auditory stimuli (Clark, 1983), they do not categorize them hedonically. This is a general problem, and not peculiar to the chemical senses. Research by Nelson (1973, 1976) reveals that among the first words in a child's vocabulary at age 24–60 months there are adjectives or attributes describing various properties (colour) or states (hot) but hardly any evaluative adjectives or attributes (bad, nice). It is important to note that one quite evident property of objects is size (big and bigger). Likewise, words for food comprise over 25 per cent of the vocabulary. The rest are eating utensils, clothes, animals and toys. The vocabulary is a select one, involving the things in life that children act upon. Children are not usually exposed to contaminated food and therefore have no adjective for it. In general, one attempts to protect children from having unpleasant perceptions. All food is described as 'pleasant', so that it will be accepted. Likewise, medicine is 'good for you' or 'yum-yum'. Of course, children are warned against potentially harmful objects, for example, hot ones, but the lexicon problem appears to be academic until such objects actually have been experienced.

Words indicating disgust and dislike are not the only ones missing in the young child's lexicon. While clothes represent a large and diverse category,

diaper (or nappy) is not among a child's first words, even though it must be experienced as often and as intimately as any other piece of clothing. Nelson (1973, p. 30) wonders, 'Is "diaper" a baby taboo word?' She does point out that the problem with this kind of negative evidence is that the absence of a certain word does not necessarily mean that the baby does not have the corresponding concept. On the other hand, the fact that child uses the word 'good' does not mean that he or she means what is said. However, in general linguists agree that words are only likely to survive in a child's vocabulary if they share meaning with those used by adults. Linguistic data on young children therefore strengthen the argument that odour hedonics is acquired with age and is not part of a child's lexical system or his or her innate world knowledge.

4.6 CONCLUSION

One cannot predict a child's response to an odour knowing only the nature of the stimulus. One must know the age and experimental factors affecting the child's acquisition of the meaning and description of odours. The odour *per se* has no intrinsic effect, although other attributes of the stimulus might. Trigeminal stimulation is one such problem (see Engen, 1986). There is no evidence of a hedonic perceptual scale, nor any evidence of words denoting such knowledge even at the age of 3.

However, the new-born child has a developed olfactory system and does respond to odours, especially to differences in their intensity. But the response is as to a signal, the meaning of which is to be determined in the situation in which it occurs. To humans generally odours are only epiphenomena but, as such, sensory cues by which events or situations are remembered and coded in larger contexts.

While some odours, perhaps body odours, may have salience which makes their meaning easy to acquire, present evidence appears to favour the hypothesis that the odour is arbitrary. In general, what appears to be biologically significant is not the odours, but the existence of a system whereby children learn to adapt to a complex chemical world where novel odours are created daily by engineers and perfumers. The olfactory system is a *tabula rasa* which prevents unadaptive rigidity and permits flexibility in dealing with the environment.

The practical implication of this is that to control the responses to odour, one must control the situation in which they are experienced. Training people to appreciate odours and the use of marketing techniques would be aspects of such a programme. Odour perception is a ready frontier for creative people. It would be a pity if it should be limited to the study of a few odours such as musk and androstenone.

5

Perfume as a tactic of impression management in social and organizational settings

R. A. BARON

5.1 INTRODUCTION

Making a favourable impression on others is an important social task. Indeed since the impact of such impressions is both far-reaching and long-lasting in duration (Baron and Byrne, 1984), accomplishing this task in an effective manner can have important implications for an individual's career, social relations and personal adjustment. Not surprisingly, most persons are well aware of these 'high stakes'. Thus they devote considerable attention to mastering the art of successful *impression management*. In short, they attempt to develop specific skills that assist them in inducing positive reactions among others. Systematic research concerned with impression management suggests that a wide range of tactics can be used for this purpose (cf. Cialdini, 1985; Jones, 1964).

First, people seeking to enhance their personal appeal often attempt to demonstrate that they possess desirable traits such as sincerity, intelligence or competence (Price and Garland, 1981). Secondly, they frequently seek to associate themselves with positive events or people; 'name-dropping' is a concrete instance of this procedure. Thirdly, they engage in a cluster of related procedures best described by the term *ingratiation* (Wortman and Linsenmeier, 1977). These include flattering the target persons (those whose esteem they wish to capture), showing a high degree of interest in them, agreeing with them or otherwise demonstrating similarity and adopting an informal, self-deprecating style (Godfrey, Jones and Lord, 1986). Finally, and most germane in this chapter they may engage in efforts to improve various aspects of their physical appearance or, more generally, physical presence.

A substantial body of research (Berscheid, 1985) shows that social strategies can yield important benefits. Specifically it has been found that attractive persons are generally liked more than unattractive ones, and are also perceived as possessing additional positive qualities to a greater degree (e.g. social skill, intelligence, independence – see Brigham, 1980). Perhaps more disturbing, persons of high physical attractiveness often seem to gain a considerable edge in hiring decisions (Dipboye, Arvey and Terpstra, 1977), and are perceived as having higher capabilities than persons of low attractiveness (Heilman and Stopeck, 1985). In addition, there is some indication that they do attain a higher degree of success in their careers (Dickey-Bryant, Lautenschlager and Mendoza, 1986).

Given such outcomes, it is far from surprising that many persons vigorously engage in an effort to enhance their physical appeal in a wide range of contexts – those that are purely social in nature (e.g. a first date, visiting a 'singles' bar) as well as career- or work-related contexts (e.g. participating in a job interview, calling on a potential customer, attending an important meeting). Attempts along these lines take many different forms. However, the most important involve *style of dress* and *personal grooming*.

With respect to the former, much evidence suggests that the way in which one dresses does indeed exert a strong effect on the impression one makes on others (e.g. Solomon, 1985). The findings of research on this topic are complex, but generally point to the following conclusion: adopting a style of dress appropriate to the occasion is probably the best strategy for creating positive impressions (Forsythe, Drake and Cox, 1985). Thus, when applying for a position in a large, tradition-bound organization, one should dress in a subdued, conservative manner. In contrast, when attempting to capture the attention of potential partners in a frenetic 'singles' bar, a more dramatic and informal style would probably be best. While much research has examined the impact of style of dress as a tactic of impression management, much less attention has been directed to the efficacy of personal grooming in this respect. The research reported in this chapter concerns the impact of one important aspect of grooming, the use of perfume or cologne.

As suggested by the huge sums spent each year on their purchase, most people appear to assume that such products are effective in generating positive reactions among others. Further, informal observation suggests that large numbers of individuals are reluctant to enter varied social situations without a splash, dab or spray of their favourite scent. Are such beliefs correct? Do scents actually enhance the appeal of their users to other persons? The studies summarized below suggest a mixed reply. In some contexts, and under some conditions, scents *can* yield such effects. In other contexts, and under other conditions, however, they do not seem to produce these benefits and may in fact 'backfire', inducing negative rather than positive reactions

among their intended targets. The investigations pointing to such conclusions, as well as the mechanisms that seem responsible for the complex effects of artificial scent in a variety of situations, will now be described.

5.2 THE IMPACT OF PERFUMES ON FIRST IMPRESSIONS

Advertisements for perfumes, colognes and similar products often suggest that their use will aid purchasers in the accomplishment of one crucial social task: attracting romantic partners. In short, such advertisements imply that strangers of the opposite sex will be more strongly attracted to a given individual if he or she uses an appropriate scent than if he or she does not. In order to determine whether this is indeed the case an initial investigation concerned with first impressions in a social context was conducted (Baron, 1981). It was reasoned that since scents are pleasant, and tend to induce positive affective reactions among people exposed to them, they might also enhance first impressions of their users among members of the opposite sex (Byrne and Clore, 1976).

Participants in the project were male undergraduates at Purdue University. When they arrived for their appointments, they found another person (a female accomplice of the researcher) already present. Both individuals were then informed that the investigation was concerned with the manner in which people form their first impressions of others. To study this topic, the experimenter explained, he would ask each participant a series of questions. Both persons would listen to their partner's responses and, on the basis of such information, form a first impression of this stranger.

For each question the accomplice responded first, and provided simple, uncontroversial answers that were prepared in advance and thoroughly memorized. For example, the first question was: 'What factors made you choose to come to Purdue instead of another university?' The accomplice's response, identical for all subjects, was: 'Gee, I don't know. Several, I guess. It's pretty close to home, so I can get back there on weekends. And it's got a good reputation. A lot of my friends came here, too, so that was one reason. I guess all those things together.' Her replies to the remaining three questions ('What are your career plans or goals?'; 'What are your favourite hobbies or leisure-time activities?'; and 'What do you think is the most serious problem facing the USA today?') were of a similar, simple nature. After the accomplice responded to each question, the subject, who was seated directly next to this person, gave his reply. Following the last question, the accomplice and subject were taken to different rooms, where they indicated their first impressions of one another on a special form. Separate items on this form requested that they rate their partner on twenty different dimensions involving personal traits (e.g. conceited–modest, warm–cold, shy–bold). In

addition, they rated the extent to which their partner was attractive and well-groomed, and also indicated how much they liked her. Subjects' responses to these items constituted the major dependent measures in the study. All ratings were made on seven-point scales. Of course, the accomplice actually made no ratings of the subject.

In order to determine whether scent would affect subjects' reactions to the accomplice, in this simple context, straightforward procedures were employed. For half of the participants prior to the start of the session the accomplice placed two small drops of a popular perfume ('Jungle Gardenia') behind each ear. For the remaining participants she did not employ scent. Because of the lingering qualities of this perfume, these two conditions were conducted on alternate days. Preliminary pilot testing indicated that this procedure was effective. The accomplice's scent was distinctly noticeable, but far from overpowering in the scent-present condition. In addition, since style of dress has previously been found to exert important effects upon evaluative reactions towards strangers (e.g. Forsythe, Drake and Cox, 1985), the accomplice's mode of dress was varied too. In one condition (informal dress) she wore jeans and a sweatshirt, while in another (formal dress) she wore a skirt, blouse and hose. This dress variable was manipulated orthogonally to scent, so that half of the subjects in each scent condition encountered the accomplice dressed in one of the two contrasting styles.

Analyses of variance performed on subjects' ratings of the accomplice's attractiveness, and their liking for her, failed to yield the predicted main effects for use of scent. However, these analyses did yield significant interactions between scent and style of dress ($F(1,93) = 11.01$, 13.36, $p < 0.002$, $p < 0.001$) respectively. The means pertaining to these interactions are shown in Table 5.1. As can be seen from this table, scent enhanced subjects' ratings of and liking for the accomplice when she dressed in an informal manner. However, when she dressed more formally the opposite was true: participants rated the accomplice as less attractive and reported liking her less when she used scent than when she did not.

Additional analyses performed on subjects' ratings of the accomplice's

Table 5.1 Mean ratings of liking for the accomplice and the accomplice's attractiveness as a function of artificial scent and mode of dress

	Liking for accomplice		*Accomplice's attractiveness*	
Mode of dress	*No scent*	*Scent*	*No scent*	*Scent*
Informal	5.09	5.87	4.87	5.50
Formal	5.58	5.00	5.67	4.91

personal traits yielded corresponding significant interactions between scent and style of dress for two items: warm–cold and unromantic–romantic ($F(1,93) = 8.77$, 4.80, $p < 0.005$, $p < 0.03$) respectively. The form of these interactions was identical to those for ratings of attractiveness. Specifically the accomplice was rated as warmer and more romantic when she wore scent than when she did not and was dressed informally. However, the opposite was true when she dressed in a neater or more formal manner.

At first glance, the results of this initial study were somewhat puzzling. Contrary to predictions, the use of scent did not uniformly enhance reactions to the accomplice. Instead, it appeared that this grooming aid produced positive effects only when the accomplice was dressed informally. However, when she dressed in a more formal manner, opposite results were obtained: the use of scent actually reduced ratings of her attractiveness, and led subjects to perceive her as colder and less romantic. What mechanism could account for this pattern of results?

One possibility was suggested by comments offered by participants during debriefing sessions conducted at the end of each experimental hour. At this time, several of the male participants indicated that they had judged the accomplice to be conceited, overly concerned with her appearance and unapproachable when she wore perfume and dressed formally. In short, on a college campus where informality was the rule rather than the exception, this combination of careful dress and use of a specific grooming aid was somewhat unusual and distinguished the accomplice fairly sharply from most other students. Also additional comments by subjects suggested that their explanations for this behaviour by their partner were generally unflattering. As already noted, they perceived her as conceited and overly concerned with her appearance. In addition, others noted that she was probably 'dressing up' to impress some specific person – some male other than themselves! This of course reduced her apparent availability, and so her appeal to participants. In sum, the results of this initial study suggested that the impact of perfume on first impressions is quite complex. Rather than enhancing such reactions in the simple, uniform fashion suggested by many advertisements, the impact of this grooming aid seems to depend strongly on several other factors (e.g. the context in which it is used and the reasons why subjects thought the smell was there).

Although the findings of this investigation were not entirely consistent with initial predictions, they were encouraging in two respects. First, they suggest that it is possible to study the impact of perfume under carefully controlled laboratory conditions. Secondly, they indicate that, at least under some circumstances, scent can serve as an effective tactic of impression management. However, it should be recalled that these findings were obtained in what might be described as a purely social context: an initial 'get-acquainted' meeting between strangers of the opposite sex. Would scent

exert corresponding effects in other contexts too? Specifically would it affect impressions in situations where there is more at stake than simply impressing a potential romantic partner? In order to obtain information on these questions two additional studies, both focusing on important organizational processes, were conducted.

5.3 THE IMPACT OF PERFUME DURING EMPLOYMENT INTERVIEWS

Despite growing concern about their validity and fairness, employment interviews continue in widespread use as a selection and placement technique. Indeed such interviews constitute the first and often most crucial contact between persons seeking employment and organizations with available positions. Because the outcome of such interviews can have profound effects upon the future course of applicants' careers, such people often engage in strenuous efforts at impression management in this context. In short, they do everything in their power to produce the most favourable impression possible on the interviewer. Thus they attempt to 'dress for success' (Cash, 1985), to present an 'image' of competence and intelligence and to enhance their physical appearance in several different respects. Since the use of scent is often part of these efforts, an intriguing question arises: does the perfume actually produce the beneficial effects desired by interviewees? In other words, does it enhance the ratings they receive from interviewers? Again, to the extent perfume induces positive affective reactions in the target person's liking for applicants, and hence their ratings, they might well be enhanced (Byrne and Clore, 1976). On the other hand, the use of scent might also be viewed as inappropriate or manipulative by interviewers, and their evaluations of applicants employing this grooming aid might be reduced accordingly. To determine which – if either – of these contrasting effects might occur, two experiments involving simulated job interviews were conducted. Because the procedures and purposes of these investigations were somewhat different, they will be described separately.

5.4 THE 'SWEET SMELL OF SUCCESS'?
Sex of applicant and interviewer and perfume as determinants of ratings in simulated interviews

In the first of these studies (Baron, 1983) male and female subjects played the role of a personnel manager and interviewed another person (a male or female accomplice of the researcher) for an entry-level management position. During the interview subjects read a series of questions to the applicant (i.e. the accomplice). The questions were typed on index cards, and were quite

straightforward in nature (e.g. 'What are the major goals you are seeking in your career?' 'How do you get along with other people?'). The accomplice's responses to each question were prepared in advance and thoroughly memorized. As in earlier research (Baron, 1981), they were simple and non-controversial in nature.

Following completion of the last question, the subject was taken to a separate room where he or she rated the applicant on a number of different dimensions. Four of these were job-related (e.g. potential for future success, an overall hiring recommendation). Four others related to personal characteristics (friendliness, modesty, intelligence and warmth). Three additional items were concerned with the accomplice's appearance (grooming, neatness and attractiveness). Subjects also rated their liking for this person, the extent to which their ratings of the applicant were affected by his or her appearance and their own effectiveness as an interviewer. As previously, all ratings were made on a seven-point scale.

In order to assess the possible impact of scent on ratings of the applicant the accomplices either placed two small drops of a perfume or cologne behind each ear prior to the start of each day's session or did not make use of these grooming aids. The scents employed were chosen on the basis of a pilot study in which male and female subjects rated the attractiveness of eleven popular perfumes and colognes presented in identical, unlabelled plastic bottles. The scents receiving the highest ratings ('Brut' and 'Jontu') were used respectively by male and female accomplices.

A multivariate analysis of variance performed on the four job-related items yielded an interaction between sex of subject and use of artificial scent that closely approached significance ($F(4,34) = 2.56$, $p < 0.07$). Follow-up univariate analyses then indicated that this interaction was significant for three of the four dependent measures: qualification for the job in question ($F(1,37) = 4.23$, $p < 0.05$); potential for future success ($F(1,37) = 8.21$, $p < 0.025$); and overall hiring recommendation ($F(1,37) = 4.32$, $p < 0.05$). The means involved in these interactions are presented in Table 5.2. As can be seen from this table, the pattern of results was identical for

Table 5.2 Mean potential for future success and overall hiring recommendation as a function of sex of subject (interviewer) and artificial scent

	Potential for success		*Hiring recommendation*	
Sex of subject	*No scent*	*Scent*	*No scent*	*Scent*
Male	5.53	5.22	5.87	4.90
Female	5.78	6.20	5.56	5.80

each measure. In all cases male subjects (interviewers) assigned lower ratings to the applicants when they wore scent than when they did not, while females showed an opposite pattern.

A multivariate analysis of variance performed on the items relating to personal characteristics (intelligence, warmth, friendliness and modesty), yielded a highly similar pattern of results. Again, the interaction between sex of subject and scent approached significance ($F(4,34) = 2.51$, $p < 0.08$). Follow-up univariate analyses indicated that this interaction was significant for two measures, warmth and friendliness ($F(1,37) = 6.24$, 8.80, $p < 0.025$, 0.01) respectively. The means involved in these interactions are presented in Table 5.3, where it can be seen that once again males and females reacted differently to the use of artificial scent. While males rated applicants lower in intelligence and friendliness when they wore scent than when they did not, females rated applicants higher on these dimensions when they made use of scent than when they did not.

Table 5.3 Mean ratings of accomplice's intelligence and friendliness as a function of sex of subject (interviewer) and artificial scent

	Intelligence		*Friendliness*	
Sex of subject	*No scent*	*Scent*	*No scent*	*Scent*
Male	5.44	5.10	6.68	6.10
Female	4.08	5.64	5.30	5.85

Additional analyses revealed that males reported liking the applicants less when they wore scent ($M = 3.56$) than when they did not ($M = 5.10$), while females reported liking the applicants more in the presence ($M = 5.21$) than absence ($M = 4.62$) of such scent ($F(1,37) = 4.28$, $p < 0.05$). Further, males rated themselves as poorer interviewers when the applicants wore scent ($M = 3.70$) than when they did not ($M = 4.78$), while females rated themselves as slightly more effective in the presence of scent ($M = 4.29$) than in its absence ($M = 3.92$) ($F(1,37) = 3.52$, $p < 0.07$). Finally, males reported being affected to a greater degree by the applicants' personal appearance ($M = 4.47$) than did females ($M = 3.88$) ($F(1,37) = 3.13$, $p < 0.10$).

The results of this investigation offered no support for the view that scent yields uniformly beneficial effects for its users in the context of employment interviews. While female interviewers did react more favourably to applicants when they wore artificial scent than when they did not, male interviewers demonstrated an opposite pattern: they rated applicants less

favourably when these persons wore perfume or cologne than when they did not. What might account for this unexpected sex difference? Findings for several of the dependent measures point to one possibility.

Males, then, rated themselves as less effective in the role of interviewer when the applicants wore scent than when they did not. In contrast, females did not report a similar pattern. Further, recall that males reported being influenced to a greater degree than females by the applicants' appearance. Combining these results, the following pattern emerges. Males realized that their ability to serve as an effective interviewer would be reduced by applicants' efforts at impression management. As a result, they experienced annoyance or resentment towards the accomplices in the present study when these persons engaged in such tactics, and so rated them less favourably on several dimensions. In contrast, females knew that they are less susceptible to such techniques, and so did not react negatively to them. In short, the obtained interaction between scent and sex of subjects may derive from differences in the ability of males and females to 'filter out' or cope with irrelevant aspects of applicants' grooming or appearance.

Of course, this interpretation should be viewed as only tentative in nature. Additional confirmatory evidence is necessary before it can be accepted with confidence. For example, research designed to directly assess the ability of both sexes to ignore various aspects of applicants' appearance would be informative in this regard. However, it is interesting to note that these suggestions agree with evidence indicating that in several species males react more strongly to certain naturally occurring scents (e.g. pheromones) than do females (cf. Leshner, 1978).

5.5 'TOO MUCH OF A GOOD THING'?
Effects of scent and non-verbal cues on evaluations of job applicants

Regardless of the mechanisms responsible for the findings of the study described above, they point to one important conclusion: efforts at impression management may sometimes 'backfire' in the context of employment interviews. That is, an individual who attempts to generate a favourable impression by engaging in various tactics of impression management may sometimes reduce rather than enhance the ratings they receive. As noted above, one reason for such effects may involve annoyance on the part of interviewers, who resent being exposed to such treatment and attribute negative characteristics (e.g. excessive manipulativeness) to people who employ it. If this is the case, then an interesting prediction follows: in some instances, at least, several tactics of impression management may actually be less successful than a smaller number or only one. This would be so because the combination of several such tactics would be more apparent,

and so more likely to generate resentment and other negative reactions among recipients. In order to investigate this possibility an additional study was conducted.

In this investigation (Baron, 1986) male and female students again played the role of a personnel manager, and conducted brief employment interviews with another person (actually a female accomplice of the researcher). For half of the participants this person wore perfume, while for the remainder she did not. In addition, for half of the subjects in each of these conditions, the accomplice emitted a high level of positive non-verbal cues (e.g. smiling, leaning towards the interviewer); for the remainder she emitted a low level of such cues. Previous research indicates that such cues are often used by individuals as a tactic of impression management (Godfrey, Jones and Lord, 1986), and that they strongly affect the ratings received by applicants in job interviews (e.g. Rasmussen, 1984). On the basis of the reasoning outlined above, it was tentatively predicted that subjects would assign higher ratings to the accomplice when she employed only one of these two tactics of impression management (i.e. wore perfume or emitted many positive non-verbal cues) than when she made use of both.

The procedures were similar to those employed in the preceding study with two exceptions. First, the accomplice either emitted a high or low level of positive non-verbal cues during the interview. These cues consisted of smiling frequently, maintaining a high level of eye contact with the subject and leaning towards the interviewer (adoption of a friendly, informal posture). The accomplice was carefully trained, so that she could readily emit contrasting levels of these cues in the two experimental conditions (neutral non-verbal cues, positive non-verbal cues). Secondly, a measure of the subject's recognition memory for information presented during the interview was also included. This measure was employed to determine whether efforts at impression management by the accomplice would interfere with accurate encoding or retrieval of social information (cf. Fiske and Taylor, 1984). Other dependent measures were identical to those used in the earlier study (Baron, 1983). After completing the interview, subjects rated the applicant (i.e. accomplice) in terms of job-related characteristics (e.g. motivation, potential for success), and personal characteristics (e.g. attractiveness, friendliness). Procedures for manipulating the use of scent and for conducting the job interviews were identical to those described earlier.

A multivariate analysis of variance on subjects' ratings of the applicant on job-related dimensions yielded a significant main effect of non-verbal cues ($F(5,61) = 6.02$, $p < 0.005$). This effect stemmed from the fact that subjects rated the accomplice more favourably on all of these measures when she emitted a high rather than low level of positive non-verbal cues. In addition, the three-way interaction between sex of subject, non-verbal cues and use of artificial scent closely approached significance ($F(5,61) = 1.98$,

$P < 0.07$). Follow-up univariate analyses revealed that this interaction was significant for ratings of the applicant's potential future success ($F(16,5) = 3.90$, $p < 0.05$) and approached significance for ratings of intelligence ($F(1,65) = 2.76$, $p < 0.10$). The means involved in the interaction for future success are shown in Table 5.4. As can be seen from this table, the predicted 'too much of a good thing' effect appeared among male interviewers, but not among female interviewers. Male interviewers assigned slightly lower ratings to the accomplices when these persons both emitted a high level of non-verbal cues and wore perfume than when they made use of only one or other of these tactics of impression management. In contrast, female interviewers assigned significantly higher ratings to the accomplice when she wore perfume and emitted many positive non-verbal cues than when she adopted only one of these tactics.

Table 5.4 Mean ratings of accomplice's potential for success as a function of non-verbal cues, sex of subject and artificial scent

	No scent		*Scent*	
Sex of subject	*Neutral cues*	*Positive cues*	*Neutral cues*	*Positive cues*
Male	4.50	5.50	5.29	4.90
Female	4.80	5.70	3.89	5.67

A multivariate analysis of variance performed on the data relating to personal characteristics of the accomplice (i.e. the applicant) yielded a significant main effect for non-verbal cues ($F(4,62) = 7.80$, $p < 0.005$) and a significant interaction between scent and sex of subject ($F(4,62) = 3.06$, $p < 0.025$). Follow-up univariate analyses indicated that subjects assigned higher ratings to the accomplice for personal grooming ($F(1,65) = 3.82$, $p < 0.05$) and friendliness ($F(1,65) = 29.25$, $p < 0.001$) when she emitted many rather than few positive non-verbal cues. The interaction between scent and sex of subject stemmed from the fact that male interviewers rated the accomplice as more attractive when she wore perfume ($M = 6.00$) than when she did not (M 5.33, $p < 0.05$). In contrast, female interviewers rated the accomplice equally attractive whether she wore perfume ($M = 5.38$) or did not ($M = 5.40$).

The subject's memory for information presented by the accomplice during the interview was assessed by six questions pertaining to this information. Answers were scored as correct (1) or incorrect (0), and an analysis of variance was performed on the combined measure. This analysis yielded a significant three-way interaction between scent, non-verbal cues and sex of subject

($F(1,65) = 4.27$, $p < 0.05$). The means involved in this three-way interaction are presented in Table 5.5. As can be seen from examination of these data, males and females differed significantly with respect to memory under only one condition, when the accomplice both wore perfume and emitted positive non-verbal cues ($p < 0.05$). Under these conditions males recalled significantly less information than females. Differences between the sexes were not significant in any other instance.

Table 5.5 Mean recognition memory for information presented by the accomplice as a function of non-verbal cues, sex of subject and artificial scent

	No scent		*Scent*	
Sex of subject	*Neutral cues*	*Positive cues*	*Neutral cues*	*Positive cues*
Male	5.33	5.70	5.63	4.78
Female	5.80	5.80	5.56	5.56

The results of this study offer support for the view that where impression management during job interviews is concerned, there can indeed sometimes be 'too much of a good thing'. Male interviewers actually reduced their ratings of the accomplice in terms of job-related and personal dimensions when this person both wore artificial scent and emitted many positive non-verbal cues. This pattern of findings is of interest, for when used in isolation, each of these techniques significantly enhanced the ratings assigned to the applicant.

Somewhat surprisingly, though, this pattern was not observed among female interviewers. Their ratings of the accomplice were enhanced by the combination of two tactics of impression management, relative to the use of only one. What accounts for this striking sex difference? One possibility involves the mechanism outlined above, as an interpretation of the results of the preceding study.

Briefly, males may be less effective in ignoring or 'filtering' various aspects of applicants' personal appearance. Further, they appear to be aware of this relatively high 'susceptibility' to appearance-related factors. As a result, when confronted with attempts at impression management, males may react more negatively than females. They realize that they may experience difficulty in coping with such tactics, and that these tactics adversely affect their performance as interviewers. Consequently they down-rate applicants who use such tactics.

Support for this interpretation is offered by the fact that males, but not females, demonstrated significantly less recognition memory for information

presented by the applicant when this person both wore perfume and emitted many positive non-verbal cues. This suggests that the use of such tactics was more distracting to males than to females, and interfered with their ability to process social information in an effective manner (cf. Fiske and Taylor, 1984). Additional evidence concerning the validity of this interpretation can be obtained in future studies specifically designed to assess the impact of various self-presentational techniques on information processing by males and females.

Regardless of the precise mechanism underlying the contrasting reactions of males and females in this study, the present findings appear to have important practical implications. In particular, they suggest that the use of impression management tactics by job applicants can interfere with the effective processing of relevant information by at least some interviewers. As a result, important information, relevant to hiring decisions, may be unavailable to interviewers at later times, when judgements relating to various applicants are made. The overall result may then be substantial reductions in the accuracy and fairness of such decisions. Clearly this possibility is disturbing for individuals and organizations alike.

5.6 GENERAL DISCUSSION

The results of the research reported here are both complex and varied in nature. Yet, together, they present a fairly consistent picture. First, and most generally, they suggest that the use of scent can indeed affect the impressions users make on others. In this regard, they serve to extend previous findings indicating that several other aspects of personal grooming or appearance (e.g. style of dress, physical beauty) can produce such effects (cf. Dickey-Bryant, Lautenschlager and Mendoza, 1986; Forsythe, Drake and Cox, 1985). Secondly, they indicate that contrary to widespread belief, the impact of this particular grooming aid is not always positive. In certain cases (e.g. when users are dressed informally, when they are interviewed by female interviewers and when they employ no other tactics of impression management) perfume and cologne can indeed yield positive outcomes. But under other circumstances (e.g. when users are dressed more formally, when they are interviewed by males, when they employ other tactics of impression management) their effects may be less favourable. Thirdly, the mechanisms determining the precise nature of such outcomes appear to be complex, involving: (a) affective reactions induced by artificial scents among target persons; (b) attributions on the part of such persons concerning the reasons behind users' decision to apply such scents; and (c) basic aspects of social information processing (e.g. the ability to 'filter' or ignore extraneous input in various situations).

Clearly, if this related series of investigations demonstrates one thing, it is this: perfume *is* important in the context of social interaction – whether such interaction occurs in informal circumstances or as part of structured organizational processes. However, in my opinion this is only a beginning – an initial probe into what appears to be an extremely complex issue. Remaining to be completed are such tasks as: (a) determining the range of situations in which artificial scents affect social behaviour; (b) examining the impact of this factor upon processes other than first impressions (e.g. influence, leadership, attraction, negotiation); (c) investigating the potentially complex interactions between artificial and naturally occurring scents; and (d) identifying the precise psychological and physiological mechanisms underlying such effects. Completion of each of these tasks will require a great deal of additional systematic research. Given the important effects of artificial scent already uncovered, however, there seems little doubt that both for the scientists involved and society as a whole this will be effort well invested.

PART III

Odour perception and the language of the brain

6

Contingent negative variation (CNV) and the psychological effects of odour

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6.1 INTRODUCTION

There have been several attempts to measure objectively the psychological effects of odours (Dodd and Van Toller, 1983), but as yet no electrical brain wave responses to odours have been confirmed (Allison and Goff, 1967; Pattig and Kobal, 1979; Tonoike and Kurioka, 1982). In this chapter we will look at the psychological effect of odours on brain activity. We will concentrate on odours that are stimulating or sedative.

In 1964, Dr W. Grey Walter and his colleagues found an interesting electrical phenomenon in the human brain that they called the *contingent negative variation* (CNV). This is an upward shift in the brain waves recorded by electrodes attached to the scalp, occurring in situations where subjects are expecting something to happen. For example, a subject is given a sound stimulus followed by a light stimulus. When the light appears, the subjects are requested to turn it off as quickly as possible. Within the interval between the two stimuli there appears a slow, upward shift from the baseline of the subject's electroencephalogram (EEG). This shift in the EEG is what Dr Walter called the CNV. Unfortunately a CNV is not obvious within a single EEG trace. Therefore, the EEG must be averaged to clarify the CNV amplitude. Under normal conditions a clear CNV can be obtained in normal adults using between ten and twenty trials.

The CNV has been studied extensively under various experimental conditions to determine how this shift in the EEG correlates with human psychological and physiological states (Tecce, 1972). Psychological factors which have been found to affect the CNV are attention (Tecce and Scheff,

1969), expectancy (Walter *et al.*, 1964) and conation (Low *et al.*, 1966). In addition, there are several studies in which altered states of consciousness were correlated with the degree of the CNV (Naito, Johnson and Lubin, 1971; Yamamoto, Saito and Endo, 1984). For example, Ashton *et al.* (1974) performed experiments in which the central nervous system stimulant caffeine and the depressant nitrazepam were administered. The authors reported that CNV amplitude increased with the administration of caffeine, while it decreased with administration of nitrazepam. These results suggest that CNV is directly affected by stimulation or sedation of the brain.

In our study we examined whether CNV can be used objectively to observe stimulating and sedative effects of odours. Our experiments showed that the odour of jasmine, which is said to have a stimulating effect, increased CNV amplitude, while the fragrance of lavender, which is said to have a sedative effect, decreased our subjects' CNV. We can therefore assert that the CNV is a very sensitive measure for determining the effects of odours on brain electrical activity.

6.2 THE EXPERIMENTS

Our subjects were four male perfumers who have a highly developed ability to discriminate odours, and three male graduate students who had no formal training with respect to odours. They ranged in age from 18 to 40. Twenty kinds of essential oils were used as aromatic stimuli in the study. Subjects smelled filter-paper impregnated with one essential oil at a time. Filter-papers with oil added were used as blanks. These were presented 1–3 s before each trial. Averaged increases or decreases in a subject's CNV could then indicate whether odour had a stimulating or sedative effect on the brain.

Odour concentrations in this study were about the same as those of commercial perfumes. The filter papers contained 0.02 g of each essential oil, except for rose oil, where 0.002 g was used.

During the experiments subjects sat in a comfortable chair in a dimly lit, sound-attenuated, electrically shielded, airconditioned room. The sound stimuli employed consisted of a buzzer (S1) (about 70 dB) delivered from a speaker behind the subject's head. The light source was a small red light-emitting diode (LED) (S2) located 1 m in front of the subject at eye-level. Subjects were asked to turn off the light as quickly as possible by pressing a hand-held button.

An experimental run consisted of twenty trials, each lasting approximately 3 min each. Each trial started with the presentation of an odour (Fig. 6.1). Subjects were asked to breath in and out three times. On the third inhalation the filter-paper containing the odour was brought beneath the subject's nostrils. It was quickly removed, so that the subject had no aromatic

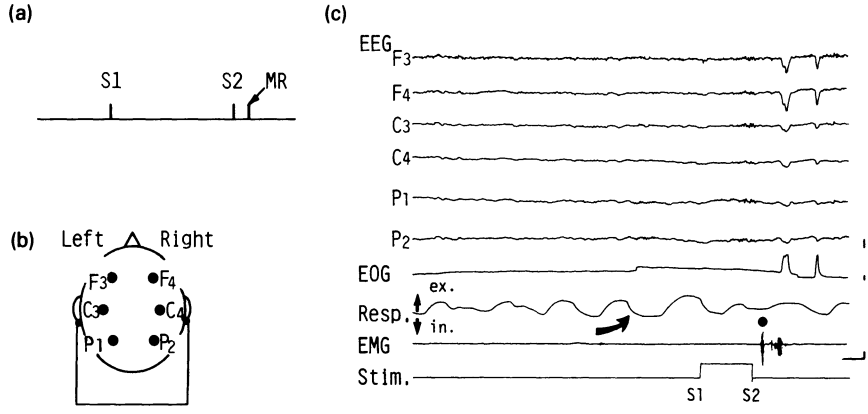


Fig. 6.1 The experimental design for the CNV test. (a) The sequence of stimulation – S1 is a sound stimulus, S2 is an LED visual stimulus and MR is a motor response (pressing a button). (b) The positions where the electrodes were attached to the scalp. F, C and P correspond to the frontal, central and parietal sites respectively. (c) The polygraph obtained during recording of the CNV. The investigator, observing the pattern of respiration of the subject, instructed him/her to inhale and exhale. At the third phase of inhalation a bottle of the test odour was brought to the subject's nose (shown by the arrow), and after 1 to 3 s, the stimulus by sound (S1) was presented, then the stimulus by light (S2) was presented 2.3 s after S1. The subject had been asked to press a button as soon as possible when the stimulus S2 was given (shown by the muscular activity denoted by in the EMG trace). EEG, electroencephalogram, EOG, electro-oculogram, Resp, respiration (ex – exhalation; in – inhalation), EMG, electromyogram of the thenar. Calibrations were made for EEG, EOG and EMG with 50 μV; paper speed, 1.5 cm/s. The CNV paradigm shown here constituted one trial, and twenty trials were carried out for each test odour.

stimulus after S1. The buzzer was sounded 1–3 s after the odour, and 2.3 s later the LED light came on which the subject turned off as quickly as possible. The inter-trial interval varied by 20–30 s; between each run there was a resting period of 5–10 min.

A total of four runs was carried out for each subject, lasting one and a half hours in all; usually two kinds of odour were tested, and each odour was compared to a blank. Eye movement during each trial was minimized by asking the subjects to fix their gaze on the LED.

The EEG trace was recorded via silver–silver chloride cup-electrodes fixed to the scalp with collodion after cleansing of the skin with alcohol. The electrode resistance was below 5 kΩ. Standard electrode positions were the Fz, Cz and Pz, following the international 10–20 electrode system (Jasper,

1958); sometimes F3, F4, C3, C4, P3 and P4 were also used. All were referred to linked earlobe electrodes which served as the common reference for monopolar recording. The EEG was amplified with an electroencephalograph (Nihon Koden EEG-4321) with a 5 s time constant and with an upper cut-off point of 30 Hz. The electro-oculogram (EOG) was recorded from bipolar electrodes situated above and below the left eye. This served to monitor eye movement. A flow sensor was attached just under the nostrils with double adhesive tape to monitor respiration. An electromyogram (EMG) was recorded via electrodes attached to the thenar muscle to monitor the subjects' reaction times to the LED onset. The skin potential level (SPL) was recorded bipolarly between an electrode attached to the palmar surface of the index finger and another electrode attached to the inside surface of the forearm. This measure was used to monitor the level of consciousness (sleepiness/alertness). Recording started when the baseline drift of the EEG had settled after electrode attachment, which usually took at least half an hour. To obtain a clear CNV signal we recommend that EEG recording is not started until at least half an hour after attachment of the electrodes. Subjects were familiarized with the procedure by practice runs with blanks.

All signals, except for the skin potential level (SPL), were recorded in analog form on magnetic tape by a tape recorder (TEAC-21) for off-line analysis on Signal Processor 7507 (Sanei Instruments Co.). Ten to twelve trials were selected for averaging the EEG to obtain a CNV for each odour. Trials were excluded from averaging if there appeared vertical EOG artefacts or baseline drift on the EEG signal. Approximately 40 per cent of the records showed contamination by eye potential. The SPL was amplified with a DC amplifier (Chino EB 22605) and written out on a pen recorder at a paper speed of 15 mm/s. An XY plotter (Roland DG, DXY-980) was used to write out the average response on graph paper, covering in real time the period from 500 ms before the S1 to 300 ms after S2.

The magnitude of each CNV written on the XY recorder was determined by measuring the peak negativity occurring within 500–1000 ms after S1, compared to the visually determined baseline available prior to S1. The baseline amplitude for each trial was defined as the average value of the voltage recorded during the 500 ms period immediately preceding S1.

6.3 CNV AMPLITUDES AT DIFFERENT SITES ON THE SCALP

When we examined CNVs recorded at different sites on the scalp, we found that the CNV differed, depending on that part of the head being monitored (Fig. 6.2). In the frontal part of the head, an early shift, denoted by a blackened circle, was noticed at 500–1000 ms after S1 was given. After that, the EEG gradually returned to the baseline. In the central part of the head an

early shift similar to that in the frontal site was noted, but in this area CNV continued to rise, denoted by a triangle, and continued to do so through S2 and up to just before the motor response starts. In the parietal part of the head there was no early shift after S1 such as that observed both in the frontal and central sites, but a late, continuous shift like that observed in the central site was seen. Thus it is likely that CNV has two parts, the early one being dominant in the frontal part of the head and the later one dominant in the central and parietal parts.

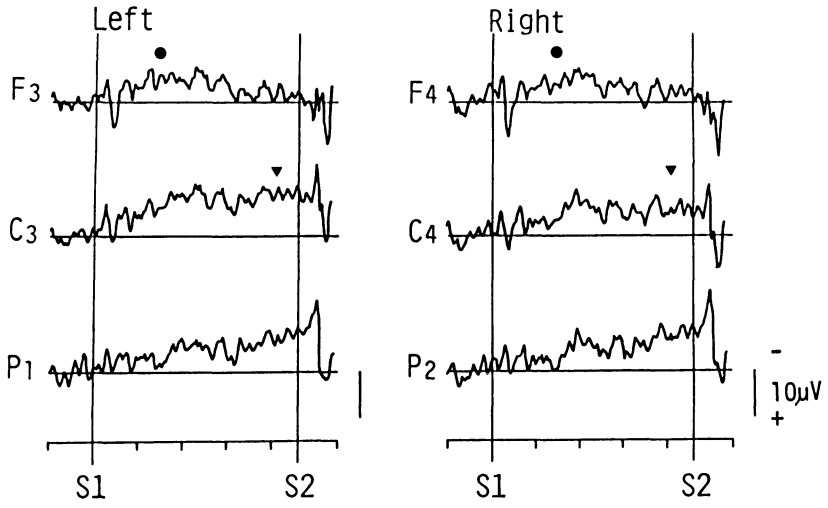


Fig. 6.2 CNV at different sites on the scalp. CNV waveforms are observed among the different sites on both the left and right sides of the scalp. The earlier shift (denoted by ●, from 500 to 1000 ms) of the CNV were dominant at the frontal sites, and the later shift (denoted by ▼, about 1000 ms preceding S2) dominant at the central sites. Evoked potentials by S1 (sound) were centrally dominant and those by S2 (light) parietally dominant. Calibration with 10 μV.

Previous studies have suggested this also (see Rohrbaugh, Sundulko and Lindsley, 1976). The reason for the location of the two parts of the CNV has to do with localized brain functions. The frontal part of the brain deals with attentiveness and alertness among other thinking processes. Thus when the subject hears the warning sound, the frontal part of his brain is stimulated, causing the early CNV shift, whereas the late CNV shift appears in the central and parietal parts of the brain, responsible for motor responses among others, i.e. voluntary movement. As mentioned above, we know that the degree of CNV is smaller in a subject whose attention is low. That is the reason why in our study we emphasized the early part of CNV because it appears to be closely related to the alert–relaxed continuum.

6.4 EFFECTS OF ODOURS ON CNV

An example of CNV obtained from a subject exposed to jasmine oil, which is said to have a stimulating effect, and lavender oil, which is said to have a sedative effect, is shown in Fig. 6.3. Careful observation of this figure shows that, in the shaded area, at between 500 and 1000 ms, there is an increase in CNV magnitude with jasmine and a decrease with lavender. These results were very clear, and encouraged us to continue our study of fragrance and the brain in this way. The average magnitudes at the early shift of CNV in five subjects were calculated (Fig. 6.4). With jasmine odour, there was a statistically significant increase in the early shift at the frontal (F3, F4) and the central sites (C3, C4). F3 and F4 at the frontal sites showed a significant difference ($p < 0.05$) between the three odours at both the left and right sides, while at the central sites this was only true for C3 on the left side ($p < 0.05$). P1 and P2 at the parietal sites did not show any significant differences between the three odours. Largest differences in magnitude of CNV occurred at the frontal site; this suggests that the frontal site is the best place to observe effects of odour on CNV.

These changes in CNV with jasmine odour were observed after the

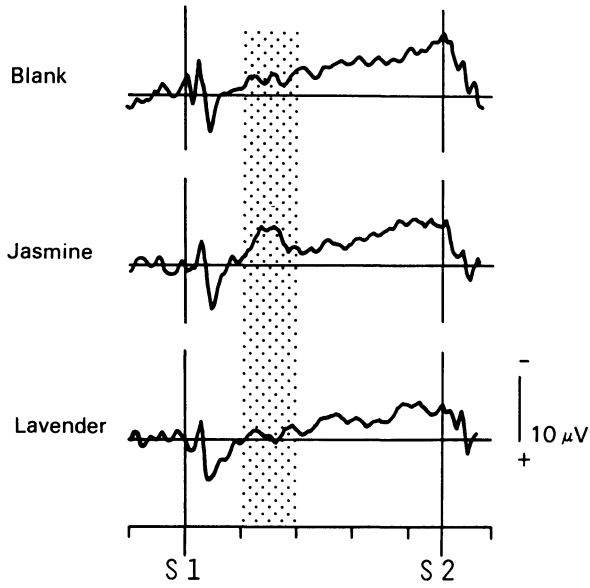


Fig. 6.3 CNV obtained from one subject under the presentation of blank, jasmine and lavender odours. Recording sites and test procedures are given in Fig. 6.1. Under the presentation of jasmine, notable, early shift of CNV are observed. Calibration 10 μV (averaged for twelve trials).

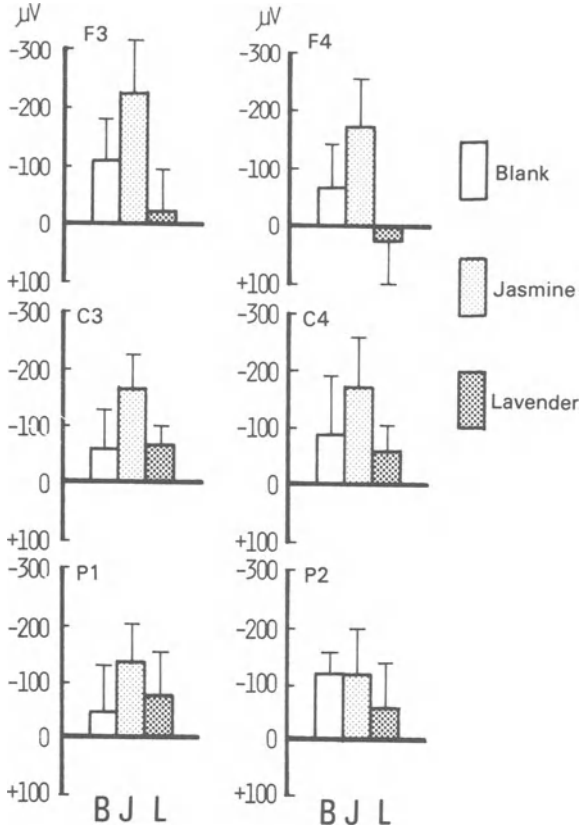


Fig. 6.4 Mean values of the early shift of CNV in 5 subjects under the presentation of blank (B), jasmine (J) and lavender (L).

subjects took a nap and then drank coffee to recover from drowsiness (Fig. 6.5). There is a considerable difference in the magnitude of the early CNV shift at the frontal site between the sleepy subjects and after those same three subjects took a nap and drank coffee. The average magnitude of the early CNV is shown in the figure. In comparison with the normal value, when the subjects took coffee after a nap, the magnitude increased significantly ($p < 0.01$).

The CNV is strongly affected by the level of consciousness (drowsiness or alertness). This is the reason why we simultaneously measured skin potential level (SPL), which is another index of the level of consciousness (Hori, Miyasita and Niimi, 1970). It can be seen in Fig. 6.6 that the SPL was decreasing during the CNV test before the subject took a nap. Afterwards, the subject slept for about 15 min; this was accompanied by an extremely

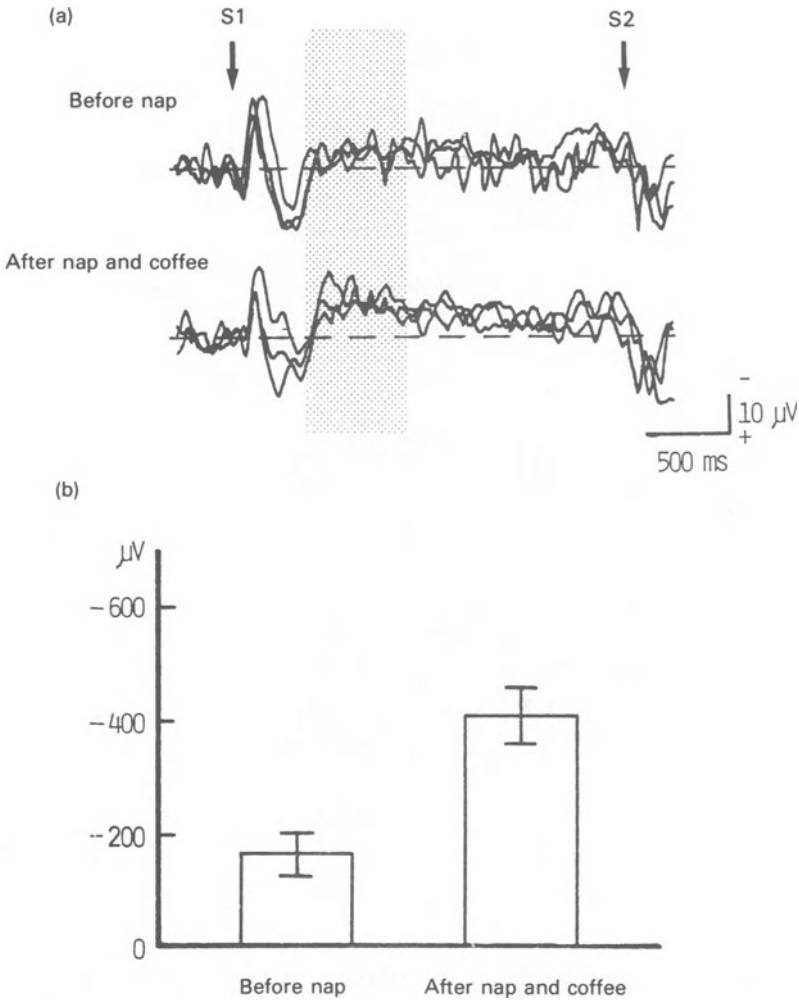


Fig. 6.5 Effect of coffee on CNV. (a) Difference between the magnitude of CNV for sleepy subjects and the same subjects after a nap and a cup of coffee. (b) Difference between the mean values of the early shift of CNV.

low-level SPL. On awakening, the SPL returned to its initial level. The SPL then remained mainly constant during the following series of tests. An increase in the CNV with jasmine and a decrease with lavender is shown in the figure; however, the SPL remains unchanged. Consequently one of the things that we should bear in mind is that always we must measure the effect of odours in subjects with stabilized SPL levels – otherwise the effect of

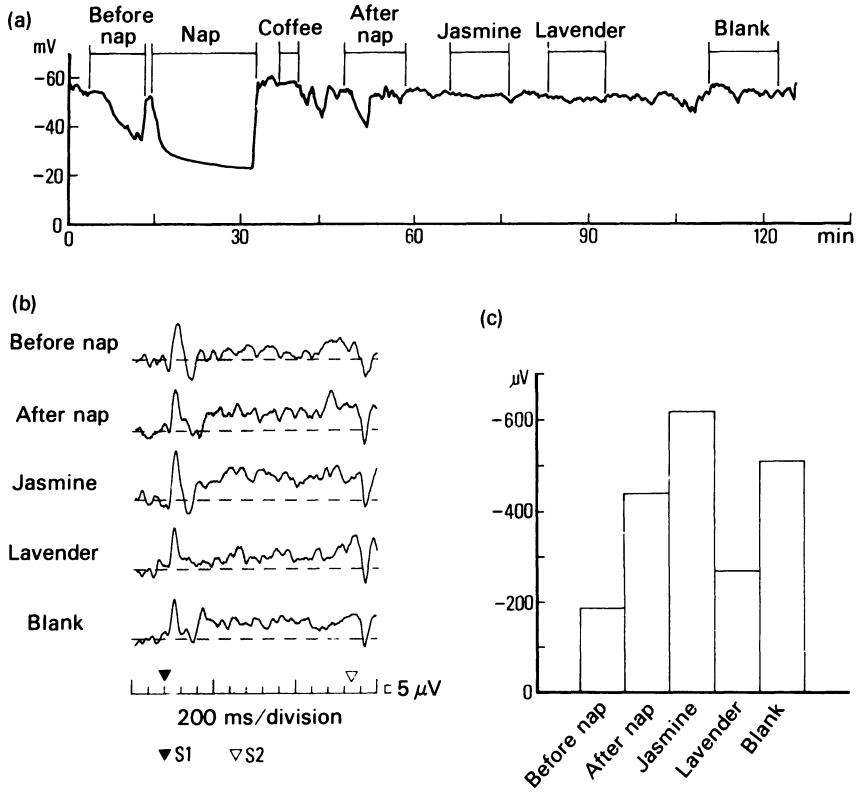


Fig. 6.6 An example of a simultaneous recording of CNV and SPL in one subject. (a) Skin potential level during a series of CNV tests. (b) CNV waveforms on each test. (c) Histogram of CNV magnitude.

odours on CNV will be inconsistent and irregular. Another important point is that no difference in SPL was noted for the three different odours. In other words, both jasmine and lavender clearly affected CNV magnitude without changing the level of the SPL.

Do odours affect the brain without affecting other physiological phenomena such as reaction time, heart rate and SPL? We can see the effect of the essential oils used in our study, on reaction time and on heart rate (Fig. 6.7). They clearly had no effect on reaction time or heart rate. We can, then, presume that these essential oils affect brain waves almost exclusively, and any effect they may have on other physical functions is minor.

Other studies established that central nervous system depressants, chlorpromazine (CPZ) (Tecce, Cole and Savignano-Bowman, 1975), nitrazepam (Ashton *et al.*, 1974) and nitrous oxide NO_2 (Penwick *et al.*, 1979)

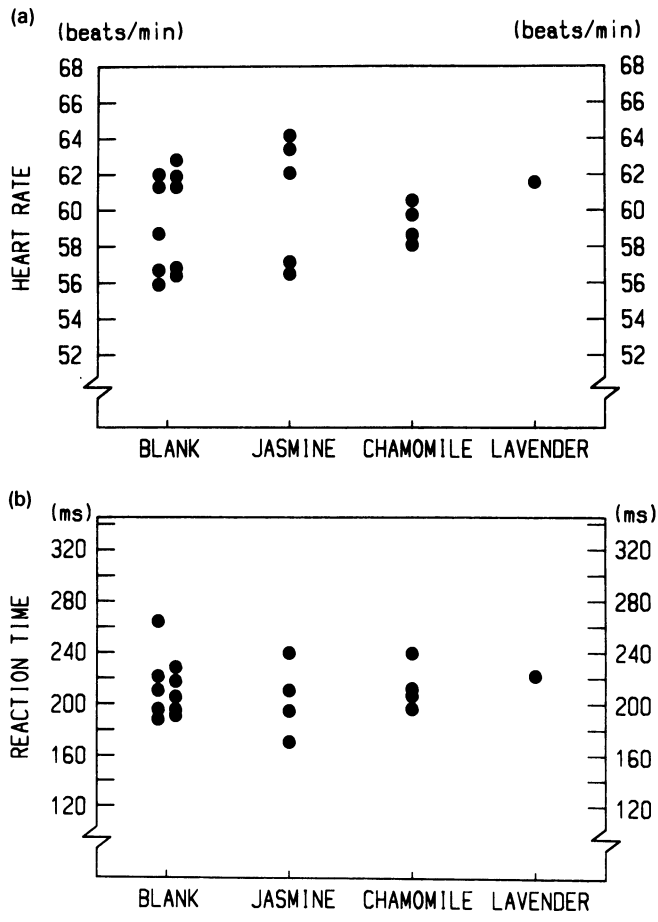


Fig. 6.7 Effects of essential oils on heart rate (a), and reaction time (b).

greatly decrease CNV magnitude and slow reaction time, whereas the stimulant caffeine (Ashton *et al.*, 1974) increases CNV magnitude and shortens reaction time. However, the enhancing effect of jasmine odour on CNV magnitude occurs without apparent changes occurring in reaction time and heart rate. This means that jasmine odour does not have a stimulating effect such as that of caffeine. One explanation may be that the jasmine odour is not concentrated enough to have any effect on reaction time or heart rate. Further studies are needed in this area.

The suppressing effect of lavender on CNV magnitude also occurs without affecting reaction time or heart rate. This may mean that lavender odour has its own kind of sedative effect, unlike the effect of a drug such as nitrazepam. Furthermore, we must consider the possibility that lavender has a distracting

effect. There is increasing evidence showing that distraction suppresses CNV (McCallum and Walter, 1968). This reduction is accompanied by a slower reaction time (Tecce and Scheff, 1969). It has also been shown that most subjects showed increases in their heart rate during a distracting influence (Tacce, Savignano-Bowman and Meinbresse, 1976). The fact that no increase occurred in heart rate during lavender test conditions seems to indicate that lavender does not have a distracting influence.

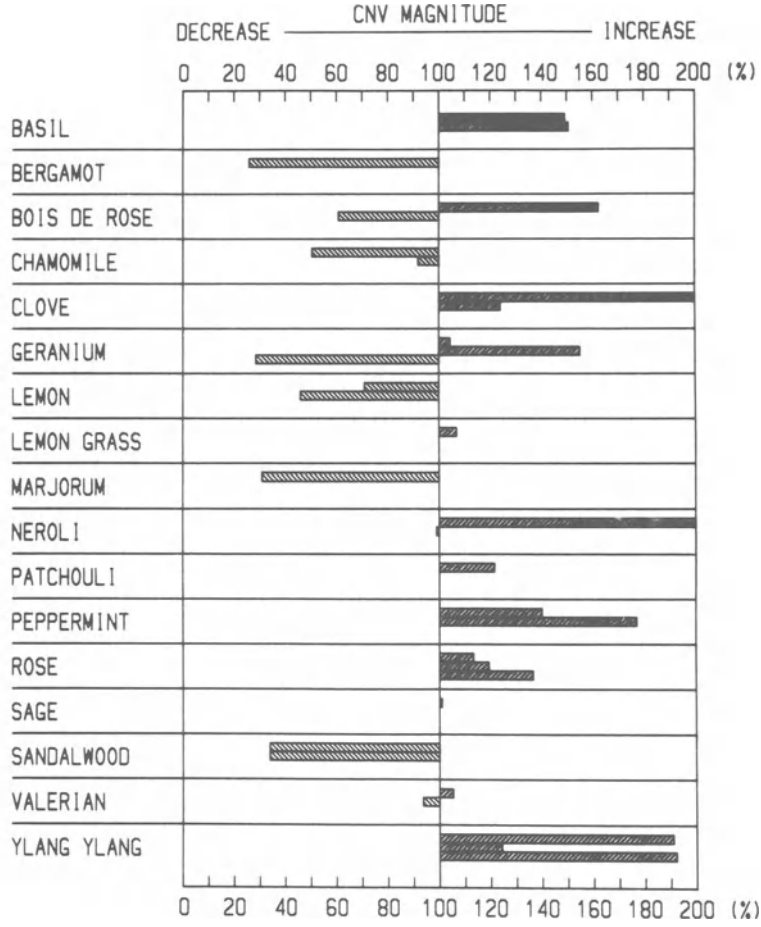


Fig. 6.8 Varying patterns of CNV changes caused by essential oils.

The effects of seventeen essential oils, besides jasmine and lavender oils, on CNV magnitude are summarized in Fig. 6.8. The CNV magnitude of a blank was taken as 100 per cent. An average increase or decrease in the

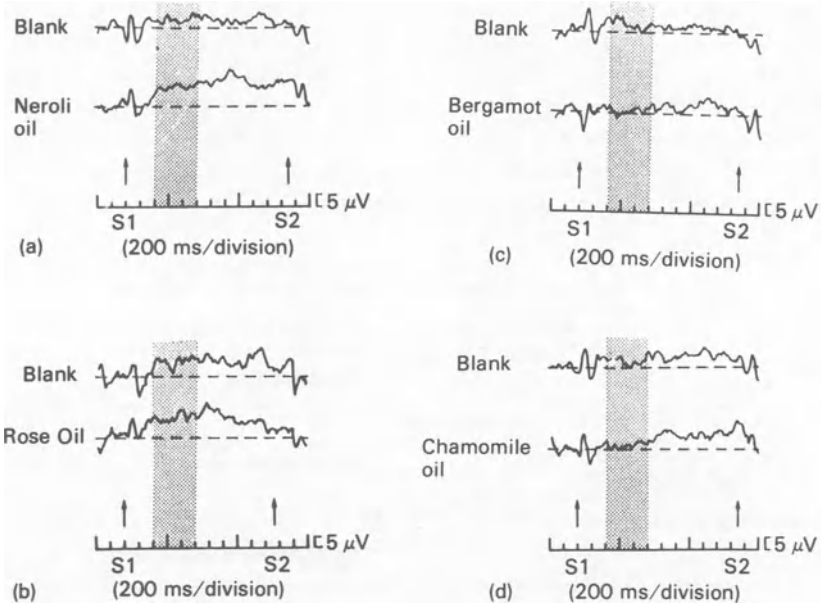


Fig. 6.9 CNV obtained from one subject exposed to essential oils. Neroli and rose oils increased CNV, as in (a) and (b), while bergamot and chamomile oils decreased CNV, (c) and (d).

subject's CNV could then tell us whether a certain odour had a stimulating or sedative effect on the brain. Typical records of both increasing and decreasing effects of essential oils are shown in Fig. 6.9.

6.5 CONCLUSION

In the majority of the essential oils tested in our laboratory changes in CNV magnitude seem to agree with the properties attributed to them in some books on aromatherapy (Lautie and Passebecq, 1979; Tisserand, R., 1985; Tisserand, M., 1985). However, there are some essential oils showing a contradiction between CNV findings and their supposed properties. For example, rose oil, which is said to be sedative, increased CNV. There is clearly a great need for additional detailed studies in this important area. With new testing procedures, such as the CNV test, the properties of essential oils can be studied much more carefully. Further studies are obviously in order.

We examined the possibility of using the CNV as a monitoring device to

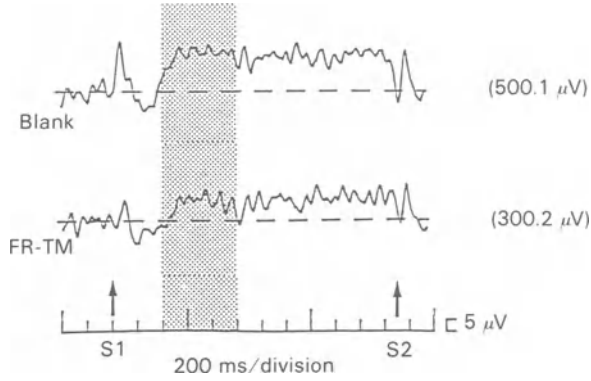


Fig. 6.10 Suppressing effects of perfumed bath product on CNV obtained for one subject.

evaluate the effects of new perfume products. The results of the CNV test for perfumed bath products designed for relaxation (Fig. 6.10), and for a perfume for invigoration (Fig. 6.11), showed a significant difference against the blank. Use of CNV is recommended for the evaluation of commercial perfumes or cosmetics.

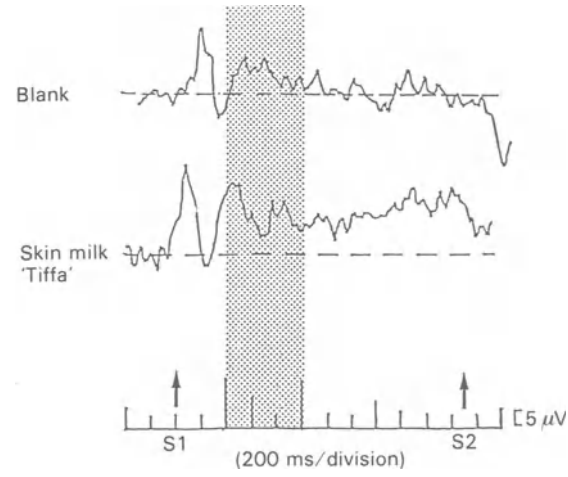


Fig. 6.11 Enhancing effect of a perfume designed for invigoration for one subject.

Although our study of odour and the brain using the CNV has just started, the results are clear and fascinating; jasmine caused an increase in CNV, whereas lavender caused CNV to decrease, regardless of the sex of the

subject. Indeed the stimulation of the brain by jasmine was quite similar to that by coffee in the same subjects. We were able scientifically to prove the truth of the old adage that jasmine stimulates and lavender relaxes (Lautie and Passebecq, 1979; Tisserand, R., 1985).

The authors would like to thank Mr Jeffrey D. Winchester for his help, advice and encouragement in the preparation of this chapter.

7

Emotion and the brain

S. VAN TOLLER

7.1 INTRODUCTION: *HOMO SAPIENS*, THE MICROSOMATIC SMELLER

My first introduction to the subject of olfaction concerned an experiment to discover how quickly ewes learned the smell of their post-partum lambs (Smith, Van Toller and Boyes, 1966). For humans who are visually dominated it is difficult to imagine the world of an animal that can see perfectly adequately but chooses to use its sense of smell. As the cold, grey days of March in the northern hills of Britain slowly unrolled I became aware of the fact that the 'stupidity' of sheep came about because they preferred to use their sense of smell. In a flock it is clearly of advantage to rely on the sense of smell. We thought that keeping down-wind of the animals would enable us to advance and get to the ewes that were in labour. Unfortunately we found that they visually spotted us almost before we spotted them. Later I observed ewes and lambs locating each other with great accuracy using their sense of smell. I saw ewes, without turning their heads to see, kick away presumptuous lambs who were not their own, and who attempted to suckle them. I came to wonder at their smell sense that was clearly more finely tuned than mine. My superior human cognitive abilities were often thwarted by the sheep whose olfactory sensory ability seemed little short of miraculous at times.

This introduction highlights the 'mental block' humans have when they try to understand the sense of smell. I feel that one way of overcoming this block is to gain knowledge about the olfactory abilities of animals. The insightful novel by Suskind (1985), referred to in Le Norcy's chapter, presents its readers with an opportunity to discard, or at least begin to reduce, visual bias. Suskind's story is about a human freak, called Grenouille, who possesses a phenomenal smell sense. Like an animal, Grenouille is able to remember the olfactory imprint of everybody he meets. Immediately he encounters somebody, he is able to discern mood and likely actions by this person's smell. This amazing book should be read by everyone

concerned with smells. However, it is a work of fiction and imagination, and one might question if it could happen in reality.

By one of those strange coincidences a psychological account of a human experiencing an enhanced sense of smell has recently been published by Sachs (1985). Sachs's clinical case, related in a chapter called 'The dog beneath the skin', concerns a bizarre incident which happened to a New York medical student, Stephen D., aged 22, who had been taking 'highs' using cocaine, PCP and amphetamines. One night he vividly dreamt that he was a dog, experiencing a world 'unimaginably rich and significant in smells'. On waking, he found that he actually retained this amazingly acute olfactory ability. He found that his other senses were also enhanced but to a more limited extent. For example, he found his leather-bound books '[which] looked similar before, now had quite distinct and distinguishable hues'. He experienced a dramatic eidetic visual perception that enabled him to project anatomical things he wished to draw on to the paper, and he merely needed to trace the projected outlines. But it was his sense of smell that was transformed with a magical redolence.

Stephen D. found himself living in a world, where 'all other sensations, enhanced as they were, paled before smell'. Linked with his enhanced sense of smell, 'there was a sort of trembling, eager emotion, and a strange nostalgia, as of a lost world, half-forgotten, half recalled'. He went into what he calls a scent shop: 'I never had much of a nose for smells before, but now I distinguished each one instantly – and I found each one unique, evocative, a whole world.' He went into the clinic and sniffed, and later writing about it said, 'In that sniff recognised, before seeing them, the twenty patients who were there. Each one had his own olfactory physiognomy, a smell face, far more vivid and evocative, more redolent, than any sight face'. He found that sexual smells were exciting and increased in terms of meaning but not more so than food and other smells. During this episode of acute olfactory awareness he found that pleasant smells were intense and unpleasant smells less so.

Suddenly, after a period of three weeks, Stephen D. lost his sensory acuity and his senses returned to normal. He said that he was glad to be back but nevertheless missed his redolent phase: 'I am glad to be back, but it's a tremendous loss, too. I see now what we give up in being civilised and human.' He was an intellectual and reflective person, prone to abstraction and categorizing things, but during his enhanced sensory acuity he had felt no need of his human cognitive abilities. During the transformation his sense of smell told him all he needed to know about the world. There was no need for his cognitive abilities as everything was marked and clearly identified by his smell sense. In short, abstract thought and intellectual abilities were redundant.

We should be very grateful to Oliver Sachs (1985) for bringing to our

attention this interesting and illuminating olfactory case. It begins to explain how with the evolution and refinement of the other sensory systems, plus the developing cognitive abilities, humans lost their dependency on the phylogenetically old sense of smell. We might wonder if this could be the basis for the human 'expulsion' out of the Garden of Eden? Was there a point in time when the sense of smell of *Homo sapiens* became overridden by other sensory and cognitive brain circuits? At this juncture, could there have been a vague remembrance of an older, more care-free, halcyon period in human development? I am not meaning to imply that the sense of olfaction has been forgotten or reduced to an irrelevancy. The sense of smell was too important to be left behind as a mere hindbrain reflex. As we shall see, like the emotions, the sense of smell was transformed into new and subtler forms. It is remarkable how in the olfactory sense evolution seems to parallel changes undergone by emotion. The importance of the limbic system to both the olfactory sense and the emotions is illustrated in Fig. 8.3 by King in Chapter 8.

In a similar manner, Le Gros Clark (1952) highlighted the significance of the olfactory sense in the evolution of *Homo sapiens*, when he suggested that Descartes 'Cogito ergo sum' should be changed to 'Olfacio ergo cogito', 'I smell, therefore I can think'. Animals use the olfactory sense to gain precise and specific information about the world; they have no use for the sense of smell as an aesthetic sense. As Stoddart has pointed out in this book, humans have a long history involving the use of perfumes and fragrances as aesthetic experiences. Lord Adrian once said that the entire brain was a chemoreceptive organ, and that there could be few better ways of beginning to understand the workings of the brain than by studying the olfactory sense.

7.2 THE SENSE OF SMELL

In the past it has often been said that the sense of smell has special qualities not found in the other senses, but as we begin to understand more about the olfactory processes, we are learning that it has much in common with the other sensory systems (Van Toller, 1985). For example, odour has often been thought of as having a special relationship with memory, but recent experiments are beginning to show that it is different in degree rather than different in kind (Engen, 1982; Walk and Johns, 1984; Lyman and McDaniel, 1986).

As argued with persuasion by Engen in Chapter 4, odour associations are learned and there appear to be few, if any, inherited reactions to smells. Dodd, in Chapter 2, using an interesting argument has suggested that certain smells imprint more readily than others, and presumably these would be species-specific. However, the case for readily imprintable smells remains to be demonstrated. In the terminology of computer technology reactions to

smells are 'software' and there are no fully authenticated 'hardware' smell reactions. We have reported (Kirk-Smith, Van Toller and Dodd, 1983) the first studies which attempted to investigate how odour conditioning takes place. Kirk-Smith and Booth (1987) have presented a short review of this aspect of olfaction. Baron, in Chapter 5, has also presented results that begin to unravel the complications of social factors in the perception of perfumes on others. As we shall argue in the next section, like olfactory responses, most emotional responses are learned; such learning may result in idiosyncratic responses. Thus for both the sense of smell and emotions we find high incidences of idiosyncratic responses.

7.3 EMOTION

To set the study of emotion into context we must remember that the origins of emotion lie in the biological past of *Homo sapiens*. We must remember that for 99 per cent of human history humans have been hunters and food gatherers. If the life of the planet we inhabit is reduced to a 24-hour time-span, we find that human life began about four seconds ago in this day. Archaeological records of humans go back some 5 million years but the subsequent development of urban and primitive industrial life has occurred within the last 12 000 years. This means that the social fabric we take for granted is relatively new in terms of human evolution (Maxwell, 1984). It has only been just over a century since the Industrial Revolution, which replaced human dependence on muscle power by machinery. Within our own lifetime we are experiencing the commencement of the computer revolution, which is beginning to supersede many of the cognitive aspects of the human brain.

In popular belief emotions are held to be lower-order feelings and behaviour that humans would best be without. This view appears to stem largely from the philosophical school of the rationalists. Reason was held by Descartes to be a specifically human attribute as opposed to the emotional, non-rational and instinctive behaviour of the lower animals. Not all philosophers held this view; for example David Hume wrote, 'reason is the slave of passion'. But the rationalist position predominated, arguing that animals expressed the purest form of emotion with humans having, at least partially, overcome the limitations produced by emotion via development of their rational faculties.

Does the account by the rationalists present a true picture of emotion and its role in human behaviour? The first point to make is that it is to humans that we must look to see emotion in full flower (Van Toller, 1976). By comparison with human emotions animals reveal a pale imitation. It is in humans that we see emotion from its most ugly to its most beautiful.

Emotion is as much a part of the highest intellectual achievements among *Homo sapiens* as it is of their most diabolical acts. In the work of genius we find a perfect synthesis of the emotional and intellectual components, neither being sufficient by themselves. Intellectual achievement devoid of emotion is easily recognized as a pallid form of intellectual imitation. It is therefore a fallacy to suppose that at some point in the future humans will undergo a metamorphosis and shed their ugly skin of emotion to reveal the beautiful skin of pure rational thought.

Emotion, like olfaction, although a phylogenetic old brain system, was too important to remain as a simple reflex mechanism. Each subsequent development of the brain resulted in the emotional systems being carried through into the developing brain areas. Each subsequent stage resulted in emotion being transmuted into new and subtler forms. Each stage in the development of the brain changed and modified human emotion.

During the early part of this century there were many attempts, both practical and theoretical, by neuropsychologists to find the locus of emotion in the brain. They were all doomed to failure because emotion is represented in all the behavioural systems of the brain (Fig. 7.1). Human motivational systems of hunger, thirst and sex appear to have undergone similar, though less dramatic, change and refinement. It is in humans that we find eating and drinking replaced by the rituals of dining. Similarly, human sexual activity may take exotic and deviant forms. The point being made is that although

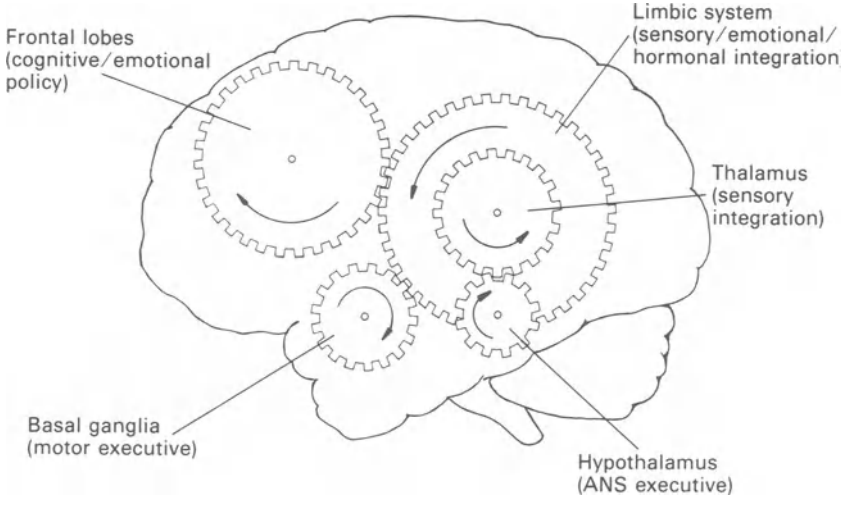


Fig. 7.1 Schematic drawing showing the integrative nature of the brain in which sensory, motor, emotional, autonomic (ANS) and cognitive functions act in a smooth, discrete and continuous manner.

the basic functions of emotion and motivation still have their primary modes of action in their original brain structures, they have come to take on new behavioural dimensions which arise from circuits in the newer areas of the human brain.

Emotion is, to a large extent, dependent upon individual learning. There appear to be few primary biological emotions, but many secondary or learnt emotions (Van Toller, 1976). Another complicating factor is that to a large degree emotion is ignored in the educational processes. One result of this is that knowledge about personal emotional make-up is acquired slowly throughout life. In recent times we have witnessed groups of middle-aged people joining encounter-groups in attempts to come to terms with their 'emotional' problems. Thus learning about emotion lacks formal and educational structures. Knowledge about emotion is attained by imitation, identification and learning from peer groups. Indeed, as Ruckmick (1939) pointed out a long time ago, children are taught that intellectual ideas should be divorced from emotional ideas. As most teenagers come to experience, if not actually acknowledge, one does not hold intellectual ideas devoid of emotion. A political belief is not a sterile piece of intellectual knowledge, but an attitude with a firm and vigorous emotional base.

We find that olfaction is similarly ignored by educational processes. To put this into context we must contrast olfaction with the emphasis both parents and formal schooling situations will place upon the learning of colour names and, to a lesser extent, the naming of sounds. Partly to help overcome this type of problem the Warwick Olfaction Research Group has developed an odour kit in conjunction with the Royal National Institute for the Blind and Avon cosmetics (Hinds, 1984). Clearly this is only a beginning; we find the same ignorance in the perfume industry, which shows a marked reluctance to educate the general public about perfumes and fragrances. Presumably it is felt that if the mystique is removed, the interest will be killed, but the reverse appears to be true judging by the attempts that have been made to educate the general public in New York (see Green in Chapter 13).

In recent years it has become clear that an important and complex set of structures and their pathways in the brain relating to emotion is the limbic system. Interestingly, the limbic system was originally known as the rhinencephalon, or the smell brain. It was Broca, the French anatomist, who in 1878 renamed it 'le grand lobe limbique', when he realized that the dolphin although having a well-developed limbic system, possessed little or poor olfactory ability. The limbic system consists of a complex inner ring of brain structures, below the cerebral cortex, arranged into 53 regions and 35 associated tracts (Watts, 1975). A brief consideration of the number of possible combinations and interactions that could be involved will demonstrate its potential for playing an important role in emotion and personality. The latter has been highlighted by Mensing in Chapter 10. A

major function of the limbic system is to combine the many parts of the brain; these are shown schematically in Fig. 7.1. We should also remember the role of hormones and the autonomic nervous system (Van Toller, 1978); consideration of all these will enable us to appreciate the vital role that the limbic system plays in behaviour and, in particular, emotion.

Watts (1975) stated that a major function of the limbic system was to interpret the total sensory input into the brain as either 'pleasant' or 'unpleasant'. After evaluating input in terms of 'innocuous' or 'dangerous', the limbic system makes instant decisions and directs the resulting integrated somatic and sensory activity. It is important to realize that the integrated activity includes all the concomitant hormonal and nervous activity. Moreover, these complex physiological activities are normally conducted in a smooth, harmonious and orchestrated manner. It is the limbic system that produces the orchestration.

7.4 THE BIOSOCIAL THEORY OF EMOTION

In the booklet *The Forgotten Nose*, published in 1984 by the Fragrance Foundation, New York, there are a number of quotations which suggest a special link between emotion and the sense of smell. Cain draws attention to the connections between the olfactory tissues and 'the part of the brain that deals with emotion'. Groupy is quoted as saying, 'the sense of smell has powerful and direct connection with our emotions, more so than any other sensory system'. There are other quotations in this fascinating publication which link emotion and odour. Reading the general literature on perfumery we find remarks suggesting a special relationship between emotion and perfume. In Chapter 9, dealing with aromatherapy, Tisserand argues the case for a special role between odours and emotion. However, despite these statements, there have been few actual suggestions as to how emotion and olfaction might be linked. The present chapter attempts to remedy this by drawing attention to possible links.

I have recently reviewed the published English scientific literature in an attempt to discover what links had been forged between the two systems (Van Toller, 1985). This review produced much of the framework for the first International Conference on the Psychology of Perfumery but it produced little in the way of direct answers to the initial question. The early psychological studies involving emotion and odour were related to the hedonic dimensions of smell or the relationships between pleasant and unpleasant smells. The hedonic dimension was originally thought to be a single continuum with pleasant and unpleasant aspects located at opposite ends. These early studies failed to find a simple relationship between odours.

To relate the rest of this review would take us too far away from the main theme of this chapter and the interested reader is directed to the original.

In 1962, Schachter and Singer reported a series of experiments that were to have a profound effect on social psychology and to provide a framework for a social/cognitive theory of emotion. Their experiments extended an earlier clinical study reported by Maranon (1924), who was interested in injecting adrenalin into his medical colleagues and also his patients to see if he could produce emotions. He failed in his attempt, in part because perhaps his colleagues would have known what was expected from the injections. However, he reported what he called an 'as if' or 'cold' emotion. With hindsight, we know that Maranon had elicited an internal physiological reaction from his colleagues and patients, but these reactions were not reported as 'emotion' because they were not in a social situation where experience of different emotions would be appropriate. For example, in the medical setting his patients would have surely attributed any reactions they might have had to the treatment they thought they were being given. It would have taken a very sensitive set of psychometric scales to have differentiated emotional feelings that his patients attributed to the medical setting.

It was the missing 'social consequence' that was provided by Schachter and Singer (1962). Their basic experimental design involved subjects injected with adrenalin or an inactive (placebo) substance. Subjects taking part in the experiment were divided into three groups. The placebo-injected subjects served as the control group. The second group was informed about the physiological consequences of being injected with adrenalin, which is an autonomic nervous system arouser. The final group was told that the injection was a vitamin substance related to visual acuity. All subjects were told that they were about to take part in an experiment concerned with vision; however, before the vision part of the study, subjects were asked to fill in a questionnaire. The questionnaires were designed to evoke different types of emotion. Also while completing the questionnaire the subjects were placed in social situations designed to arouse emotional reactions. The manipulated emotion/social situation was achieved by having an experimenters' 'stooge' filling out a similar form but acting in a prescribed way. For example, if the situation was designed to evoke happiness, the stooge acted in a happy, silly manner. One set of forms asked impertinent questions and the 'stooge' acted in an angry manner. Thus Schachter and Singer's subjects were primed to produce certain emotions in response to injections of the adrenalin. This was the important dimension overlooked by the earlier study of Maranon (1924).

The conclusions drawn by Schachter and Singer were that subjects who had received injections of adrenalin, and had been told the true consequences of the injection, tended to respond with more emotion than subjects who

were given an injection of adrenalin but not told of the true consequences. In marked contrast, the placebo group were said to have experienced little emotion. Schachter and Singer argued that their subjects were aroused by the injected adrenalin and attributed the induced feelings to the social/emotional setting they found themselves in. This cognitive theory of emotion is called the 'attributional theory of emotion' and many further studies have been carried out since the original investigation, for example, the work of Kemper (1978).

Schachter and Singer showed that the social setting was an important determinant of emotion. If we turn our attention to olfaction, we see that a perfume can evoke emotion in a similar manner. A beautiful perfume will elicit the learnt response of turning round to look for a beautiful woman. In this response we discover that perfume has a set of attributes, some of which are emotional. Perfume also has another emotional role because, in addition to the social setting, another important determinant of emotion is change of sensory perception. We have only to think of the controlled generation of fear and anxiety in fairground rides or horror movies to realize the significance of this statement. Solemn music together with a solemn occasion will invoke appropriate feelings of sorrow. Heath (1986) has also pointed out that emotion is associated with a change in sensory perception. Thus we can begin to explain the relationship between perfume and emotion. Perfume, or for that matter any olfactory stimulus, is likely to evoke an emotional response, though of course the response may be slight. The response may also depend upon the internal physiological states, which Cabanac (1971) called *alliesthesia*. For example, the smell of food cooking before a meal may provoke hunger pangs, but after eating the same smell may be aversive.

At this point, we should recall the comments cogently put by Engen in Chapter 4 about reactions to smells being learned. Perfume, in most cases, will evoke pleasant or sensual responses because these are the responses that are mainly associated with perfume. However, this may not be the case. Allergies apart, a person may have learnt a different or idiosyncratic response to a particular perfume. It is also a fact that children tend to dislike the smell of perfumes. Apart from their keener sense of smell making them more sensitive (Van Toller, Dodd and Billing, 1985), it seems that perfumes are too sophisticated for the young, who lack an aesthetic dimension. If children do like perfumes, those they prefer tend to be single notes or simple floral perfumes. There is of course the added complication of children learning aversive reactions to perfumes. For example, the smell of perfume in the home can mean that their parents are going out for the evening. Boys often learn to consider fragrances as things to be disliked.

Stoddart in Chapter 1 has presented an explanation of the importance of the role of fragrance in the social evolution of *Homo sapiens*. In addition to his suggestion that perfume has a biological protection role, it should be realized that perfumes are sophisticated chemical compounds and mixtures, with

marked effects on human aesthetic sensory experiences. As suggested above, they evoke emotion. When I test my domestic animals using a perfume, their responses are best described as quizzical. They can detect the smell and track down its source but they are not interested in the smell of a fine fragrance. For animals, as pointed out by Harder (1984), smells must evoke clear-cut significances; they must have biological messages. The animal world has no place for fine fragrances, although ironically basic animal smells are often important elements in the finest fragrances.

To return to our example of perfume and emotional response, suppose we encounter a strong and powerful perfume, one in which a lot of 'personal space' is being created by its user. We look around in an attempt to locate the source, and see a beautiful film star. This will evoke emotions relating to beauty and perhaps allurement. In a converse example, suppose we are making a visit to a zoo and encounter a water buffalo not displaying its usual (to our human noses) foul smell, but the beautiful 'film star' smell. In this situation it would be our turn to look quizzical and, most likely, the incongruity of the situation would produce laughter. In a more solemn setting where laughter was inappropriate, we should probably begin to giggle, even collapse helplessly with hysterical laughter – the strength of our giggling indicating the power of the evoked emotion.

Fragrances are often applied to the body in controlled emotional settings. The woman who applies a perfume or the man who splashes on after-shave in the morning, as Mensing in Chapter 10 mentions, may be doing it for a number of reasons. However, if you ask people why they apply perfume or fragrances, you will often be told that 'it makes me feel good'. For example, the application of after-shave comes at the end of the morning toilette and, in large part, it appears to be used because of its emotional effect of well-being. It is being used for its sensory role; the initial intake of the fragrance invokes good feelings and pleasant emotions. For the rest of the day its effects, for the wearer, will largely go ignored and unnoticed.

7.5 EMOTION AND OLFACTION

If we look at the question of olfaction from the perspective of emotion, we find that it has been totally ignored by theorists in the field of emotion. Bull (1951) is a good example of this because before propounding her theory of emotion, she had actually carried out experiments on the olfactory drive of humans (Bull, 1944). The failure to consider olfaction as an appropriate and relevant matter for an account of emotion in humans is again illustrated in a comprehensive review by Solomon (1977). Presumably we must conclude that Solomon felt that the sense of olfaction played no significant role in human emotion. His considered, academic view appears in sharp contrast to

popular views, where the relationship between emotion and odour are often mentioned. This is a situation that may reflect a genuine belief that there is no relationship between emotion and olfaction, or it may indicate a lack of appropriate training in early life resulting in connections between the two subsequently being ignored. This point is further illustrated in a chapter by Stern, Farr and Ray (1975) dealing with the emotion of pleasure. Stern and his colleagues actually considered odour – perhaps one should say *mentioned* odour because their section on this topic is brief and the topic rapidly dealt with; this is a strange omission, for the presentation of pleasant odours could potentially be a very useful technique when examining pleasurable emotions. In fact it was such a consideration (among others) that prompted me to commence studies of olfaction.

As stated at several points, olfaction and emotion are similar, in that neither receives the long and protracted educational processes enjoyed by the cognitive processes and, to a lesser extent, the senses of vision and hearing. Children rarely receive the systematic training that would enable them to begin to understand their emotions (Van Toller, 1976). This is also the situation for the olfactory sense. Indeed it has been suggested that civilization results in a diminution of the olfactory sense, and claims have been made that primitive people and feral children, or youngsters reared in the wild, have a superior sense of smell, yet there is scant evidence to support the supposition. Hinds (1984) failed to find evidence for the familiar claim that blind children have superior olfactory ability.

What other evidence is there that the sense of smell is linked with emotion? We might look for overlap between lists of descriptors that have been used to characterize emotion or the sense of smell. Davitz (1969) compiled a list of words used to describe emotion; it is notable for its absence of words relating to the sense of smell. Similarly, we can study lists of olfactory descriptors (Crocker and Dillon, 1949; Harper, Bate-Smith and Land, 1968), these lists contain no terms and descriptors that would be found in a list used to characterize emotion. It may be the case that subjects felt that it was inappropriate to use emotional terms when describing odours, or the converse when asked to describe emotions.

Gustave Jager is the one philosopher who did consider the relationship between emotion and olfaction, but his fanaticism perhaps did more harm than good. Jager emphasized, some would say over-emphasized, the role of odour in emotion. For him odour and emotion were synonymous, but his views have more than a touch of fantasy about them. A summary of his interesting but extreme position can be found in Bloch (1934).

Daly and White (1930) produced a seminal paper of great value because it was written jointly by a psychologist and a chemist. They suggest that females in ancient times used perfume as a way to heighten natural odours. They state, 'the "passion" in man, when stripped of its euphemisms, is

simply blind responses to tropisms'. In support of this claim they point out the change in response towards the smell of valerian which, to the modern nose, has a penetrating 'goaty' or sweaty smell. During the sixteenth century valerian was considered to be a pleasant perfume and was placed among clothes and used extensively in medicine. At this period body smells would have been strong as bathing was considered an act to be performed at infrequent intervals. Perhaps the smell of valerian served to attenuate or round-off the sharpness of body odour? Daly and White (1930) suggest it was the process of sexual repression that led to valerian being considered an unpleasant odour. However, it seems equally reasonable to suppose that an increase in the incidence of personal hygiene would result in a change in the perception of this odour.

7.6 PSYCHOPHYSIOLOGY

How can we measure emotional response to an odour? A traditional method has been to use psychometric scales in which subjects scale a list of descriptors relating to emotional feelings. One problem with psychometric scales is that they introduce a largely subjective element. A method of overcoming this difficulty is the use of psychophysiological responses.

Psychophysiology is the study of covert physiological responses that accompany behavioural changes. Long-term psychophysiological changes can be measured using bodily fluids such as sweat, saliva, blood and urine. Short-term changes often involve the amplification and recording of the minute bioelectrical potentials that are found in the body. These may include muscle potentials and heart rate as well as the electrical potentials generated within the brain. The latter are recorded by the electroencephalograph (EEG). Thus a subject's reaction to an odour may be measured by using psychophysiological techniques. As pointed out above, the advantage of these techniques is that they overcome problems associated with subjective responses. A subject's covert psychophysiological response is more likely to be 'off the top of the head'.

To give an example of the use of such a technique we measured the electrodermal response (EDR) to the odour 5-alpha-androstan-3-one (Van Toller *et al.*, 1983). Stoddart and Gower in Part 1 have described the chemistry of this compound, but the interest for a psychological study is that androstan-3-one is a complex biological sex pheromone excreted by the boar. Because of its occurrence in male sweat and urine, it has been suggested that it may have a similar role in humans. We might wonder at a sex pheromone when such a large proportion of the human population cannot detect the odour. We were also interested to see if we could detect any differences in response between males and females.

In terms of its smell, it is also of great interest because in the general population a high level of specific anosmia is found towards it. Approximately 50 per cent of the population cannot detect it. Of the remaining 50 per cent who are able to detect it, approximately 25 per cent find it pleasant and the remaining 25 per cent find it very unpleasant. It was clearly of interest to attempt to unravel the reasons as to why it is a pleasant smell to some and unpleasant to others. It was a lengthy study because we wished to see the first response to the odour and subjects were not therefore given prior exposure to it by us. This meant, then, that many subjects went through our study before we knew that they were unable to detect the odour.

Subjects were placed in a comfortable chair in the experimental situation, and electrodes for recording the skin's electrical activity were attached to their fingers. Each was fitted with a blindfold to eliminate visual cues, and headphones designed to eliminate background noise. Use of headphones meant that at certain points in the experiment we were able to talk to our subjects. The subjects were deliberately placed in a situation that involved perceptual isolation. They were asked to breath at a steady, natural and even rate, and from time to time they were presented beneath their nostrils with the odour on a perfumer's smelling strip. All subjects in the debriefing session reported the experiment as relaxing and interesting.

A number of significant findings were made and reported in the original publication, and one finding was of particular relevance to psychophysiological techniques for the assessment of odours. A small number of subjects, when they were presented with the odour, gave a clear skin response, indicating that the brain had registered reception of an odour. However, when they were asked whether or not an odour had been presented (this was done over the headphones), they indicated that they had not received an odour; subjects indicated reception of an odour by signalling, using a foot pedal. A subsequent presentation of androstenone elicited the same pattern, i.e. a clear skin response, but denial of having received the smell. We were in the curious situation of the brain having given a clear-cut indication of reception and processing of an odour, while the subject denied that an odour had been received.

Among other things, the debriefing session aimed to establish the detection threshold. In the case of the subjects we are now discussing, they would suddenly say something like 'this is the smell you gave me in the cubicle during the experiment'. They were always at a loss to say why they had denied receiving the odour during the recording part of the experiment. With the first one or two subjects who showed this effect, we were baffled for the explanation, but subsequently came to realize that this class of subjects had no verbal label or category in which to place the odour. They therefore 'ignored' the odour, but as we had observed, their brains had registered the smell and subsequently they had no trouble in recalling the smell, once they

had been given an opportunity to attach a verbal label to it. Without the use of the psychophysiological technique, the subjects would have been categorized as being specifically anosmic towards the compound.

This finding, plus our interpretation, was supported by the fact that the males who found the smell pleasant gave the largest skin response. Females who found the smell pleasant gave a moderate skin response. This finding was interpreted as indicating that females would be more likely to have verbal labels and categories for pleasant smells and fragrances. The males, lacking these labels, needed more brain processing power to deal with the incoming sensory information. The smallest responses were recorded by subjects who found the smell objectionable. In this case, we assumed that the brain made a simple 'ugh!' response which requires very little processing by the brain.

7.7 BRAIN-EVOKED POTENTIALS

Can we use the electrical activity of the brain to gain information about the response to odour? Techniques recording the electrical activity (EEG) of the brain are non-invasive, relying on electrodes stuck or firmly held on to the scalp. These electrodes detect the minute electrical currents on the surface of the brain, the cerebral cortex, and these electrical signals are then amplified by a factor of a million times. Empson (1986) gives an account of the basic techniques used in EEG studies.

There are few previous accounts in the scientific literature of attempts to use EEGs to measure reactions to smells. Moncrieff (1977), proposing that emotions could be modified by the use of odours, mentioned the recording of EEGs but provided no evidence of their value. Brandl, Kobal and Plattig (1980) reported analyses of EEG correlations with subjective ratings of pleasant and unpleasant odours; using a statistical technique called discriminant analysis, the authors found a pattern composed of 80 per cent of the power spectra correlated with an odour rated as 'very unpleasant' and another pattern composed of 60 per cent of the power spectra correlated with an odour rated as 'very pleasant'. The authors suggested the possibility of verifying subjects' ratings by direct classification of EEG recordings.

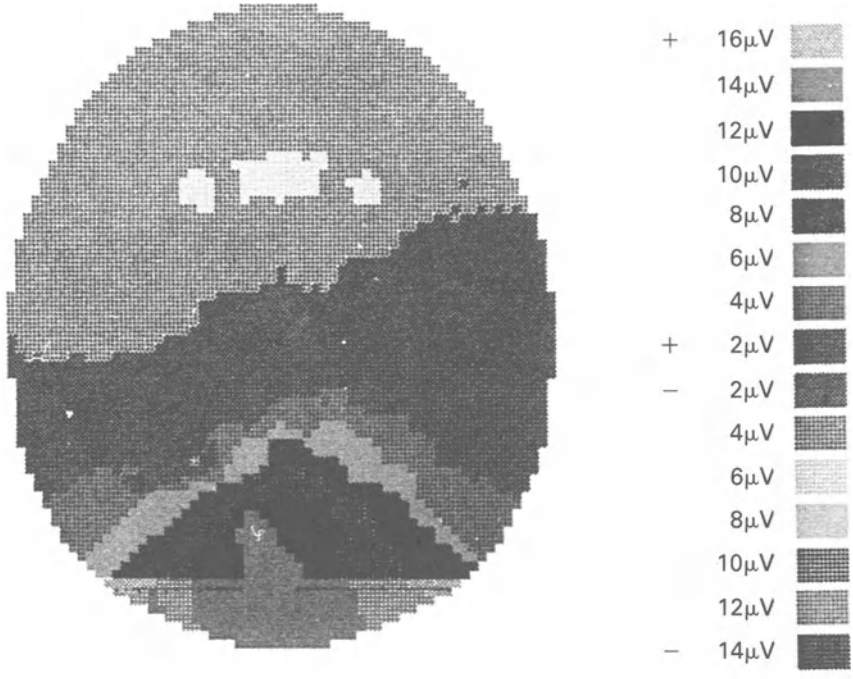
In Chapter 6 Torii has given an account of the contingent negative variation (CNV), which is a DC voltage measure found when subjects are waiting for an anticipated event. Torii reported that average responses from subjects smelling lavender before the commencement of the trials produced a decrease in DC voltage; subjects smelling jasmine before the trials showed an increase in voltage. I have approached this problem using AC voltage measures and different experimental techniques, and the remaining parts of this chapter are an account of what has been achieved.

In the last few years a great deal of research has been directed towards a technique called *evoked* or *event-related potentials*. Evoked potentials refer to definite changes in the electrical activity of the brain in response to a sensory input (Loveless, 1983; Gaillard and Ritter, 1983). The procedure involves the presentation of a sensory stimulus to a subject who is 'wired up' in the manner outlined above. Visual or acoustic stimuli are usually used; for example, visual evoked potentials (VEP) are recorded from an area of the scalp on the back of the head immediately over the visual cortex (Fig. 7.2). Kobal (1981), in a series of detailed experiments, has shown that olfactory evoked potentials (OEPs) can be recorded reliably. The average signal from an evoked potential is about 10–29 μV. In relation to the total electrical background activity or 'noise' of the brain, of the order of 50 μV, the EP is small; its size means that one needs to average EPs over a fairly large number of trials in order to obtain a strong signal. What happens is that after a number of trials, the structured activity of the signal can be clearly discerned in the random electrical 'noise' of the brain. What can we learn about the 'language' of the brain from the evoked potential? Perhaps the most important point is that event-related electrical potentials occur in real time as they happen, thus subjects' response is close to the ideal 'off the top of the head'.

Gerd Kobal and I have collaborated on a study investigating olfactory-evoked potentials and somatosensory-evoked potentials. We presented the odours and trigeminal stimulants to the left and right hemispheres of the brain. This experiment has been reported in Kobal, Hummel and Van Toller (1986) and Van Toller, Hummel and Kobal (1986); the odours were hydrogen sulphide and vanilla, and the two somatosensory or trigeminal stimulants were carbon dioxide and menthol. Although trigeminal stimulants are often incorrectly referred to as 'odours', they are in fact part of the touch sense. The trigeminal or fifth cranial nerve has extensive innervation in the nasal passages. The olfactory nerve is the first cranial nerve and is restricted to the olfactory epithelia.

A major aim of the study was to look for differences in typographical distribution of the electrical responses to the four stimulants. We also examined the results from random stimulation of the left and the right hemispheres of the brain. Unlike the other main sensory systems, the olfactory system does not cross extensively into the opposite hemisphere. The left nostril initially communicates with the left hemisphere, and the right nostril initially communicates with the right hemisphere.

Our experiment used fourteen subjects, with electrodes attached to their scalps according to the international 10/20 system. The 10/20 electrode positions are shown in Fig. 7.3 (Craib and Most, 1973). We recorded EEGs from electrodes Fz, Cz, Pz, C3, C4, F3, F4 and Fp2; the electrodes were referenced to A1, attached to the earlobe. The olfactometers developed by


+ 16μV
14μV
12μV
10μV
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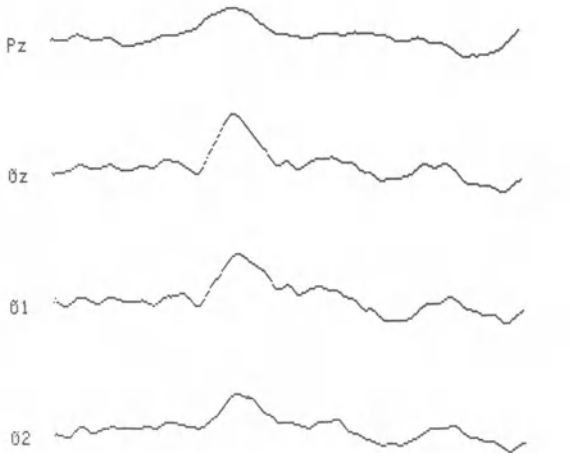
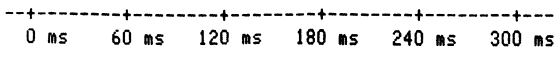

Pz
Oz
O1
O2


0 ms
60 ms
120 ms
180 ms
240 ms
300 ms

Kobal (1981), delivered a 200 ms pulse of the odours or trigeminal stimulants, with controlled humidity and temperature, to either nostril according to a prearranged random order. Subjects were unable to detect any tactile, thermal or mechanical indication of when the stimulants were about to be given. The average interstimulus interval was between 40 and 50 s. The study used two olfactometers which were also randomized in terms of stimulating the left or the right nostrils. By using a video game we were able to check that our subjects maintained a high level of vigilance throughout the experimental sessions. To average the OEPs we used four separate classes. These were right and left nostril stimulation and correct and incorrect identification of the nostril stimulated.

Maximal evoked potential amplitudes to the trigeminal stimulants (CO_2 and menthol) were shown at the Cz electrode position, with decreases in amplitude to the frontal parts of the cortex compared to the parietal or side of the head. In general, the amplitude responses irrespective of the nostril stimulated were larger on the right side of the brain than on the left side. Earlier potential components in the EPs appeared, first, at the central electrodes, then at electrodes situated at the sides of the head and, finally, at the frontal electrodes. Later potential components had the reverse order of appearance. Stimulation of the left nostril produced shorter latencies.

Responses to the pure odours, hydrogen sulphide and vanillin, resulted in different typographical distributions compared with the trigeminal stimulants. With pure odours, maximum amplitudes were found at the parietal electrodes on the sides of the head, but the amplitude depended upon the side stimulated. Remember that when pure odours were used, subjects guessed at about chance level which side was being stimulated. This means

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Fig. 7.2 Visual evoked potential (VEP). Map of cortical electrical activity using a Neuroscience machine. The map represents a view looking down at the top of the head. The nose (not shown) would be at the top of the map and the visual cortex at the bottom of the map. The two hemispheres of the brain are represented by the left and right halves of the map. The electrical activity in terms of positive and negative voltages are shown on the scale to the right of the map as different density patterns. Lack of colour in the figure has resulted in considerable loss of sensitivity because colour shades are not shown. The figure shows the averaged result from a subject viewing thirty-two trials of checker-board pattern switching back and forth. The visual cortex, at the back of the head, shows increased electrical activity as the visual cells of the cortex simultaneously process the incoming visual information. Selected waveforms from the electrodes Pz, Oz, O1 and O2 are shown in the four traces below the map. The values shown on the scale are in milliseconds (ms). The activity shown in the map refers to activity at 112 ms, i.e. just before peak activity on the Oz, O1 and O2 electrodes. For electrode positions see Fig. 7.3.

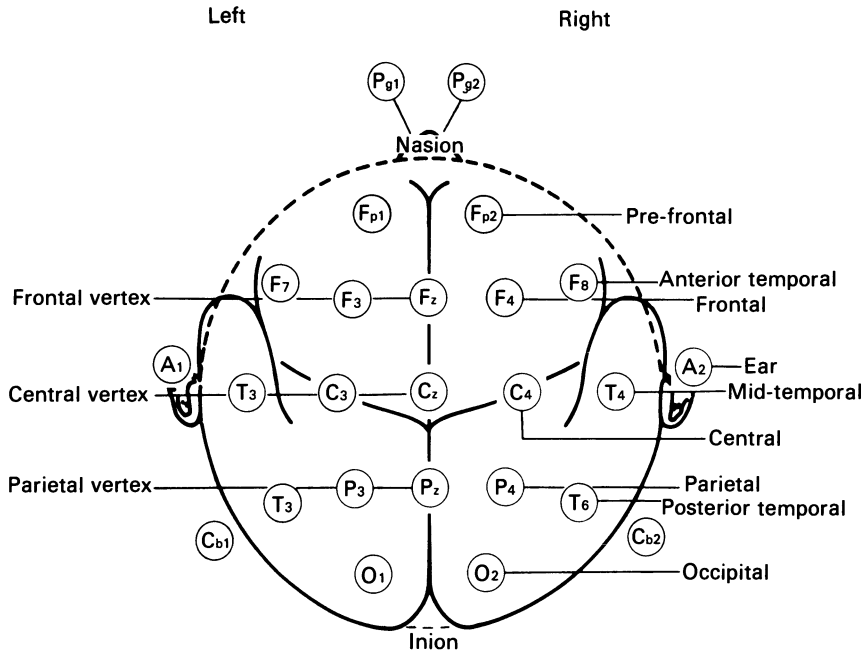

Fig. 7.3 10/20 electrode positions. This drawing is taken from Craib and Most (1973) showing the international 10/20 electrode positions which are calculated according to the individual's head measurements. The Cz electrode can usually be located fairly accurately by asking a subject to touch the middle point on the top of their heads. The two ear positions, A1 and A2, are reference electrodes. The frontal vertex, F7 and F8, and temporal, T3 and T4, electrode points are shown on the map as well as the midline Fz, Cz and Pz electrodes bridging the left and right hemispheres of the brain.

that on about half of the presentations their guesses were incorrect. When hydrogen sulphide was the stimulus, the early components of the evoked potential were largest after stimulation of the right nostril. When vanillin was the stimulus, the largest responses, together with lengthening of the latencies, were found when the left nostril was stimulated. In trials where the subjects guessed the nostril being stimulated correctly, the latencies were shorter. This was found for both of the odours. In trials where subjects guessed incorrectly, the potentials were slower but had larger amplitudes.

The results showed that subjects could reliably indicate which nostril was being stimulated when menthol and carbon dioxide were being used, but the reliability levels fell to chance levels when the subjects were asked to indicate which nostril was receiving a pure odour. This result was in contradiction to

von Bekesy's (1964) statement that the human nose possessed a directional ability which was equivalent to the directional ability found in the auditory sense (Van Toller *et al.*, 1980). Our study showed, for the first time, that typographical distribution of the evoked potential was different for a somatosensory or trigeminal stimulant compared to that of a pure odour. In addition, it suggested that the evoked potential could be an important tool for studying interactions between odours and cognition.

The main limitation of this technique for the study of emotional responses to odours is the need to average signals over many trials. Averaging means that a subject's initial, early acquisition trials are lost. We can never, for example, see the first responses to a novel odour, not experienced before. If we wish to study emotion, it is crucial to see the responses made initially before stereotypical responding begins.

7.8 BRAIN ELECTRICAL ACTIVITY MAPPING

Brain electrical activity mapping (BEAM) is a technique that involves the application of computer technology, developed by Duffy and his colleagues (Duffy, McAulty and Schachter, 1984) for on-line analysis of EEG data. In addition to on-line analysis of EEG, it can also be used for analysis of evoked potentials. The EEG data are subjected to a fast Fourier transformation and displayed as coloured topographical maps. The data are stored on hard discs, allowing for repeated viewing of typographical maps of frequency and voltage changes that occurred while the recordings were made. By contrast with older methods of visually inspecting records of EEG ink tracings on paper, the technique is very fast, and it allows for rapid observation of real-time cortical activity. A number of studies have been run; for example, Duffy and McAulty (1985) have shown that the technique has value as a clinical tool for the diagnosis of dyslexia.

The value of the BEAM technique for olfactory studies is that we can see the sensory and cognitive cortical activity produced by an odour. In addition, the typographical maps enable us to observe the electrical activity of the cortex on individual trials. Unlike the evoked potential or the contingent negative variation technique reported by Torii in Chapter 6, the BEAM technique does not require averaging over a number of trials.

What is involved in these analyses of the cortex, and what can we conclude from such studies? The cortex of the brain contains billions of nerve cells and at various points on the cortex there are specialist areas which can give us valuable information about how an odour is being perceived by our subjects, in terms of both its cognitive and emotional components. In Fig. 7.2 we show a map of the visual cortical areas of the brain firing in response to a changing visual pattern watched by the subject. In addition, the BEAM

technique allows, visually, observation of the two hemispheres of the brain and how they react to events. In general terms, the two hemispheres of the brain are held to have separate specializations. The left hemisphere deals with the spoken and written language, number skills and reasoning. The right hemisphere deals with emotional aspects and imagination, showing musical awareness and art appreciation. These specialized functions have been observed in clinical patients with damaged brains, and it must be remembered that in the normal person the two sides of the brain work together in a harmonious and orchestrated manner. So the BEAM technique allows us to gain valuable information about how the cortex of the brain processes information in terms of its specialist parts and the activity of the two hemispheres.

Subjects taking part in these studies were seated in a comfortable chair and blindfolded. They were asked to breath at a uniform and natural rate, inspiring air through their noses and expiring air out through their mouths. Because of difficulties in hiding the nature of our chemoreception studies, in most cases subjects were aware that they would be given odours to smell but they were not aware of the nature of the smells or the exact timing of the presentation of the odours. Under these conditions we found that the cortical activity of the brain was relatively uniform. It should be noted that the maps shown in Plate I and Figs 7.3–7.5 are single shots, 2.5 second segments, of a continuous electrical activity. Unfortunately it is not possible to show this unfolding pattern of electrical activity here. Nor is it possible to show the colours and their contours. Following the EEG recording part of the session, subjects were given the odour to smell and asked to carry out a series of sensory evaluations using psychometric scales.

7.9 CONCLUSION

We can now give some preliminary findings of our studies. In the last section it was noted that the research carried out in Gerd Kobal's laboratory had shown differences in evoked potential between odour and trigeminal stimuli. This same result using the BEAM technique is shown in Fig. 7.4. The subject has been presented with the trigeminal stimulus of smelling-salts to smell. The initial cortical activity that can be seen halfway down the right hemisphere is over the somatosensory or touch area of the cortex. The activity often extends into the premotor area of the cortex as if the brain is preparing to get away from the noxious substance. It is important to note that on no occasion when we used a trigeminal test did subjects show any somatic or muscular movement.

The next example (Plate I, see colour plate section) is taken from an EEG recording where a subject was smelling a perfume that was later – during the

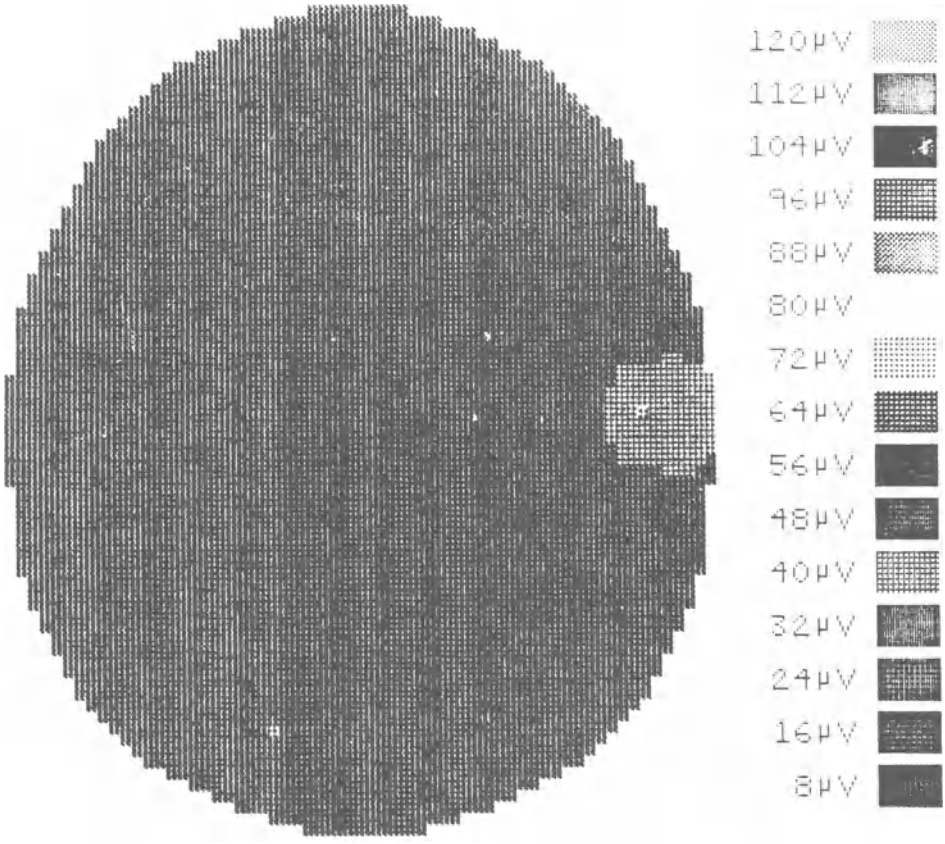

Fig. 7.4 The BEAM map shows the cortical electrical activity of a subject presented with the trigeminal stimulus ammonia. The activity shown on the right of the right hemisphere represents increased activity in the area of the somatosensory part of the cortex.

psychometric sensory evaluation part of the session – rated as 'very pleasant'. Shortly after placing the odour beneath subjects' nostrils, increased bursts of electrical activity were shown on the surface of the right hemisphere. Interestingly a similar burst of activity was shown shortly after the odour was removed. This reprise was as if the brain were confirming that the smell had been pleasant.

The final example (Fig 7.6) concerned a subject who was being presented with a (later rated) pleasant smell. This subject did not show any right hemispheric burst of electrical activity, but instead showed continuous left hemisphere activity throughout the odour presentation. In particular, much

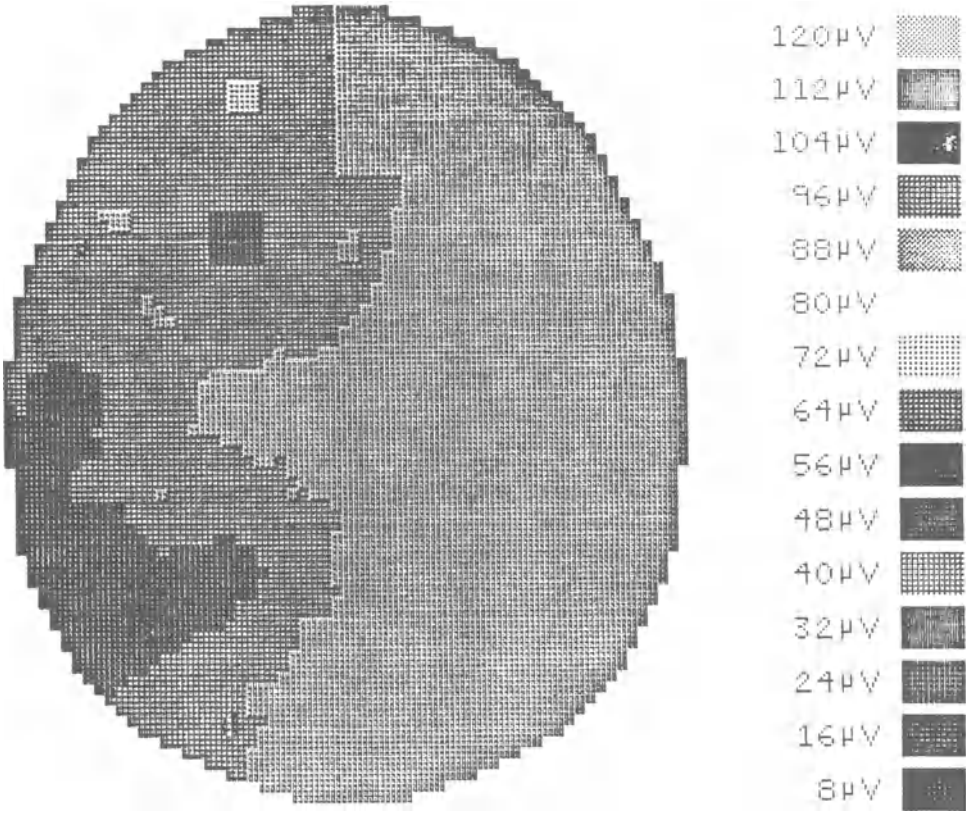

Fig. 7.5 The BEAM map shows the cortical activity of a subject presented with a smell later identified by psychometric scaling as pleasant. Shortly after the odour was placed below the subject's nostrils, the right hemisphere of the subject showed increased electrical activity.

of the electrical activity appeared to be around the Broca speech area of the cortex, just above the half-way point on the left edge of the hemisphere. This was an unexpected result that became clearer during the subsequent sensory evaluation part of the session. It appeared that the subject, whose native language was not English, knew the name that the smell reminded him of in his native language – but he was not able to think of the English name and this was bothering him during the presentation. The subject was not one of our usually naïve subjects, and he guessed that he would be asked if he could name the odour.

BEAM is proving to be a valuable technique for odour evaluation; it will

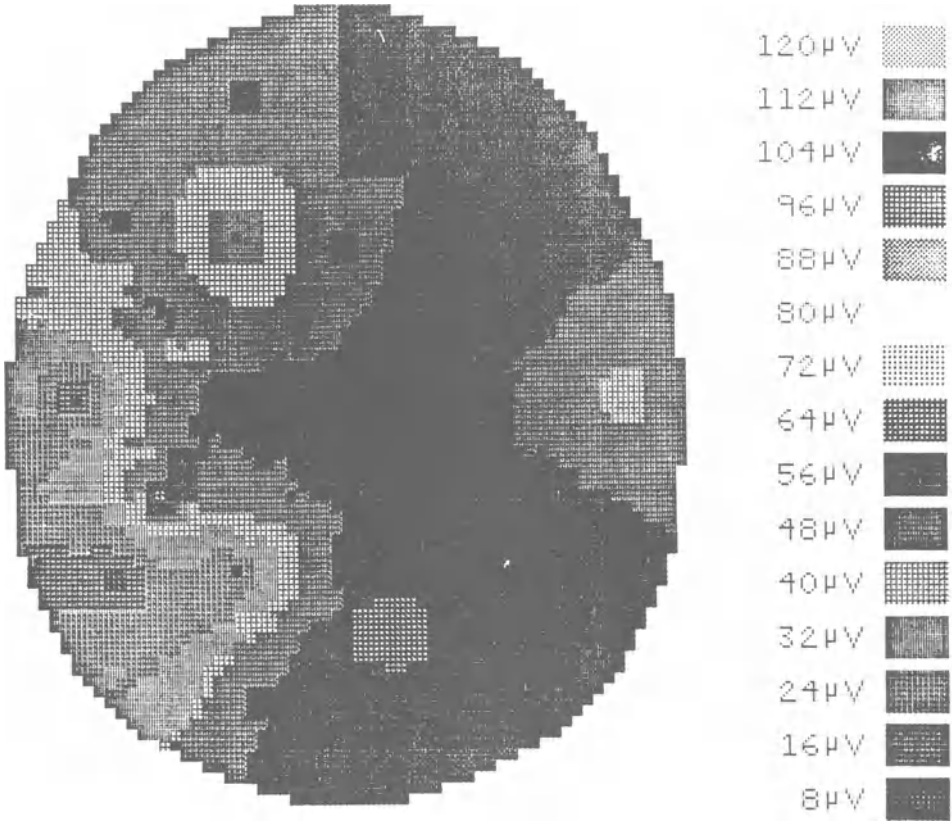

Fig. 7.6 The BEAM maps shows increased electrical activity of the left hemisphere shortly after the subject was given a pleasant odour to smell. The increased activity on the right rather than the left hemisphere arose because the subject was able to recall a name for the odour in his native tongue but could not think of an English equivalent. It should be noted that the subject had not been asked to name the odour. The cortical activity shown is in the area of the Broca speech area. It should be emphasized that at no time did the subject talk, or attempt to talk, during the presentation, the electrical activity shown is premotor.

extend our knowledge of cortical processing of odours. Investigations are currently proceeding to obtain information about the language of the brain in response to smells. The various typographical EEG distributions made in response to odours are being analysed and categorized.

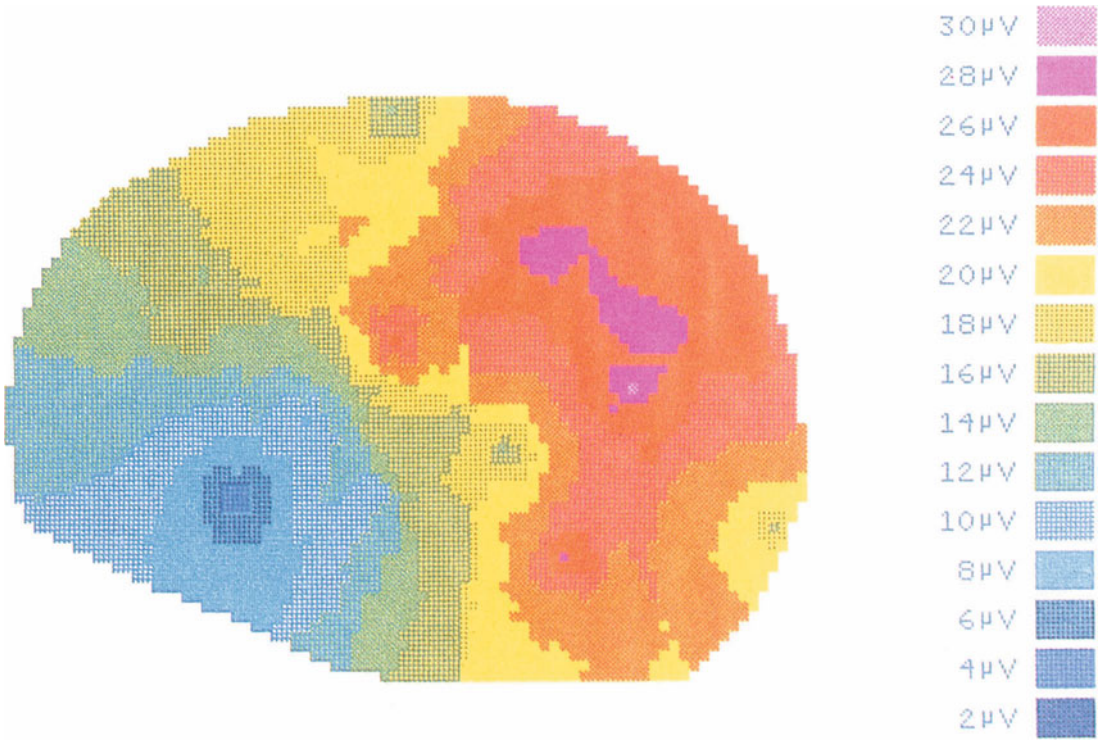

Plate 1 The BEAM map shows the cortical activity of a subject presented with a smell later identified by psychometric scaling as pleasant. Shortly after the odour was placed below the subject's nostrils, the right hemisphere of the subject showed increased electrical activity.

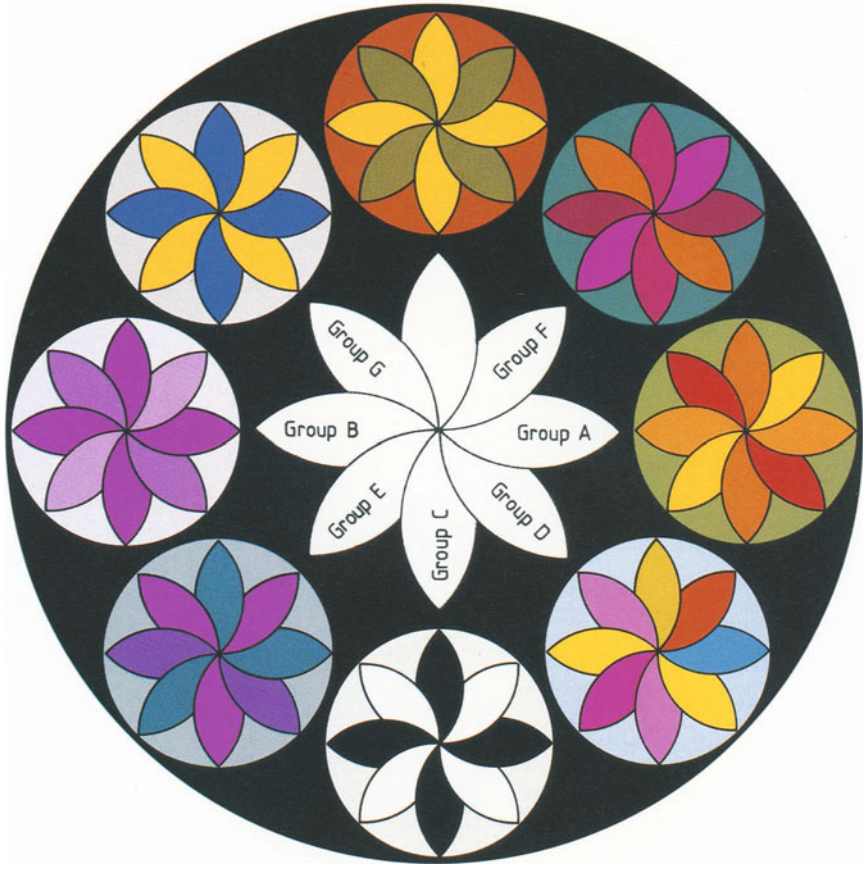

Plate 2 The Mensing preferred colour rosette for female perfume users. The coloured rosettes indicate personality types and their fragrance needs. It is designed to help perfume consultants to identify the likely interests of a perfume buyer.

PART IV

Fragrance therapies

8

Anxiety reduction using fragrances

J. R. KING

> And so he would now study perfumes . . . He saw that there was no mood of the mind that had not its counterpart in the sensuous life, and set himself to discover their true relations, wondering what there was in frankincense that made one mystical, and in ambergrise that stirred one's passions, and in violets that woke the memory of dead romances, and in musk that troubled the brain, and in champak that stained the imagination; and seeking often to elaborate a real psychology of perfumes, and to estimate the several influences of sweet-smelling roots, and scented pollen-laden flowers, or aromatic balms, and of dark and fragrant woods, of spikenard that sickens, of hovenia that makes men mad, and of aloes that are said to be able to expel melancholy from the soul.
>
> Oscar Wilde, *The Picture of Dorian Gray*, 1891

8.1 INTRODUCTION

To a psychiatrist like myself, practising in Redditch, Worcestershire, the need for an effective stress-relieving therapy is only too apparent. Redditch is a new town, still unsettled, a place where anxiety and stress-related difficulties are common. Traditional advice offered to sufferers from such problems has been to 'get away from it all – take a relaxing holiday by the seaside'. For my patients this advice is not easy to follow since the town is about as far away from the sea as you can get in the UK.

An ideal solution perhaps would be some means of taking that relaxing break by the seaside, without ever leaving the couch. A method of

approaching this apparently impossible goal, using a new technique of *enhanced relaxation*, is described in this chapter.

8.2 STRESS: THE VICIOUS CIRCLE

Stress and tension are not of course confined to Redditch, but are universal; a testament to the size of the problem is the vast quantity of tranquillizers consumed each year. Of late, there has been considerable disenchantment with these drugs, which not only lose their effectiveness after a time, but also produce a state of dependence (Ashton, 1986). Correspondingly, there has been a renewed interest in alternative means of combating stress.

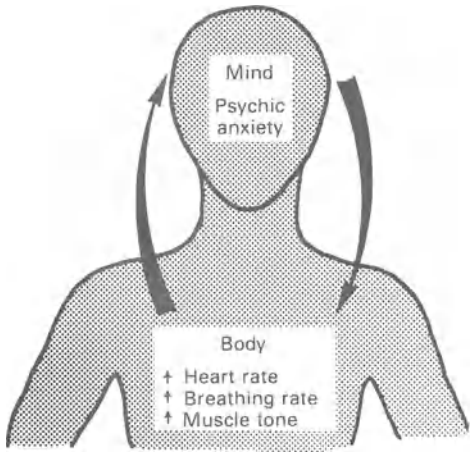

Fig. 8.1 Fight or flight reaction.

The vicious circle or positive feedback loop (Fig. 8.1) by which anxiety tends to reinforce itself may be illustrated by considering a specific example. Speaking in front of an audience is a situation which is stressful for many people. The more distinguished the audience, the more stressful will be the experience. The mind perceives a threat – performance anxiety – and the body reacts with the 'flight or fight' reaction in which heart rate, breathing and muscle tone increase in preparation for heroic effort. This biological reaction, handed down to us through evolution, may be appropriate for primitive man facing a sabre-toothed tiger, but is hardly appropriate for the civilized speaker in front of an audience. Neither is it any more helpful in

the case of a modern executive where this reaction is more likely to produce psychosomatic disorders such as high blood pressure.

Furthermore, the aroused state of the body feeds back to the mind, thus completing the vicious circle. At one level the speaker may fear that his or her trembling hands will be noticed by his audience, and this may cause increased embarrassment and apprehensiveness. At another, less obvious, level the increased heart rate signals a threat to the brain internally and the mind promptly feels more anxious. At one time, there existed a whole psychological theory of emotion based on the physical functioning of the body (reviewed in Van Toller, 1979). While this view is probably an exaggeration, it is a fact that drugs such as beta-blockers, which stop tremor and slow the heart, produce a dramatic reduction in anxiety in public speakers. They protect the body from stress and may improve performance. There is some evidence also that a combination of beta-blockers and tranquillizers, acting on the body and the mind in unison, is particularly effective (Hallstrom *et al.*, 1981).

Drug therapy alone, however, is seldom sufficient. Many victims of stress are intelligent individuals, possessing a high degree of drive and holding down demanding jobs or coping with difficult family situations. Such people are often highly motivated to involve themselves more fully in their own treatment, rather than depending passively on tablets. The benefits of active involvement have been underlined by the eminent Oxford psychiatrist, Professor Michael Gelder (1979); among them are increased self-esteem inherent in conquering a problem by one's own efforts, strengthened therapeutic alliance between patient and therapist, and greater compliance with the treatment.

Many active-involvement therapies exist. Psychoanalysis is probably the best known, but it is lengthy, expensive and of uncertain efficacy (Shepherd, 1979). Modern cognitive-style therapies are shorter and simpler, but lack an emphasis on the physical component of anxiety. An ideal means of managing stress would be a relatively simple technique which patients could learn for themselves, which would act both on the mind and body together and could be adapted for personal requirements. Relaxation training is such a therapy.

8.3 RELAXATION TRAINING

Relaxation training is by no means new, having its roots in the ancient practice of meditation or yoga (Benson, Beary and Carol, 1974). A variant of this was *autogenic training*, developed by Schultz in the 1920s. In the 1930s Jacobson described the technique of *progressive relaxation*, from which most of the present-day techniques are descended. Basically the patient settles back on a comfortable chair or couch and concentrates on progressively relaxing

every part of his or her body, helped either by the therapist in person or by the therapist's recorded voice.

The term 'relaxation' is not an entirely accurate description. Muscular relaxation, or loss of muscle tension, is certainly involved, but the experience goes beyond this and the state aimed at is more akin to a hypnotic trance. In achieving such a state the complete and informed co-operation of the patient is essential, and adequate time must be devoted to preliminary explanation. The following explanatory model used by the British psychiatrist, Ian Martin, is probably as good as any in our current state of knowledge, and has the virtue of simplicity:

> The principle behind [relaxation therapy] is fairly simple. We all appear to have two minds, one of which we may call for convenience the outer or conscious mind. This deals with our day-to-day affairs. The other is the inner or subconscious mind, which has a considerable say in the workings of our body.

This is shown in Fig. 8.2. The two minds, which correspond to the outer 'intellectual' mind and the inner 'body' mind, are in constant communication, and Martin illustrates this with the observation that if a person is repeatedly told that they are looking ill, although their conscious mind may laugh at the idea, eventually they will start to feel unwell. The opposite is also true, which is why a doctor's confident bedside manner is so important in helping the patient to feel better.

In other words, these suggestions by other people get through and

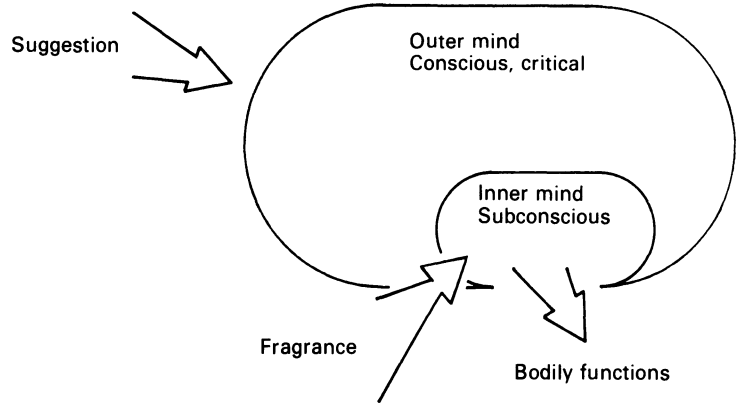

Fig. 8.2 The relationship between the conscious and subconscious minds.

influence the way we feel. What relaxation therapy does is simply to facilitate this process of suggestion. The critical function of the conscious mind is neutralized by getting it to concentrate on some word or phrase (the 'mantra'

in meditation), or the therapist's soothing, relaxing voice. With much slow repetition of reassuring phrases, the conscious mind stops interfering and allows the positive suggestions to penetrate and take full effect.

The tone of voice and persuasiveness of the therapist are key elements here. Indeed it could be inferred that the skills of the successful therapist have something in common with those of the good advertising executive or salesperson. Equally, the subject must temporarily adopt a receptive and uncritical attitude, accepting the suggestions at their face value. A scientific training, Martin points out, can constitute a handicap for the subject unless he or she is able to suspend a normally sceptical and questioning frame of mind.

Having said this, it may be necessary to reassure subjects that the process is not one of 'brainwashing', nor will they be 'hypnotized against their will'. On the contrary, the crucial element is one of the closest co-operation between subjects and therapist, both working towards a common goal. The former learn to bring about the desired changes for themselves, and the latter increasingly acts as a guide or facilitator, in providing helpful suggestions.

Initially in the session, the suggestions made are those of muscular relaxation, and the subject may be encouraged to become more aware of the difference between tension and relaxation by practical exercises. As the subject relaxes each part of the body in turn, the therapist simply feeds back the sensations that the subject is already feeling: 'All the tensions draining out of your arms as you relax them . . . as they rest heavily down, fully supported on the couch . . . No tension, no effort . . . relaxed, comfortable, and at ease . . .'

In this way, a rapport is established and the statements made become convincing ('you're right, my arms do feel heavy . . . yes, I can't open my eyes'). The power of belief here is enormous. Psychiatrists have long been familiar with the patient who presents with, for example, a paralysed arm: there is nothing physically wrong with the arm, it is paralysed simply because the patient believes that it is. In deep relaxation the body does indeed become steadily more relaxed; the decrease in muscle tone, and in heart rate, respiratory rate and skin conductance, can be measured. The benefits from these changes can be expected to persist for some hours after the session is over.

Special attention is commonly devoted to establishing a regular and slower rhythm of breathing, using the diaphragm to better effect: 'Every time you breathe out, that's a good time to relax a little more . . .' Breathing control is an important aspect of dealing with anxiety since anxious individuals tend to hyperventilate, and this in itself produces symptoms (Kraft and Hooguin, 1984). Another important aim is the establishment of a harmony between body and mind, each having a calming effect upon the other.

In the final stage the patient or subject is usually asked to imagine a

relaxing scene. This can be, for example, sunbathing at the seaside or strolling through a series of gardens, each more relaxing than the last. It is in this final stage, in the author's experience, that the majority of problems tend to occur.

8.4 PROBLEMS WITH TRADITIONAL RELAXATION TECHNIQUES

Variability of visual imagination

The power of visual imagery varies widely between individuals, and a substantial percentage are unable to clearly visualize themselves in a relaxing scene despite repeated practice.

Discord between the subject's visual imagery and the therapist's suggestions

In an attempt to help the subject imagine the scene more clearly, the therapist may be tempted to paint in the details too closely; a problem then is that these may not correspond with the subject's fantasy. For example, 'you see before you a bather in a red bathing costume, and another in a blue bathing costume'. The subject, however, has begun to imagine a bather in a pink costume, and promptly wakes up.

In an effort to overcome such limitations, the author introduced several additional features and the new technique was first described in 1983. Since then the method has been further refined and the term *enhanced relaxation* now denotes a form of relaxation therapy in which several sense modalities are used together, acting synergistically to produce a more vivid and effective experience.

8.5 ENHANCED RELAXATION THERAPY: KEY FEATURES

Stereophonic sound effects

The patient listens to the whole relaxation programme on an audiotape. Headphones are used to obtain the full stereophonic quality and to block off extraneous noise. The first half of the tape is taken up with progressive relaxation along the lines described above, except that a low-level background of music is added. The particular piece of electronic music used was composed for the film of the Apollo space missions with the express purpose of conveying weightlessness, and was found to be helpful by nearly all patients.

In the second half of the tape the relaxing scene is introduced, accompanied by appropriate sound effects. In the case of a seaside scene the sounds of distant breakers, seabirds' calls and children playing on the beach,

if skilfully mixed together, can be remarkably realistic. The narrative briefly sketches the scene with word-pictures and then leaves the patient to fill in the detail from their own experience; if they are deeply relaxed, the imagery will 'come alive' in the most vivid way, as if they are part of the scene: '. . . transported there in body as well as in mind . . . an enchanted world, created from your own happy memories . . .' A particular advantage of using a seaside scene is the sense of timelessness and unity with nature which the sea can embody: 'The eternal breaking of the waves, lulling you into a sense of contentment, suffusing you with a good relaxed feeling, soothing your cares away.'

On the other hand, care must be taken with the particular recording used and it must not be too loud. Otherwise, as we have found, an anxious patient may suddenly fear that he is being engulfed by the water and may drown.

Use of heat and light

Gentle warmth provided by a 250 W infrared Campro lamp is conducive to relaxation, and consistent with the verbal suggestion: 'Feel the warmth of the sun on your face, on this languid, hot afternoon.' The effect may be reinforced by a photoflood lamp, although not all patients find this an improvement. It is of interest that researchers in the USA consider that artificial sunlight may have a mood-elevating effect of its own in certain circumstances (James *et al.*, 1985, criticized by King, 1986).

Use of fragrance

The seaside fragrance is presented intermittently to avoid olfactory fatigue. One method is to present it on a standard smelling-strip, the end of which is blackened with indian ink. The strip is swung into position a centimetre or two from the subject's nose, whereupon the black section becomes warm under the radiant heat and releases the fragrance. In a variation of the technique a fan may be used to carry the fragrance towards the patient and give the illusion of a sea breeze. The latter method is probably preferable since it gives better control of the odour intensity.

Of these three features, the fragrance is probably the most novel component. Our impression is that it contributes powerfully to the overall experience. It may be useful to consider why this should be so.

8.6 ACTION OF FRAGRANCE: A CLOSER LOOK

Evocative nature

That fragrances can be emotionally evocative is well recognized. 'Smells',

wrote the poet Rudyard Kipling, 'are surer than sounds or sights to make your heartstrings crack'. The particular smells which have this effect may often be quite idiosyncratic to the individual; they have an almost uncanny capacity to reach back into the past and stir up memories from long ago.

To quote a personal example, the smell of an organic chemistry laboratory (the scene of many happy hours spent as a student) had a most beneficial effect upon me when, years later, I passed the laboratory *en route* to stressful medical examinations. Many others can describe similar experiences. The effect is sometimes called the 'Marcel Proust phenomenon', after the novelist who dipped a Madeleine biscuit in his tea and found that the aroma brought forth a flood of memories of a secure and protected childhood, forming the basis of his multi-volume work, *À la Recherche du Temps Perdu* (*Remembrance of Things Past*).

In view of the idiosyncratic quality of smell, finding a universally evocative fragrance is practically impossible, but the smell of the sea has been invested with particularly evocative properties in the popular imagination, and arguably comes closest to the ideal: 'The "hypnotic" smell of the sea' (Jessee, 1982).

Fragrance and emotion

Certainly smell is an emotional sense rather than an intellectual one. It adds emotional colouring to our perceptions, but does not provide us with very much detailed information in the way that vision does. Presumably this is because olfactory areas of the brain are located well away from language areas, which means that it is difficult to verbalize odour impressions, to communicate them or even to remember them in the precise way that one remembers a poem or a piece of music. The situation is sadly reflected in the fact that perfumery is not taught in our universities, unlike music or the pictorial arts.

But this very fact, which has led to the lamentable neglect of the olfactory sense, ironically makes fragrance the ideal candidate for use in relaxation work. Returning to the model illustrated in Fig. 8.2, it can be seen that the most effective suggestions are those which by-pass the critical interference of the verbal, conscious mind. This is precisely what fragrance does, targeting directly into the 'inner mind', in this model.

We may note, incidentally, a certain resemblance in Fig. 8.2 to the Freudian topography of the mind, and it is of interest that Freud drew a parallel between repression to the unconscious of unacceptable (sexual) material and the turning away in disgust from unpleasant smells. Disgust is probably a learned response acquired during toilet training; it may be speculated that in the processes of becoming civilized we tend to reject the whole subject of odours, banishing them from consciousness. The neglect of

the sense of smell may thus have a dynamic explanation as well as a purely anatomical one.

Anatomical basis

The model in Fig. 8.2, although schematic, can be considered to have anatomical correlates. The inner mind corresponds to a primitive structure in the centre of the brain, formerly known as the 'olfactory brain' and now termed the 'limbic system'. The limbic system is the area of the brain which controls emotions and mood states, and it can be seen from Fig. 8.3 that it is closely integrated with the olfactory pathways. So intimate is this

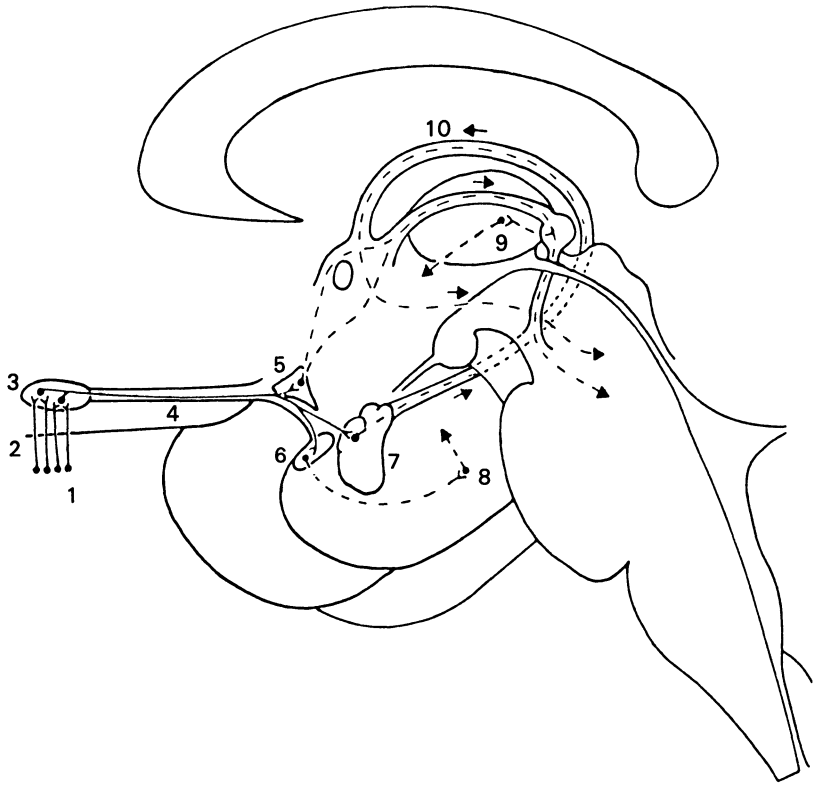

Fig. 8.3 Olfactory projections of the limbic system. The limbic system was formerly called the 'rhinencephalon' or smell brain; these circuits are now known to be very important in controlling emotional reactions: 1, olfactory receptor layer; 2, olfactory nerves; 3, olfactory bulb; 4 olfactory tract; 5, olfactory tubercle; 6, prepyriform cortex; 7, amygdaloid complex; 8, hypothalamus; 9, thalamus; and 10, stria terminalis.

integration, that it would perhaps not be fanciful to describe the olfactory receptor areas, high in the roof of the nose, as that part of our emotional apparatus in contact with the outside world.

Indeed Dodd and Van Toller (1983) have drawn a parallel between the action of fragrance molecules on these receptor sites and the action of psychotropic drugs such as antidepressants, which also act on receptor sites in the brain. They have coined the term *osmotherapy* to describe the directly beneficial effect of the fragrance, a term which lacks the arcane and potentially quackish connotations of the more general expression 'aromatherapy'. Naturally the effects of a 'smelly drug' are relatively transitory on the one hand, but the total freedom from side-effects on the other hand would be an undeniable advantage.

It is interesting to speculate that this connection between smell and emotion may be a two-way relationship, i.e. smells influence mood states, but those mood states may well in turn modify the experience of a smell, by actually changing what is going on in the nose. This sort of interaction is certainly known to occur with other systems in the body, for example, those concerned with the perception of pain. In the olfactory system a kind of 'autonomic tuning' (Gellhorn and Loofbourrow, 1963) may operate via the trigeminal nerve, in which varying degrees of emotional colouring may be imparted to incoming odours (Van Toller, 1985). Conceivably by this means, the induction of a pleasant mood state by a fragrance could make that fragrance more pleasant, a positive interaction which would render fragrance an even more powerful tool than we suspect it is already.

8.7 ODOURS AND DISEASE

Presumably the converse to the above might equally apply, in that objectionable odours might become more and more noxious and intolerable. Certainly the idea that bad odours cause disease is as old as medicine, as witness the word 'malaria' (Italian, 'mala aria', or 'bad air'; it was believed that the disease was caused by the exhalations of marshes in the neighbourhood of Rome). More recently, Lawson, (1985) a general practitioner, has asserted that many ailments commonly encountered in general practice are caused by intolerance to the harsh odours of commercial air-fresheners. This claim, though it adds substance to earlier work by Randolph (1970), must be treated with some scepticism as the evidence presented is rather anecdotal. Other general practitioners taking an opposite line have actually proposed that relaxing fragrances could be used in their waiting-rooms. In doing so, they echo the sentiments of Sir William Temple, three centuries earlier, who wrote: 'The use of scents is not practised in modern physic but might be carried out with advantage, seeing that some

smells are so depressing and others so inspiring and reviving' (*Essay on Health and Long Life*, 1690).

8.8 USE OF FRAGRANCE ALONE

There is no doubt that the psychological effect of a fragrance is highly dependent on the context in which it is encountered. To quote one of Jellinek's examples, the perfume in a lipstick may communicate good quality to a woman trying it on. To a man kissing the woman it may communicate sexual attraction. If this same man were to find the same odour on first sipping a glass of water in a restaurant, it would mean poor sanitary standards and he would find it highly objectionable. Similarly, it is one thing to experience a sea fragrance while walking along the seashore or listening to seaside sound effects, but quite another to smell it in a different context or in isolation. A true marine smell, experienced on its own by someone who had never been to the seaside, might well be considered unpleasant.

There are two main reasons for using such a fragrance in *enhanced relaxation therapy*. For the majority of subjects it will already have an association with carefree holidays and a feeling of well-being, and therefore has a head-start on many other fragrance types. Secondly, the fantasied seaside scene gives added depth and meaning to the seaside fragrance and vice versa, i.e. synergism takes place because the context is right. Proof of this is not easy to come by, although work by Marks (1978) and Henion (1970) may be relevant.

We may expect still that an evocative odour, used on its own, will have a beneficial effect, but that this will be less than when it is experienced in its usual context. For example, a patient might carry around with them a sea fragrance, using one of Givaudan's Fragrance Cassettes for the purpose. They would take a sniff of it before entering a stressful situation. Of course, a new association would in time be formed between the sea fragrance and the stressful situation, but this could be offset by 'refresher courses' of enhanced relaxation, when the effect waned.

For how long would such an effect remain viable? Early work (e.g. Engen, 1977) supported the traditional belief that olfactory memories once acquired were particularly long-lasting, and were resistant to later interference and decay. However, later studies have tended to cast doubt on this conclusion. The best advice one can offer, in the present state of knowledge, is that such a fragrance would be best used sparingly and for brief periods, to preserve its value as a conditioned stimulus.

If a fragrance is used alone, it should preferably be one which has been employed in sessions of enhanced relaxation, which will have deepened its evocative power. That this can happen is confirmed by my own observation,

on presenting five different interpretations of a sea fragrance to a patient some weeks after she had completed a number of relaxation sessions. Without hesitation, she selected one of these as reminding her of the sea and making her feel relaxed. This was the fragrance used in her relaxation sessions, although she did not at first remember where she had experienced it before (King, 1983).

Of course, it is also feasible to use fragrance quite independently of relaxation. For an imaginative example I am indebted to my colleague Dr A. D. Armond, one of whose anxious patients, who had as a chief form of relaxation working on motor bikes, keeps an oily washer in his pocket for use as an 'evocator' during times of stress. The effects of using fragrance in this way are probably modest, but nevertheless valuable.

8.9 CONSTRUCTION OF THE FRAGRANCE

The chief difficulty encountered in the accurate reproduction of natural fragrances in the environment is in avoiding an end-result which is too 'perfumistic'. Commercial perfumery is of necessity orientated largely towards imparting distinctive and appealing notes to consumer products, where performance and popular appeal are of the essence. Many commonly used materials such as the synthetic aldehydes, which give plenty of punch to a soap powder, need to be used with much more restraint for our present purpose.

In duplicating fragrances of nature, natural products come very much more into their own and fortunately can be used practically regardless of expense since the quantities required are so small. Thus, once again, we are back in the 'Golden Age of Perfumery'.

Sea fragrances

A casual glance at the market reveals no shortage of stylized fragrances projecting a 'sea-fresh' image. Most of these can be described as 'sea fantasies' rather than true 'sea odours', although some are remarkably effective in producing the desired association. An example worthy of mention, in my opinion, is the masculine fragrance 'Signoricci' by Ricci, (1965), which somehow contrives successfully to evoke the sea.

True seaside odours are among the most difficult to replicate accurately, and any perfumer who attempts to do so is sailing in relatively uncharted waters. In my own experience the natural material sea absolute is practically indispensable in any attempt at this difficult task. It is described by Arctander as having the typical odour of seaweed drying out on the coastline, after a storm. Maritima (IFF) resembles part of this odour, found in

the dryout of the absolute. Another useful material is Ambre 150B.SA (Firmenich), a type of ambergris reconstitution in which the sweet, seaweed-like tones of wood and moss are emphasized.

Two materials by Givaudan which perform well are Adoxal, a fresh green-aldehydic note, and Cetonal, a light woody aroma chemical with sea-breeze overtones. Dodd observes (personal communication) that oil or tarry nuances can have a place in the overall odour profile, and in this connection there are commercial bases which will suggest an element of weathered timbers and driftwood fires, of still waters and the tarry, smoky smell of harbours.

Among the commercial sea bases is Naarden's Oceano NB.123, created in the late 1970s and described as 'a salty stimulator of the imagination . . . which breathes the atmosphere of wind and water'. It has a very different note from the absolute, being sweeter and more perfumistic, and reminiscent of rocky pools rather than rough seas. Synarome's Algenone provides yet another variation on the same theme, this time with a cool and watery melon-like odour which also brings to mind suntanned bathers and suntan lotion. Finally, it seems reasonable to suppose that fishy notes (shrimps, shellfish) might have a place in the construction of a sea fragrance, although in practice I have personally found these materials tricky to use.

Other fragrance types: hay, woodland and floral odours

Not everyone finds a seaside scene relaxing. Some prefer a walk in the countryside, which lends itself to excellent sound effects in the form of bird song in the woods, a distant village atmosphere with church bells, the sounds of a farm with tractors chugging past, and so forth. Consonant fragrances are not difficult to construct, using natural materials such as hay absolute. The literature mentions oils, such as patchouli, vetivert and olibanum, but in my experience these easily become heavy and are better omitted. On the other hand, crude Kenyan cedarwood oil, not mentioned at all in the published literature, is very useful.

The sweet coumarin note, which is pronounced in the odour of fine, well-dried grass, is best contributed by tonka absolute, which is smoother and more natural than synthetic coumarin. Maurer (1958), whose account of hay fragrances written thirty years ago is still unsurpassed, notes that synthetic coumarin produces a harsh 'custard powder' note. Dihydrocoumarin (melilotin) lacks some of the harshness of coumarin, while 5-ethylcoumarin (Coumaran) is sweeter and more ethereal, with a floral-honey backnote; 7-methylcoumarin has a sweet, mildly aromatic woodruff note.

Plants such as the common meadow-sweet possess a related rustic fragrance, but the odour is released only after drying and enzymic (glycosidic) degradation. The resultant mild, sweet and powdery persistent scent probably represents the end-point of various complex chemical

interweavings of salicyl aldehyde and coumarin, which is not easy to duplicate precisely. A rough approximation can be made, employing materials such as heliotropin and (in traces) methylacetophenone. Dimethyl hydroquinone is also often advocated.

Further useful materials are flouve and lavender absolutes, which contribute a slight floral quality suggestive of the small flowers found in hayfields, and bergamot oil whose light, ethereal freshness is most valuable. A hint of a natural grass-green note, provided by IFF's Triplal, is effective in conferring added realism upon hay fragrances. Clover notes (amyl salicylate) and the warm, summery smell of anisaldehyde can be useful, but run the risk of bringing an association with commercial fragrances such as 'Brut'.

The problem of avoiding commercial-product associations again applies to the creation of woodland odours, where one does not want to end up with the usual pine bath oil smell. However, such natural woodland odours are considerably easier to replicate than sea fragrances. Natural materials such as Siberian fir needle oil, fir balsam oil, and the like, are indispensable. With the addition of a leafy green background (cis-hexenyl salicylate), plus various dank fungal and earthy notes of the forest floor, the true odour picture of a forest begins to emerge.

Turning to a 'country gardens' theme, here the fragrances are considerably more varied and very much easier to construct. The idea of a well-stocked garden opens the door to the whole range of floral fragrances, and provides fertile ground for imaginative combinations of these floral notes with green complexes redolent of new-mown lawns or fresh-clipped hedges. 'A garden is the greatest refreshment of the spirits of man', wrote Francis Bacon, and the fragrant possibilities are certainly endless. Floral fragrances are the very substance of perfumery and although the creation of true-to-life flower impressions is not usually a primary commercial aim nowadays, the technology exists. A good reference source to all scented garden plants is that of Genders (1977).

Enhanced relaxation therapy had its birthplace at the Middlesex Hospital, London, where my former chief, Dr Oscar Hill, describes the picking of a rose and smelling its perfume as part of his relaxation imagery. Today it would be possible to ask patients which particular species of rose they prefer, and to furnish its exact perfume, from the range of hundreds of rose bases which line the perfumer's shelves. It is perhaps of interest to note that rose is among those floral odours classified by Jellinek (1954) as 'narcotic', by which he meant, 'Intoxicating to the senses . . . the result is a general sensation of relaxation'. The familiar nature of the rose fragrance is also in one respect advantageous since familiar fragrances tend to be more liked (Foster, 1963; Moncrieff, 1966) and are easily acceptable. On the other hand, the frequency with which rose and other floral odours are encountered

in everyday life means that they have many more associations, and the highly specific conditioned response may therefore be more difficult to maintain.

8.10 FURTHER REFINEMENTS

Fragrance-enhanced relaxation is a treatment that will appeal to those therapists who are perfectionists. The illusion of being transported body and soul to a far-away beach is easily shattered by some flaw, such as a scratch on the sound effects record, which reminds the patient that they are, after all, only listening to a tape.

Unfortunately the commercially available tapes of 'relaxing sounds' which I have so far encountered fall far short of the required standard. Considerable time and effort are necessary in a professional recording studio in order to achieve a truly realistic and relaxing effect. The recording must also of course be played on high-quality equipment. Similarly, the fragrance must be faithful to nature and devoid of any ersatz quality, otherwise the effect will be lost.

A curious parallel exists between this fussy attention to detail needed for success and the circumstances which trigger the patient's problems. Let us take a patient with a problem of, say, blushing and stammering every time they find themself in an interview situation. We bring the patient before a group of medical students to demonstrate this fact, and what happens? They cope with the interview perfectly. The fact that they were expected to blush and stammer has subtly altered the situation by introducing an artificial element, and the response no longer occurs.

Returning to the use of fragrance, the intensity is most important. The worst mistake of all is to have the odour too strong. The pleasantness of odours tends to vary inversely with the concentration (Henion, 1971), and just as a perfume can be ruined by over-enthusiastic use of a particular ingredient, so a relaxation session can be spoilt if the fragrance becomes in any way obtrusive. It must be remembered that the ozone-like odour experienced at the seaside is present at an almost infinitesimal level; the relaxation session should respect this fact.

A somewhat less restrictive scenario is that of the 'country garden'. Here the scents of the perfumed blossoms and herbs are more robust, the joys they bring are more openly acknowledged. The aspiring fragrance therapist has more room for manoeuvre; he or she can, if desired, re-create for the patient the olfactory pleasures of a leisurely stroll through this Garden of Eden, lingering at intervals to take in the scents of favourite flowers. This reconstruction of paradise is made possible by the 'fragrance wheel', a motor driven windmill-like arrangement which introduces different fragrances successively into the airstream. In this way, the pleasures of a stroll in a

garden or through the countryside at the height of summer can be enjoyed in the middle of winter.

One of the features of enhanced relaxation may be the inclusion of music. Here we may remark on the close interrelationship of music with fragrance, a kinship which is symbolized by some perfume names such as 'Arpège' (from 'arpeggio'). Like a musical composition, a fragrance is composed of individual 'notes' combined to form chords or 'accords', and these fragrance accords may be thought of as complementing one another like the instruments in an orchestra. A perfume as it evaporates changes with time, unfolding different harmonies but keeping to the same general theme, like a piece of music. Each stage harmonizes with the last like the movements of a symphony.

At the turn of the century an odour organ was developed and smell recitals given in the Central Hall, London. The idea was that the smells would influence the emotions of the audience. Is it too fanciful to suppose that Beethoven's *Pastoral Symphony*, as part of a relaxation session, could reinforce a countryside scene and a rural fragrance?

8.11 ROLE OF FRAGRANCE IN ENHANCED RELAXATION: VERIFICATION

For years poets and philosophers have expounded on the emotional effects of fragrance, but scientific studies have come only recently. The Warwick group, in an important experiment (Kirk-Smith, Van Toller and Dodd, 1983), demonstrated that an odour could be paired with an emotional state, so that the emotional state could be re-evoked when the odour was perceived later on. The emotional state involved was a negative one, produced in response to stress, but at around the same time the preliminary studies of King (1983) suggested that a positive state of relaxation could be similarly conditioned. In both cases, the conditioning was unconscious, i.e. the subjects were unaware of the fragrance.

Further work is currently in progress in collaboration with Dr Van Toller, to test the hypothesis that fragrance can produce a measurable change in the depth of relaxation among patients suffering from anxiety-related disorders. Owing to the large variation in physiological responses produced by different patients, the best design probably involves using each patient as their own control. In the initial phase, the subject undergoes at least six sessions of enhanced relaxation in which the fragrance is intermittently introduced during the phase of deep relaxation. The imagery used makes no reference to fragrance, and it is our experience that in these circumstances fragrance is rarely consciously perceived, provided that the odour intensity is low. Whereas in therapy the enjoyment of the fragrance can be encouraged, in a

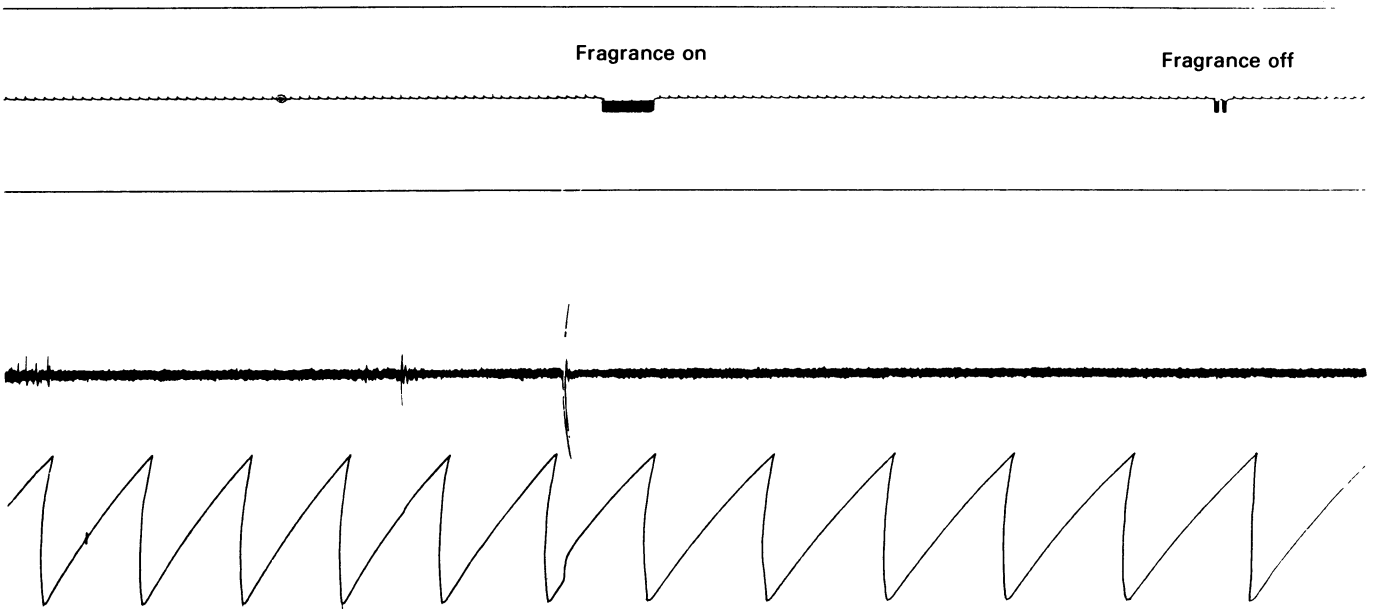

Fig. 8.4 The effect of an odour on muscle activity. The figure shows a 17 per cent reduction in activity of the frontalis muscle of the forehead. The presentation of the 'seaside smell' is indicated in the upper trace. The middle trace shows muscle activity, while the bottom trace shows integrated muscle activity.

scientific trial it is important to avoid conscious perception of the fragrance in order to eliminate placebo effects.

At the end of six weekly sessions the patient can be considered adequately conditioned to the fragrance, and electromyographic (EMG) recordings are then made of activity in the frontalis muscle (over the forehead) during subsequent sessions. Muscle activity during periods of brief presentation of the fragrance is compared with similar periods of time immediately before presentation; a significant decrease in activity during presentation of the fragrance would confirm the subjective reports of earlier, uncontrolled studies, that it has a specific beneficial action. It is unlikely that at these low levels of intensity the fragrance itself would have any significant action on the EMG, other than by virtue of its conditioned association (Schwartz, 1979).

A trace obtained from one patient, in which a 17 per cent reduction in integrated EMG activity followed the first presentation of fragrance, is shown in Fig. 8.4. There are a number of technical difficulties in these studies, among them the thorny problem of ensuring an optimum odour intensity for individuals of differing olfactory thresholds, without divulging the purpose of the experiment. However, the use of brain imaging (see Van Toller in Chapter 7) promises to provide an elegant solution to this problem.

8.12 APPLICATIONS OF ENHANCED RELAXATION THERAPY

The technique holds promise in the area of anxiety reduction, as an alternative and possibly more effective variant of relaxation training, and the indications will be broadly the same; these may be stated as follows.

Anxiety-based disorders

These conditions are characterized by irrational feelings of apprehensiveness and fear, with accompanying bodily (autonomic) disturbance. The anxiety may be diffuse or focused on specific situations (phobias). The physical components of anxiety are likely to respond best to relaxation training (Tarrier and Main, 1986). Severe degrees of anxiety may not respond to relaxation when they are based on an underlying biochemically mediated depressive illness (Snaith, 1981).

Phobic conditions may be tackled in several ways. Patients may, during their relaxation session, deliberately imagine themselves for a short time in the feared situation. The state of bodily relaxation is incompatible with the experience of anxiety and the patient therefore becomes de-sensitized to the phobia – 'psychotherapy by reciprocal inhibition' (see Wolpe, 1958). Or patients may consciously summon up a feeling of anxiety in order to 'neutralize' it by returning rapidly in their imagination to the relaxing scene – 'stress innoculation' (see Meichenbaum, 1977).

Alternatively, patients may apply their newly acquired skills in relaxing themselves when they actually find themselves in the feared situation. A new link is thus forged between the situation and feelings of relaxation. Here the fragrance may be of additional help.

Residual anxiety

This condition is found following successful treatment of depressive illness (Snaith, 1981). Relaxation techniques are unlikely to help depression itself, however.

Psychosomatic disorders

These conditions are aggravated by stress, such as tension headaches, asthma and hypertension. See Patel and North (1975); Rachman and Wilson (1980).

Insomnia

Included here especially is initial insomnia (difficulty in falling asleep).

Cigarette, alcohol or tranquillizer dependence

Such conditions may occasionally be helped by the techniques of relaxation therapy. However, this use is insufficiently proven, being an incidental bonus sometimes noted during the treatment of anxious patients.

8.13 WIDER APPLICABILITY

Stress-related problems are practically universal. At one end of the scale they may constitute medical illness, but at the other they merge into normal experience. Returning to our earlier example, some anxiety during public speaking is normal; the difference is one of degree.

I think that the use of enhanced relaxation and fragrance with normal individuals might well have wider relevance for the promotion of well-being. Technical advances in fragrance application, such as the aroma disc and the fragrance cassette, are constantly opening up new possibilities. Now the main obstacle, in my view, is the lack of public awareness of smell (mentioned above), which inevitably holds back a greater appreciation of its therapeutic potential.

However, in recent years there have been new initiatives in fragrance education (see Green in Chapter 13) and a widespread kindling of interest culminating in the Psychology of Perfumery conference, held at Warwick University in July 1986. I have no doubt that more enlightened times lie ahead.

9

Essential oils as psychotherapeutic agents

R. TISSERAND

9.1 HISTORICAL BACKGROUND

The therapeutic use of aromatic plants, and oils made from them, dates back to earliest times. In Egypt, for both spiritual and medicinal uses, infused oils and unguents were employed 5000 years ago. Even earlier civilizations burnt aromatic herbs and woods to drive out 'evil spirits', which we might now interpret as mental sickness. In many parts of the world fragrant plants have been, and still are, an integral part of the ritual in sorcery, healing and religious practices (Tisserand, 1977, 1988).

Smoke from burning bay leaves was inhaled by the Oracle at Delphi to induce a trance-like state enabling communication with the gods. In the Old Testament the Lord instructs Moses in the creation of a 'holy perfume', based on frankincense, myrrh and other exotic gums. Whether in the form of aromatic oil or incense, such holy perfumes were presumably intended to evoke a spiritual atmosphere, or a heightened awareness in some sense. In the East incense is burned to communicate with the spirits of the dead. In South America and Africa various stimulating or hallucinogenic plants are used to induce a state of religious ecstasy. The Greek philosopher, Plutarch, wrote about an ancient Egyptian perfume known as 'kyphi': 'Its aromatic substances lull to sleep, allay anxieties, and brighten dreams. It is made of things that delight most in the night.' One of the sixteen ingredients of kyphi was *calamus* (Gunther, 1959), a potent narcotic/sedative (Dandiya, Baxter and Cullumbine, 1958; Dandiya and Cullumbine, 1959; May, Malec and Lastowski, 1964; Dandiya, Cullumbine and Sellers, 1959; Madan, Arora and Kanti Kapila, 1960; Shipochliev, 1968). The Indian variety of calamus essential oil contains up to 80 per cent *asarone* (Vashist and Handa, 1964); this toxic phenol is a precursor of TMA-2, a phenylethylamine capable of powerful narcotic effects.

Hines (1977) comments that odours are capable of creating 'an emotional,

ecstatic state of consciousness that would render individuals more susceptible to religious experience'. This he attributes to a selective stimulation by odours of the right cerebral hemisphere. The *emotive* capacity of odours is more commonly attributed to their stimulating effect on the limbic system, whose role both in memory and emotion is well known.

'Feeling good' is a basic human need – and 'olfactory ecstasy' was discovered by humankind very early on – however, the distinction between a spiritual 'high', a sexual 'high' and a plain and simple 'high' is often difficult to make. In one recent unpublished study a small group of people were given LSD for the first time, under medical control, and most of them described their experience as a kind of spiritual revelation. Kyphi, originally made and used only by ancient Egyptian priests, became so popular that it was later used by the common people in the form of a perfume. It was also employed by the Greeks as a remedy for asthma according to Dioscorides (Gunther, 1959). This eminent Greek herbalist also wrote about the aphrodisiac properties of *costus*, saying that it 'provokes venerie', a property which he also attributed to several other aromatic plants. The sexually stimulating quality of certain aromatics, such as cardamom, ginger and pepper, was well known in the Middle East; it has become immortalized in certain popular texts widely read today.

As well as their euphoric and aphrodisiac properties, aromatics were used either as stimulants or sedatives of the nervous system. Dioscorides wrote 2000 years ago of the 'soporiferous' qualities of myrrh and marjoram. In the sixteenth century Gesner (1559) tells us that rosemary essential oil 'Strengtheneth the braine'; and Pechey (1694) wrote about peppermint oil, 'The smell of it strengthens the Brain and preserves the Memory'. In China, at about the same time, the psycho-therapeutic qualities of essential oils were being put to good use. Shih-Chen (1973) attributes anti-depressant properties to rose oil, and describes chamomile oil as a sedative. By this time aromatics had a long tradition of use as euphorics, aphrodisiacs, sedatives and anti-depressants. However, the concept of strengthening the brain and the memory was a relatively new one.

In 1984, I collaborated with an acupuncturist to attempt to discover whether there was any significant correlation between particular essential oils and particular acupuncture meridians. (A meridian is a line of subtle energy which typically travels from its related organ to the end of a finger or toe.) There is one meridian which is said to be closely related to the brain. We found that 95 per cent of all the essences tested – an unusually high figure in our tests – had an energizing effect on this meridian, in particular, oils of rosemary, basil and peppermint. The only other meridian which was highly responsive to a large number of oils was the stomach meridian. This is perhaps not surprising, considering the digestion-stimulating and carminative properties of most essential oils.

9.2 TWENTIETH-CENTURY AROMATHERAPY

In spite of its early beginnings in Egypt, the invention of distillation in the tenth century, a revival of interest in essential oils as therapeutic substances in sixteenth-century Germany, and their subsequent common usage by both doctors and herbalists, the term *aromatherapy* was not coined until 1937, when a book of that same title was written by a French cosmetic chemist. In Italy, in the early 1920s, there appeared the first serious reviews of psycho-aromatherapy, written by two medical doctors, Giovanni Gatti and Renato Cayola (Gatti and Cayola, 1923a, 1923b, 1929). In 1923 they published 'The action of essences on the nervous system', explaining clearly how odours influence mood and emotion, and defining the two opposing states of anxiety and depression. Two methods of application for the essential oils are suggested – inhalation or ingestion. In digestive absorption the essential oil is introduced like other medicines, and arrives at the nerve cells by the slow transmission of the blood stream. In respiratory absorption the essences exert an influence on the brain via the nerve endings of the olfactive mucosa. The authors noted, immediately following essential oil vapour contact with the olfactory nerve endings, changes in pulse rate, blood circulation and depth of respiration. They conclude that: 'The sense of smell has, by reflex action, an enormous influence on the function of the central nervous system.'

Essential oils identified as sedatives, and therefore of use in anxiety states, include: chamomile, melissa, neroli, petitgrain, opoponax, asafoetida and valerian. Stimulating essences are said to include: angelica, cardamom, lemon, fennel, cinnamon, clove and ylang-ylang; this last oil is also credited with aphrodisiac properties. The authors point out that sometimes a light, initial dose of an essential oil will have a stimulating effect, while increased or repeated dosage may lead to a state of sedation. The experiments were conducted using smelling-pads of cotton wool impregnated with solutions of essential oils and applied with masks to the mouth; alternatively, the surrounding air was sprayed with aromatic solutions.

In recent years this early research has been taken a step further by another Italian, Professor Paolo Rovesti, of Milan University (Rovesti, 1973). He also describes two possible methods of application, one being to put one to three drops of essential oil on to a sugar lump, and to hold this in the mouth. By this method some of the essence is inhaled, while some is also ingested. The other method is to spray the air with aromatic aerosols.

According to Rovesti, 'green notes' are usually anxiety-relieving and sedative. He makes the point that mixtures of essential oils are more pleasant than single oils, and are therefore more acceptable and more effective for those suffering from nervous tension. A similar point is made by Van Toller *et al.* (1983), who comments that 'pleasant and unpleasant responses are not

opposite in terms of cognitive processing' and explains that the brain simply rejects odours perceived as unpleasant. Therefore, they do not gain the same access to the central nervous system. It would seem that pleasant odours have at least a better chance of stimulating positive therapeutic responses. For example, essential oils of valerian and asafoetida would possibly not be the ideal ingredients for an anti-stress perfume, or a relaxing massage oil. Even though they might be effective sedatives when taken orally (see below), the perceived aesthetic quality of any odiferous product is a factor which must also be considered.

Among the anxiety-relieving essential oils listed by Rovesti are:

bergamot	marjoram
lime	violet leaf
neroli	rose
petitgrain	cypress
lavender	opoponax

Against depressive states he suggests:

lemon	jasmine
orange	ylang-ylang
verbena	sandalwood

Rovesti does not give any details of controlled experimentation, but he does state that 'very conclusive experiments have been carried out in various clinics for nervous diseases, on patients affected by hysteria or psychic depression'. Although these were not controlled clinical trials, the importance of Rovesti's contribution to psycho-aromatherapy should not be underestimated.

Continuing the theme of stimulation and sedation, I do not know of any animal tests concerning aromatic oils and stimulation. However, ten essential oils have been investigated for their sedative effects. The results are impressive, except for the fact that very high doses of between 50 and 1200 mg/kg in all experiments were employed. (I will return to this point later.) The earliest published study of this nature was by Binz in 1879; he injected frogs with valerian oil and studied their responses to peripheral stimulation. Binz found that increased dosage finally paralysed the nervous system. This is not especially interesting, except for the implication that valerian oil may well be neuro-toxic, while most essential oils are hepato-toxic in very large doses (Tisserand, 1985). The first impressive study was published in 1921 by Macht and Giu Ching Ting. They set out to investigate the possibility that aromatic drugs could 'exert their therapeutic effects, not by being first absorbed into the circulation, but through a direct stimulation of the

olfactory sense organs'. This was not a new concept, but had not previously been experimentally investigated. This study pre-dates by two years the first publication by Gatti and Cayola.

Macht analysed the effects of aromatic vapours on rats which previously had been trained to negotiate a maze. Cotton-wool pads were impregnated with aromatic solutions, and as a control unscented pads, and pads with either water or ethyl alcohol, were used. Results show that valerian and asafoetida have distinct sedative effects. Thirty rats ran the maze for each. Rose oil also came out as sedative, although only six rats were used. A distinct depressant effect was noted with asafoetida, even when only trace amounts were used. This is interesting because the fumes of various compound incenses were also tested. Here it was found that small amounts were distinctly stimulating, while larger amounts were often sedative. Pure frankincense gum was neither stimulating nor sedative, and galbanum was slightly sedative.

Table 9.1 Analysis of experimental data on sedative essential oils

	Fall in body temperature	*Fall in blood pressure*	*Sleep potentiation*	*Convulsion prevention*	*CNS depression*	*General depression/ reduction in spontaneous movement*
Asafoetida	N/T	N/T	N/T	N/T	√	√
Calamus	√	√	√	√	√	√
Carrot seed	N/T	√	N/T	√	√	√
Chamomile	√	N/T	√	—	√	√
Clary sage	N/T	N/T	√	√	√	√
Geranium	N/T	N/T	N/T	N/T	N/T	√
Lavender	N/T	N/T	√	√	√	√
Marjoram	N/T	N/T	N/T	N/T	√	√
Melissa	N/T	√	√	N/T	√	√
Rose	N/T	N/T	N/T	N/T	N/T	√
Taget	√	√	√	√	√	√
Valerian	N/T	N/T	N/T	N/T	√	√
Yarrow	√	N/T	√	√	√	√

N/T, not tested.

The results of later animal experiments are summarized in Table 9.1, and the appropriate references for each essential oil are given in Table 9.2. In most cases the dosage required to obtain a significant effect is between 100 and 300 mg/kg. Fatally toxic dosages for most essential oils are between 1000 and 5000 mg/kg, and the therapeutic dosage used by aromatherapists

Table 9.2 Table of stimulants and sedatives

Essential oil	*Anecdotal source*	*Confirmation from animal tests*	*Confirmation from Japanese research*
Sedatives			
Asafoetida	7	13	—
Bergamot	16	—	Yes
Carrot seed	—	3	—
Clary sage	18	2	—
Calamus	11	5,6,14	—
Chamomile	16,17,19	12	Yes
Cypress	16	—	—
Lavender	16,19	1	Yes
Melissa	8	20	—
Lemon	19	—	Yes
Marjoram	11,16,19	—	Yes
Neroli	7,16,19	—	No
Petitgrain	7,16	—	—
Opoponax	7,16	—	—
Rose	16	—	No
Sandalwood	18	—	Yes
Taget	—	4	—
Valerian	7,9	13	—
Yarrow	—	12	—
Stimulants			
Angelica	8		—
Basil	16		Yes
Cardamom	8		—
Cinnamon	8,19		—
Clove	8,16,19		Yes
Eucalyptus	16,19		—
Fennel	8,19		—
Jasmine	16		Yes
Juniper	19		—
Lemon	8,16		No
Patchouli	16		Yes
Lemongrass	16		—
Nutmeg	16,19		—
Peppermint	15,19		Yes
Rose	17		Yes
Rosemary	10,19		—
Sandalwood	16		No

Table 9.2 (continued) Table of stimulants and sedatives

Essential oil	*Anecdotal source*	*Confirmation from animal tests*	*Confirmation from Japanese research*
Stimulants			
Verbena	16		—
Ylang-Ylang	7,16		Yes

Note:
The Japanese research mentioned here refers to the study carried out by Torii and colleagues (Chapter 6). Many of the essential oils listed here were not included in their research, but of those that were, there is an 80 per cent agreement with anecdotal and/or animal tests. This is a very encouraging figure. No doubt, further research will clarify the situation further.
Sources:
1, Atanassova-Shopova and Roussinov, 1970a; 2, Atanassova-Shopova and Roussinov, 1970b; 3, Bhargava, Ali and Chauhan, 1967; 4, Chandhoke and Ghatak, 1969; 5, Dandiya, Baxter and Cullumbine, 1958; 6, Dandiya and Cullumbine, 1959; 7, Gatti and Cayola, 1923a; 8, Gatti and Cayola, 1923b; 9, Gatti and Cayola, 1929; 10, Gesner, 1559, 11, Gunther, 1959; 12, Kudrzycka-Bieloszabska, 1966; 13, Macht and Giu Ching Ting, 1921; 14, Maj, Malec and Lastowski, 1964; 15, Pechey, 1694; 16, Rovesti, 1973; 17, Shih-Chen, 1973; 18, Tisserand, 1977; 19, Valnet, 1982; and 20, Wagner and Sprinkmeyer, 1973.

is between 2 and 4 mg/kg. In one paper (Atanassova-Shopova and Roussinov, 1970b) the authors' comment that 'Administered in very high doses that are close or equal to the toxic ones, clary sage oil has a narcotic effect'. This seems to contrast sharply with the strong sedative effect obtained by Macht with mere traces of asafoetida oil. The answer appears to lie in *how* the essential oils are administered. In every case, apart from Macht's study, the oils were given by intra-peritoneal injection. While these animal studies demonstrate that essential oils are capable of strong sedative-type effects, they also show that a very elevated dosage is necessary to obtain the desired effect, when the oils are given internally. The dosage required is about one-tenth of the toxic dose, and yet it is 100 times greater than the amounts actually used in aromatherapy.

In aromatherapy practice essential oils are not often administered orally. When they are so administered, it is invariably a purely physiological effect that is wanted, and this is the normal method used by the French medical doctors who prescribe essential oils to treat infections. However, it seems apparent that *psychotherapeutic* effects are obtained much more easily by other methods, either by inhalation or massage. Applying essential oils at the dosage levels used in the animal studies we have quoted would be both costly and hazardous, producing marked side-effects, depending on the method of application. Irritation of skin or mucous membrane could cause problems, and prolonged dosage may lead to chronic hepatic and renal toxicity

(Tisserand, 1985). Used at much lower levels, we find that, in practice, essences can be just as effective depending on the circumstances and method of administration. Low doses seem to require the potentiating or synergistic aid of additional factors, which put the subject into a relaxed state of mind. The most obvious examples of this are counselling with visualization, massage and the domestic bath. In all these situations relaxation is virtually assured and, at the same time, a fragrance can easily be introduced. In contrast, a product sprayed on to the skin, and worn while the subject is occupied with everyday affairs, is likely to be less effective.

The emotive and relaxing effects of touch have been investigated. Baby mammals frequently die if they are not licked by their mothers at birth. Any similar types of tactile stimulation will cause the same biochemical response which results in life rather than death. Several studies on rats have shown that gentle handling (by humans) in early life leads to a more emotionally stable and unexcitable animal (Montagu, 1971). Stunted growth in humans has been related to a lack of loving/touching during early childhood. If we make the assumption that humans have a more developed aesthetic sense and capacity to feel emotion, then it seems logical that we should respond even more acutely than rats to odiferous or tactile stimulation. The fact that aromatherapy treatment is carried out by a person introduces another dimension, and at present we are unable precisely to determine just how much the success of any treatment is due to the essential oils, the massage or the patient–therapist relationship. While there are many recorded cases of successful treatments which relied purely on essential oils, these are seldom concerned with psychological problems.

During aromatherapy massage the essential oils are absorbed both percutaneously and by inhalation, and so there will be some level of physiological response in addition to the olfactory/limbic/hormonal/emotional responses discussed elsewhere in this book. The absorption of essential oils through the skin has been demonstrated (Le Nouene, 1966; Macht, 1938; von Meyer and Meyer, 1959). For use in massage, essential oils are diluted at 1–5 per cent in vegetable oil such as almond or grape seed. The amount of essence which is absorbed through the skin during a full-body massage (approx. 0.1 ml) is the same as the usual therapeutic dose for oral administration. Dosage and dilution both require careful consideration. We have already seen that low dosage sometimes has the same effect as high dosage, but lower dosages may result in a complete reversal, i.e. stimulation rather than sedation. The effectiveness of different dosages and dilutions is a subject worthy of further investigation. One study (Boyd and Pearson, 1946), on the expectorant action of lemon oil, found the most effective dose was 50 mg/kg. A later study (Boyd and Sheppard, 1968) found that a much smaller dose of 0.01 mg/kg was also effective, *but amounts anywhere in between these two were less effective*. Here we seem to be getting close to the

homoeopathic phenomenon, namely that the more a substance is diluted, the more potent it becomes.

9.3 EFFECTS OF ESSENTIAL OILS ON EMOTIONAL STATES

The late Marguerite Maury, a well-known aromatherapist who wrote one of the first books on the subject (Maury, 1964), describes the effect of essential oils on the psyche:

> But of the greatest interest is the effect of fragrance on the psychic and mental state of the individual. Powers of perception become clearer and more acute and there is a feeling of having, to a certain extent, outstripped events. They are seen more objectively, and therefore in truer perspective.

How does fragrance influence our emotional state? Partly this can be explained by the connections between some of the olfactory nerve endings and other areas of the brain. The olfactory tract branches with about twelve different destinations. One of these, the piriform area, is largely responsible for conscious odour perception, but we are now beginning to understand the significance of some of the other nerve connections. The hippocampus and the amygdala are related both to long-term memory and to many types of emotion.

It would seem that there is strong evidence for a connection between odour and certain basic human drives such as food and sex, and responses such as awareness of danger. Many researchers have detected physiological changes in response to odour stimulation in areas such as blood pressure, muscle tension, skin temperature, skin conductance and brain wave patterns (Gatti and Cayola, 1923a; Van Toller *et al.*, 1983). None of these responses are under conscious control, and subjects are often unaware of their response to an odour. However, both the olfactory nerve connections and the measured physiological changes indicate that in general we do respond emotionally to odours.

Rovesti (1973) describes the response of psychiatric patients to aromatherapy:

> It may be said that the patients feel as if transported by the perfume or by the essential oil into a different, more agreeable and acceptable world, so that many of their reactive instincts are curbed and they gradually return towards normality.

These words echo those of Marguerite Maury, and also tie in with my own experience as an aromatherapist. Very often a patient's response to his or her first treatment is simply 'I feel better' or 'I feel brighter' or 'I am much more relaxed'. We should never underestimate the importance of 'feeling better'

whatever the complaint may be, physical or psychological. A more positive mental attitude in the patient is not only helpful, but frequently essential to their full recovery. Aromatherapy can and does help many people in this way, and to label their recovery as 'merely psychosomatic' only shows an ignorance of the healing process. Certainly aromatherapy does work psychosomatically since it acts on both body and mind via the olfactory nerve tracts and the central nervous system.

Those who work therapeutically with essential oils have witnessed, at first hand, their psychotherapeutic effects. They know that no matter which essential oils are used in treatment there is invariably an improvement in mood and temperament. We could describe this as a 'relaxed alertness' or simply a 'feeling of well-being'. However, there are certain essential oils which *reliably* produce this euphoric response. This is dramatically illustrated in the following extract from a letter written by a practising aromatherapist:

> My patient was suffering from acute depression. During the treatment he became convinced he was floating in the air, and kept opening his eyes, fearing he was about to bang his head on the ceiling. I barely finished the massage when I had to crawl off to the nearest floorspace where I 'passed out'.
> I came to an hour later and woke my patient with some coffee. The treatment was totally successful, and he left somewhat high and ethereal. When I work out some form of mask to wear I might consider using clary sage again!

This experience was later corroborated by the patient, although it should be stressed that imagined levitation is not a normal consequence of aromatherapy massage. Clary sage oil is one of the essences considered to be 'euphoric' and therefore of use in depressive states. Other oils in this category include jasmine (absolute), ylang-ylang, bergamot and grapefruit. Two brief case histories will help to illustrate the use of euphoric essential oils in practice.

Mrs W. came to me complaining of depression, which she said had started following a hysterectomy operation fourteen years before. She had taken tranquillizers for four years, but had stopped them six years ago. She also suffered from dizzy spells and headaches almost every day and was not sleeping well. She was a very likeable but fairly timid person, married with three children. Massage was given using a diluted blend of basil, bergamot, clary sage and jasmine; and I saw her for a total period of sixteen weeks. After the first week, she only had two more headaches, and the dizzy spells ceased completely after week 7. During the whole period her energy, confidence and the quality of her sleep steadily improved, and her depression had vastly improved by week 10. By the end of the sixteen weeks she no longer felt any need for therapy.

Mrs A. came to me complaining of arthritis in her right knee and lower

back. She also revealed that she suffered from periodic depression and, for the last month or so, had been having nightmares every night. These were very bad, and she would wake up every morning in a cold sweat. The apparent cause of these psychological problems was the fact that her son had died from heroin addiction two years before. She was 72 years old, and had also lost her husband, but had a basically strong and cheerful temperament. She took one Mogadon every night to help her sleep. The essential oils used were bergamot, clary sage, jasmine and frankincense. I also gave her a separate aromatic mixture to rub on her back and knee. During the first week after treatment she had a few strange dreams, but no nightmares at all. For the following three weeks she made steady progress, with no further nightmares. She reported feeling very much better in herself, and her depression receded. By the end of this period she had completely stopped taking the nightly Mogadon as she found that she could do without it. The following week she had three bad nightmares featuring her son (it was the anniversary of his death), but otherwise she was fine, and did not go back on to the Mogadon. On her last visit, four weeks later, it was found that she had had no further nightmares and generally felt in excellent spirits. The total treatment period was nine weeks.

9.4 CONCEPTS OF MOOD EVOCATION WITH ESSENTIAL OILS

Some 2500 years ago Greek physicians and philosophers like Hippocrates evolved a philosophical basis for medicine based on four elements and four 'humours', each of which were said to correspond to a particular mood or temperament (Table 9.3). In addition, each of the four elements is said to be a combination of degrees of temperature and moisture:

Table 9.3 The four elements and some of their associations

Element	*Humour*	*Temperament*	*Season*	*Temperature*	*Moisture*
Air	Sanguine	Confident, courageous	Spring	hot	wet
Fire	Choleric	Irritable, angry	Summer	hot	dry
Earth	Melancholic	Gloomy, sad	Autumn	cold	dry
Water	Phlegmatic	Introverted	Winter	cold	wet

Each plant, and the oil made from it, is classified as belonging to one of the elements. According to Dioscorides, for instance, cassia, cinnamon and cardamom are all 'warming and drying', and therefore come under fire, the most stimulating of the elements (Gunther, 1959). Rose oil (infused oil, not essential oil) is described as 'cooling and drying' and so comes under the earth

element. The whole philosophy is much more complex than this, but in simple terms if a patient has a disease caused by too much 'water', the cure would be found in a plant having the qualities of fire, the opposite of water.

Appropriate remedies for depression, for example, would be found under the element of air, which opposes earth (melancholy). Essential oils in this category include the citrus oils, especially bergamot and grapefruit, which are used in aromatherapy to treat depression. The relationship of the four 'mood elements' can be illustrated, as in Fig. 9.1. To the right and left of the figure it is shown how the four personality types of Mensing (Chapter 10) would fit into this scheme. In fact the original concept of the humours was a classification of personality types.

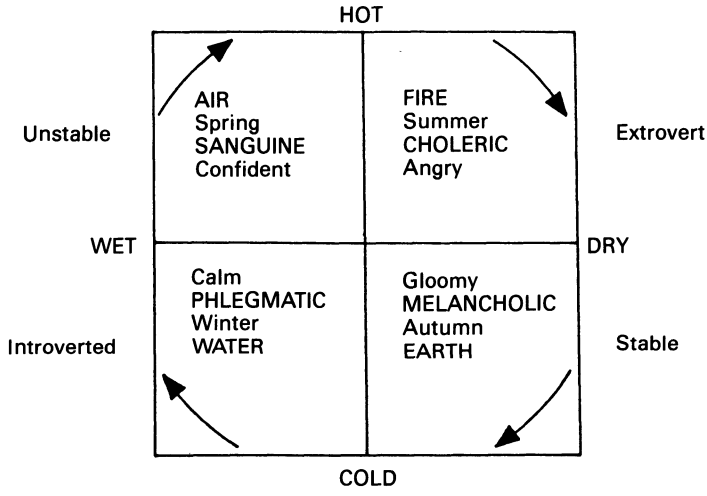

Fig. 9.1 The four basic 'mood elements'.

The four mood elements form the basis of our classification of moods, and their relationship with the four seasons clarifies the cyclic nature of the scheme. Just as seasons and moods are ever changing, so each of the mood elements lead on to the next one in a continuous cycle.

In *The Practice of Modern Perfumery* (1949), Jellinek proposes a classification of odour types and illustrates their psycho-therapeutic effects, as in Fig. 9.2. Here the words used describe the *effects* of odours, but 'fresh' and 'sultry' also describe *odour types*. Jellinek made no mention of the Greek system, and presumably had no knowledge of it; however, if we twist round the diagram, without altering the relative sequence of mood effects, it fits exactly into the first scheme. In fact Jellinek proposes eight mood effects, which closely correspond with a system I evolved from the original four moods, some years

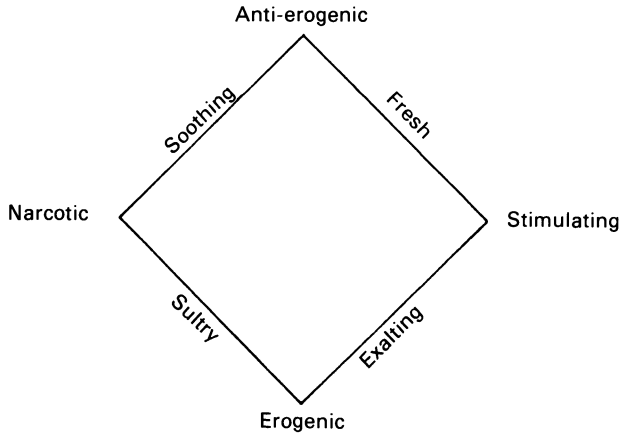

Fig. 9.2 Jellinek's scheme of odour types and psycho-therapeutic effects.

before I came across Jellinek's book. My own eight moods are defined as follows (Fig.9.3):

Clarity	Absence of confusion, everything is clear.
Rapture	In love – with someone, with life, sunshine.
Vivacity	*Joie de vivre*, excitement and joy.
Passion	Powerful feelings, often sexual.
Mystery	Fascination – unclear but intriguing feelings.
Euphoria	Blissful contentment, feeling 'high'.
Fantasy	Daydreams, night dreams, escapism.
Serenity	Peaceful calm.

I have shown in the diagram the positive aspects of each mood as well as the negative ones; each mood has both aspects. Positive turns to negative when our moods take over and start to control us to an unwelcome degree. When this happens, one solution may be aromatherapy. The appropriate essential oil forms a counter-vibration to that of the negative mood, so restoring harmony. The essential oil which induces a particular mood will counter the negative aspect of the *opposite* mood, as shown in the figure. Thus jasmine evokes mystery, and counters boredom; peppermint induces clarity, and conquers confusion; and so on. In addition to my own mood definitions, the figure shows the terms used by Jellinek, although his 'stimulating' and 'exalting' have had to change places in order to fit perfectly into my scheme.

Essential oils can be used to influence mood in four different ways:

1. To evoke positive feelings (e.g. clarity or vivacity).
2. To counter negative feelings (e.g. anger or depression).

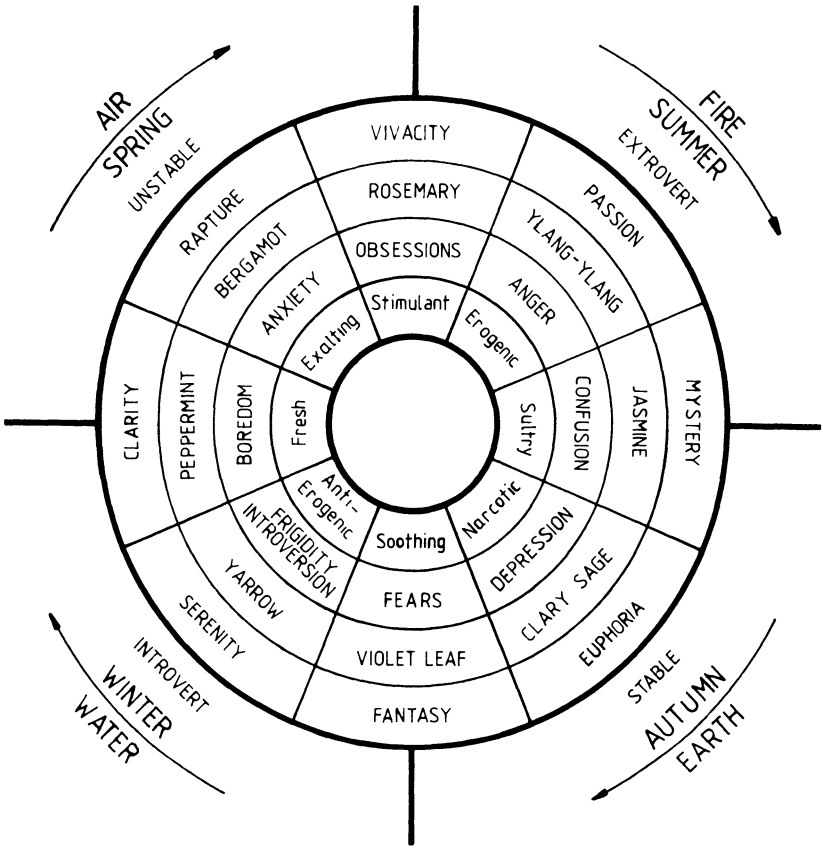

Fig. 9.3 The mood cycle, showing correspondences with the four elements and typical essential oils.

3. To influence our own mood.
4. To influence the mood of others.

We can say that most of the time we are, at some point, travelling around our own complex personal mood cycle, which is affected by so many things, including fragrances.

9.5 CONCLUSION

To conclude, there is a difference between *aromatherapy*, defined as a therapy using natural essential oils, and *mood fragrances*, which are largely based on

aromatic chemicals, just like any other perfume. A distinction should be maintained between serious forms of medicine and commercial mood products, however 'natural' the latter may purport to be. The term aromatherapy, then, is in danger of being over-stretched as different people attempt to apply it to all categories of fragrance application.

PART V

The consumer and perfume

10

The psychology of fragrance selection

J. MENSING AND C. BECK

10.1 IS SELECTION OF A PERFUME A MATTER OF CHANCE?

Previous research has led to several theories about the physical and psychological factors which influence selection of a particular perfume. One view holds that choice of perfume is non-rational and cannot be explained in psychological terms. Another group represents the viewpoint that external characteristics, such as the colour of a person's hair or eyes, determine choice of perfume (Jellinek, 1951). Last but not least, a new viewpoint based on rich classical literature (Corbin, 1984) focuses on the relationship between a person's personality and his or her choice of fragrances (Müller, 1984). This approach appears to be steadily gaining ground. The correlation between personality and fragrance was initially a supposition, but the latest research in the psycho-physiological area supports this idea (Klages and Klages, 1967; Koelega, 1970; Hacke, 1975; Van Toller, 1978; Dodd and Van Toller, 1983; Mensing, 1983; Steiner, 1986).

The physiological basis of the senses and, in particular, human odour memory are of particular interest. Smell is the only sense which has direct contact with the brain. A few decades ago the functional meaning of the *limbic system* was unknown and the system was described as the 'rhinencephalon' –the 'smell brain'. Today, however, we know that the limbic system serves as the central circuit for emotion, mood, motivation and sexual behaviour. It can be stimulated directly through the sense of smell (see Fig. 8.3 for a diagram of the limbic circuits). Furthermore, the limbic system also plays a significant role in selecting and transmitting information between our short- and long-term memories. Selection from and transmission to these two memories is performed via corresponding associative regions of the limbic system. The limbic system receives its information from the various sensory regions such as the sense of smell (Schwartz, 1980; Schmidt and

Threws, 1983). It is thus understandable why the perception of certain fragrances, as pointed out by Engen in Chapter 4, can be connected with a recollection of specific experiences, or why when we experience childhood odours, we simultaneously perceive past emotions. For example, if one were to go back and visit one's old school and smell the floor wax, many memories would return; one may relive anxious or apprehensive feelings experienced many years ago, perhaps when one had to take a test.

The olfactory receptors are so closely linked with the limbic system that a dysfunction of the latter can manifest itself in the form of a dysfunction of corresponding sensations in the olfactory system and vice versa (Hacke, 1975; Engen, 1982). Thus the symptoms of schizophrenia, for example, can manifest themselves in the form of olfactory hallucinations. A patient may smell strange odours and suspect the presence of toxic gases. This can lead to increased fears in conjunction with paranoia. Based on the fact that sensory receptors have direct contact with the emotional centres of the limbic system, we conceived and carried out two studies.

In an initial study women throughout West Germany (270 in all) who expressed an interest in perfume were asked to complete some personality questionnaires to determine their emotional characters. First, we gave each woman a sample which contained four different fragrances (4 × 3 design): fresh, such as 'O Lancome'; floral-powdery, such as 'Nahema'; oriental, such as 'Shalimar'; and chypre, such as 'Parure'. The fragrance notes are described in the *H & R Genealogy of Feminine Notes* (1986); cf. Mensing and Beck, 1984b.

We then tested their emotional mood tendencies, using Melcher's Colour Pyramid Test (CPT). This is a test that clarifies the affect structure for the dimensions of extroverted/introverted and emotionally ambivalent/emotionally stable moods (Heiss and Halder, 1975; Halder-Sinn, 1982). In addition, we tested their emotional tendencies by giving another test – the Lüscher Colour Test (Lüscher, 1974).

The data revealed surprising results. The two personality affect dimensions of the CPT were shown to be significant in revealing a person's perfume preference; the results were:

1. Extroverted perfume users, who looked for stimulation, had a significant (5 per cent level) tendency towards fresh fragrance notes.
2. Introverted women had a tendency (5 per cent level) towards oriental notes.
3. Emotionally ambivalent perfume users were significantly (5 per cent) more fascinated with floral-powdery notes.
4. Emotionally stable perfume users showed no significant tendency towards any one specific kind of fragrance note.

With these results, we could propose a hypothesis: fragrance users (other than the emotionally stable group) with a very extreme personality in one of these dimensions prefer their fragrance type in an absolute way. For example,

a very introverted perfume user favours typical oriental fragrances much more than the average users of this personality group.

The extremes of these personality dimensions can be described as follows:

Typical extroverted persons are orientated towards their environment and are dynamic and sociable. They like events and have many friends; they need people to talk to and do not appreciate being alone. They long for stimuli and like to provide stimuli; they always make the most of favourable opportunities and often act spontaneously; and they enjoy taking risks and are generally impulsive. In addition, they like to laugh and always have a quick answer; they like change and are carefree, optimistic, cheerful and enjoy communicating, and take pleasure in exercise and activities and are sometimes almost euphoric.

Typical introverted persons are quiet and rather withdrawn. They are reserved and distant, except in the company of close friends. They tend to make plans in advance and are gentle and careful, distrusting impulses of the moment. They do not like excitement, they take the things of everyday life fairly seriously, and appreciate a well-ordered life-style. They regard themselves as more sensitive than most people and show a strong orientation towards their own private world.

Typical emotionally ambivalent personalities experience varying moods. Their feelings and mood can change from one moment to the next – a fact that does not necessarily have to be experienced or regarded as negative. They seem dreamy and not psychologically resilient. At times, they give the impression of being melancholic, reflecting upon things that they cannot turn into reality. They reject anything that is too sober or too rational, and they do not want to be restricted in their moods or feelings. In certain situations their feelings may not correspond to what the social environment expects of them.

Typical emotionally stable people experience and show balanced moods and feelings. In their moods they try to gain control of the ups and downs in their lives. They do not like to experience depressed, unhappy moods. As to the social environment, they try to give the impression of being in a harmonious and balanced state of mind. They seem realistic, well-rounded and emotionally strong. They have the ability to adapt their moods and feelings to current demands.

Eysenck (1967) has postulated that an individual's ratings on these character dimensions correlate with the limbic system and the ascending reticular activating system (ARAS). This postulate is one of the most important explanations for biological personality traits, even while some questions remain open (Eysenck, 1967; Stelmack, 1981; Gray, 1983; Fahrenberg, 1985).

Neurological activities are responsible for the fact that in general extroverts experience higher degrees of stimulation in comparison to introverts, and need constant stimulation for their sense of well-being (Howarth, 1964; Eysenck and Zuckermann, 1978; Zuckermann, 1979; Radmacher, 1978, described in Amelang and Bártussek, 1985). It follows therefore that extroverts show a preference for stronger stimulating colour combinations such as red and orange, whereas introverts tend to prefer softer colours such as those found in the violet range (Lüscher, 1974; Heiss and Halder, 1975; Aguilera, 1980). These physiological processes of the brain may be responsible for the fact that the limbic system of an emotionally stable person reacts only to stimuli of a higher intensity (Amelang and Bartussek, 1985).

There is a comprehensive literature on the influences of these four personality types in the judgement of art, in particular, in the judgement of paintings (a good summary is given by Bortz, 1978; Schüster and Beistl, 1978; Kreitler and Kreitler, 1980). Very extroverted people, for example, tend to prefer bright, colourful, unconventional paintings of the modern period. In general, they try to 'experience' themselves in the work of art. Very introverted people prefer atmospheric, darker and less colourful paintings, of older styles, which provoke reflection; they look critically at a work of art. In drawing this parallel with the world of art we emphasize the fact that the importance of personality types in the appreciation of art has been recognized in aesthetics. As mentioned earlier, the limbic system, originally called the 'smell brain', has a direct influence on personality types. We also know that the limbic system is directly stimulated by the olfactory receptors (see Fig. 8.3).

The facts just described made us curious, and we decided to investigate the relationship between scent and personality (Mensing and Beck, 1984a). We used 600 German female perfume wearers; we intentionally avoided the 'typical student subject population' (Koelega, 1970), and surveyed women active in the working world who had a strong interest in the world of fragrance. All of the subjects (aged 18 to 60 years) were asked to sample twenty-one different perfume brands of all types, in a 'blind' research design. The 'blind' fragrances were from the following notes:

1. the chypre family ('Miss Dior', 'Parure', 'Mitsouko');
2. oriental-floral ('Must de Cartier-Parfum', 'Jicky', 'Oscar de la Renta');
3. oriental ('Opium', 'Shalimar', 'Cinnabar');
4. floral-fruity ('Valentino', 'Fidji', 'Anais Anais');
5. floral-powdery ('Nahema', 'Rive Gauche', 'Tosca');
6. fresh-green ('O de Lancome', 'Eau de Courreges', 'Eau de Guerlain');
7. aldehydic-floral ('Chanel No. 5', 'Chamade', 'Madame Rochas').

The study was conducted with the help of perfumery shops. Each day, for

three days, the subjects sampled seven of the 'blind' fragrances. By grading each sample the women were to determine their preference. They were then asked to wear the perfumes which pleased them most. After testing each of these on their skin, they were asked to choose one favourite.

We then asked the subjects to describe their fragrance, relatively evaluating it and using a list of fifty adjectives (by a semantic differential of four levels: 'no'; 'more no than yes'; 'more yes than no'; 'yes'); some examples of these adjectives are 'oriental', 'dry', 'warm', 'light', 'classic', 'romantic', 'feminine', 'sensitive', 'harmonious', 'sporty' and 'sweet'.

In the next phase of this study we asked the same test group to describe (using the same list of adjectives) what they imagined to be their 'ideal' perfume ('Which of the following fragrance characteristics should your perfume have in order to express your personality?'). Next we asked them which brand names of perfumes they currently preferred; and also if they used, or had used, a special perfume for a certain length of time.

Then we examined the personalities of our subjects, using psychodiagnostic tests. First, we tested the affect structure with the Colour Pyramid Test (CPT, using the version of Melcher) and the Lüscher Test. Secondly, we asked for personal opinions and descriptions mainly in the dimension of extroversion/introversion and neurosis, with the Eysenck Personality Inventory (EPI) and the Freiburger Personality Inventory (FPI). We also noted the desired life-style with a German personality test (PSS 25). Furthermore, with the data from these tests, we could categorize our subjects according to such dimensions as: narcissism, conservatism, readiness to take risks, individualism, family orientation, romanticism, materialism, androgynous self-concept and consumer orientation. Finally, we collected sociobiographical data, such as age, skin quality, eating habits, etc. In addition, we inquired about the situations and seasons for perfume preference.

Using an analysis of variance, we took the sum of the average single perfume values from each fragrance note and compared these with the CPT affect types. Contrasting the CPT affect structure types with the preference of the perfume notes measured by semantic differential, we found three significant (5 per cent level) relations:

1. Extroverted perfume users had the highest average mean for fresh perfumes.
2. Introverted perfume users had the highest average mean for oriental perfumes.
3. Emotionally ambivalent perfume users had the highest average mean for floral-powdery fragrances.

Factor analysis therefore revealed three large independent personality groups (A,B,C). But we also found four non-independent subgroups (D,E,F,G)

with typical perfume preferences (the four subgroups were found using non-orthogonal rotation):

Factor A 'Extroverted mood tendency' showed the following: search for stimulation; single colours (orange and yellow); high scores on the scales 'readiness to take risks' and 'sociability'; fresh notes – 'O de Lancome', 'Eau de Courreges'.
Factor B 'Introverted mood tendency' showed the following: less need for stimulation; high scores on the scales 'individual/alternative life-style' and 'narcissism'; lowest scores on the scale 'conservative'; single colours (dark blue and violet); tend to be younger perfume users; oriental notes – 'Shalimar', 'Opium', 'Cinnabar'.
Factor C 'Emotionally ambivalent mood tendency' showed: high scores on the scale 'romanticism and fashion-oriented'; single colours (black and white); floral-powdery notes – 'Rive Gauche', 'Nahema'.
Factor D 'Emotionally ambivalent with extroverted mood tendency' showed: high scores on the scale 'flexibility, contentment and satisfaction with life'; idealistic and cheerful; preference for bright colours; age-group – younger and older; floral-fruity notes – 'Valentino', 'Anais Anais'.
Factor E 'Emotionally ambivalent with introverted mood tendency' showed: high scores on the scale 'need for security and well-ordered life-style'; materialistic values; colour preferences – warm colours such as dark green and violet; oriental-floral notes – 'Must de Cartier', 'Jicky'.
Factor F 'Emotionally stable with extroverted mood tendency' showed: high scores on the scales 'conservative, socially active' and 'family orientation'; older age-groups; colour preferences – dark red, green, orange; chypre notes – 'Parure', 'Miss Dior'.
Factor G 'Emotionally stable with introverted mood tendency' showed: high scores on the scale 'well-mannered and classic values'; single colours – blue, yellow and silver grey. Aldehydic-floral notes – 'Chanel No.5', 'Chamade'.

In order to control our results we made a 'cluster analysis'. In contrast to factor analysis, which looks for correlation between single variables (for example, colour and fragrance), cluster analysis organizes test subjects according to common characteristics, thus making it possible to discern and formulate distinct consumer groups.

With cluster analysis, controlled by cross-validation, we could confirm the three main groups and the four subgroups already determined by the factor analysis. When we considered only the factor of colour preference, we could categorize 66 per cent of our test subjects into these seven groups. When we took all factors (personality, colour and fragrance preferences, etc.) into consideration, we were able to categorize 81 per cent of the test subjects into the seven groups.

A qualitative follow-up of the three independent personality groups A, B and C revealed the underlying logic behind perfume preferences:

1. In fresh-green fragrances extroverted women found the stimulation they needed. They told us that this kind of fragrance had an activating effect on them.
2. Introverted users of perfume stated that their oriental fragrances had a characteristic and harmonious note. According to them, fresh-green notes have the weakness of being one-dimensional and uninteresting. They describe these fresh-green notes as being 'lemon-water'. On the other hand, extroverted perfume users described the oriental fragrances as being 'too heavy' and 'too sweet'.
3. The emotionally ambivalent perfume users found the floral-powdery notes to be soft, rounded, rosy and appealing. For them, this type of fragrance was associated with a dreamy experience. This group had an aversion to chypre notes, which they found to be 'too hard', 'too intensive' and 'too strong'.

It was interesting to observe that some groups had a different conception of fragrance descriptions, such as 'fresh' or 'erotic'. For extroverted perfume users 'fresh' was associated with 'active', 'clear' and 'green'. Yet for introverted perfume users, 'fresh' was understood as a new and interesting impression of a perfume top-note. They did not associate 'fresh' with a one-dimensional 'green' impression. The 'erotic' perfume concept was perceived by these introverted users as 'deep', 'warm', 'sensitive', 'sensual' and 'mystical'. Yet to women with ambivalent-extroverted mood tendencies, 'erotic' was associated with 'light', 'playful', 'romantic' and 'tender'. Our investigation revealed some further results, especially that a perfume that fascinates has three areas of influence, as below.

10.2 THE SUBJECTIVE EXPERIENCE

First, the perfume must correspond to the emotional perfume needs of a person, as a result of their affect structure. This is virtually the basic prerequisite for the fascination of a perfume, and the selection of a perfume for continued use. If the radiance of the perfume does not meet one's emotional needs, it is at best considered interesting, but this interest will be only short-lived.

10.3 THE DESIRED LIFE-STYLE

For those who emphasize fragrance aesthetics perfume is an important part

and an expression of a desired life-style. For example, today German 'Shalimar' users associate an individual/alternative life-style with this perfume. The life-style associations are of course influenced by advertising messages about odours. In addition, certain ideas are aroused in many cases by the packaging of the product.

The life-style of a person, which includes attitudes and ideas, can be strongly influenced by intellectual factors. To put it simply, unconscious emotional factors are decisive in the first area (subjective experience), whereas in the second area (desired life-style) intellect is an added factor: 'how do I want to see myself?' 'What am I looking for?' 'How will others see me?' 'What does my social environment expect of me?' People who are looking for a perfume sometimes show a discrepancy between emotional and rational perfume needs. For example, a perfume user on the one hand may be looking unconsciously – emotionally – for a perfume that expresses a tranquil and introverted mood. On the other hand, she may think that only a lively, dynamic appearance and a corresponding life-style suit her; that is, she feels confirmed in this attitude by her social environment. This conscious attitude towards life is reflected by a rational perfume need.

The emotional perfume need often must be suppressed, especially in everyday life, to comply with the criteria and norms of the environment. That is the reason why many women use several fragrances. The feelings that a woman has in her everyday working life are often different from the ones she has in her private life. In the same way, her mood tendency can change.

10.4 SOCIOBIOGRAPHICAL DATA AND CLIMATIC FACTORS

The third area of influence has a direct effect on the other two areas. An analysis of individual perfumes showed:

1. There are perfumes which appeal to a specific age-group, e.g. the perfume 'Parure', which has a stronger appeal to that group of perfume users over 30.
2. There are perfumes whose popularity varies depending on the season, e.g. the users of 'Mitsouko' use this perfume more frequently in cooler seasons.
3. There are perfumes which change their character depending on the atmospheric humidity – a high degree of humidity easily leads to a dulling of the perception of heavy oriental perfumes.

However, there are other factors, originating with the perfume user, such as eating habits, skin quality, state of health and hormonal changes. Finally, personal experiences influence the choice of perfume. For example, a perfume

which actually corresponds to a woman would not be chosen if it makes her remember someone she does not like.

10.5 THE COLOUR-ROSETTE TEST

From the factor and cluster analysis results, which revealed the relation between single colours and fragrances, we were able to create a colour test that could predict fragrance preference. This *Colour-Rosette Test* was developed to accommodate two types of applications:

1. As a decision-making aid in perfume consulting.
2. As a fast and accurate orientation aid in perfume marketing (see Mensing and Beck, 1985).

The Colour-Rosette Test as a decision-making aid

We all know how customers buying a perfume are usually advised. One perfume tester after another is taken from the shelf, and the perfume is sprayed on the customer's hand – often until she becomes 'fragrance-blind'. In the end, it is a matter of chance whether this kind of consultation is successful. Before we go through the Colour-Rosette Test, we should explain more about how it works.

Looking at colour combinations conveys certain moods and feelings. As argued above, individual emotional moods are decisive factors for choice of perfume. Accordingly, a person's choice of perfume can be determined using the Colour-Rosette Test. This test helps to determine both the emotional and the rational perfume needs of a person. It also indicates the brand names associated with each *rosette*, or personality group. We should like to point out here the need for at least three perfumes per colour rosette presented to the client, taking into account the influence of the third determinant of 'Sociobiographical data and climatic factors' (see Plate II, colour plate section).

As we all know, personal experience is variable. This fact is reflected by the choosing of a colour rosette. For example, it may happen that a person prefers two rosettes. This indicates that the perfume user may find something that appeals to her in two or even more perfume notes. Accordingly, the perfume user has not only an affinity for the fragrances of the single colour rosette, but also looks consciously for perfumes that cover several fragrance notes. Here are some actual examples.

Fragrance users who have an affinity to groups E and C, above, tend to prefer fragrances with oriental-floral or floral-powdery notes such as 'Poison',

'Scherrer II' and 'Oscar de la Renta'. Those who have an affinity to groups B and C tend to choose perfumes like 'Chloe' and 'Ysatis'. Affinity to groups F and A means a tendency to favour perfumes like 'Armani', 'Jean Louis Scherrer', 'Miss Dior', or 'Thophée'. For the classification of single perfumes with personality/perfume needs it is important to realize that only the 'nose' of the perfume user is the decisive criterion, not knowledge about perfumery. A very good description of the perfumes is given in the *H & R Fragrances Guide, Feminine Notes* (1986) and *H & R Fragrances Guide, Masculine Notes* (1986).

The Colour-Rosette Test is used in perfume consulting. In West Germany about one-third of perfumeries work with this test.
Application The customer looking for a new fragrance is asked the following: 'Please choose the colour rosettes which appeal to you the most', and 'Which of the colour rosettes have no appeal to you at all?' The consultant advises the customer not to choose on the basis of which colours she thinks suit her, or which happen to be in fashion at the moment. Also colour harmony should not be a deciding factor.

With the help of this method (as far as the influence of current colour fashion is controllable), we can predict fragrance preference with an accuracy of approximately 80 per cent. In addition, we can predict with 90 per cent accuracy which fragrances will be rejected. In this way, appropriate fragrance samples can be selected for the customer.

The Colour-Rosette Test as an orientation aid in perfume marketing

In previous market research the age and attitudes of the test subjects to whom perfumes were given for assessment were known, but their psychological personality traits were not identified. With the Colour-Rosette Test, it is now possible, for the first time, to pre-select test subjects on the basis of their personalities. This ensures that the perfume users to whom the perfume is supposed to appeal are in fact the ones who will actually judge the perfume. Consequently, introverts and emotionally ambivalent individuals with an introverted mood tendency are selected as the test subjects for 'oriental' fragrances. Also this method of targeted selection permits savings to be achieved in the cost of market research studies.

Moreover, the market chances of new fragrance creations for the individual personality groups can be reviewed by means of the Colour-Rosette Test. Up until now, market studies always involved the inherent risk of a very good perfume creation doing poorly or only average in the test because the assessment of the test subjects was not subsequently broken down into personality groups. Through differentiated analysis on the basis of the Colour-Rosette Test it is possible to identify the personality group to whom the new creation best appeals.

Regular market analysis with the Colour-Rosette Test permits trends in a fragrance market to be identified early on, both nationally and internationally. Comparative intercultural studies in Argentina, Brazil, the UK and USA have shown that it is possible to identify the specific characteristics of our seven groups as well as their fragrance and colour preferences. However, what does change from country to country is the quantitative significance of the individual personality groups for the respective perfume market. Comparisons of group size, performed at various points in time, can be employed to indicate strong or weak shifts towards the one or the other personality group or fragrance direction.

10.6 TRENDS IN PERFUMERY FROM A SOCIOLOGICAL POINT OF VIEW

In the first part of this chapter we have explained how moods, emotions, desired life-style, and so on, are decisive factors in fragrance selection and fragrance experience. These are psychological aspects. Now we shall describe how psychological and sociological factors come together and influence each other. Moods, feeling and the whole self-concept are influenced by the environment. Changes and impulses in the social environment affect the individual's subjective moods. In this way, the fragrance selection is indirectly influenced by sociological factors. This is important in understanding trends in perfume.

We are living in extremely fast-changing, complex and confusing times. One trend follows on the heels of another. And there is not just one; there are any number of competing trends in parallel. What is 'in' today can very well be 'out' tomorrow. Such a situation can easily prompt people to say 'count me out!', and simply to ignore whichever 'taste' happens to be in vogue at the moment. However, those who belong to professional circles whose task it is, like the perfumer or the designer, to create products dependent upon the 'taste of the times', have a professional obligation to come to grips with trends and with the reasons behind them.

10.7 A FEW BASICS ABOUT TRENDS

It is a common fallacy to believe that mere chance decides the success of an idea; for example, that a famous fashion designer spontaneously has an idea, follows through on it and is then imitated by others, and a new trend results. Or that a perfumer succeeds in creating a new, fascinating fragrance which all of the others then rush to copy!

No doubt, creative strokes of brilliance do occur and there is no question

that they will continue to happen time and time again in the future, but whether these impulses will actually result in a new trend is something that no longer depends merely upon chance. The best creative minds are often the first to admit that they had such good fortune with their successful creations because they were 'in synchrony' with the times. In the 1950s and early 1960s, on the contrary, fashion designers were able to dictate a trend solely by the force of their authority.

The identical achievement ten years earlier might possibly not have been understood. Five years later and it would be hard still to generate any enthusiasm for it. In the case of aesthetic innovations timing is an especially important element since – no matter how latent they may be – needs (which a creation is to satisfy) change with the times. In today's world, where emphasis is placed on the human body, it is only natural for corresponding clothing, such as the tube dress, to enjoy such widespread popularity. This is because an individual's needs do not exist in a void, isolated from social experiences and the corresponding developments.

10.8 CHARACTERISTIC TRAITS OF A TREND

A trend cannot exist in a vacuum. It is only possible to speak of an aesthetic trend if it is able to exert a more or less pronounced influence on major segments of the population. A trend always begins with a 'gag'. The task of the gag is to break down rigid aesthetic perception structures. It would be a gag, for example, if a woman were to colour her hair bright red. However, only when gags are a manifestation of the developing spirit of the times, are they a constituent element of a trend. In most cases, a gag will only survive in weakened form in the trend itself, e.g. if, in our example, it were to become fashionable to add a streak of red to the hair. Gags that have little or no relationship to the spirit of the times become fads. Fads are very short-lived fashion manifestations that disappear again after one season at most.

From a social science viewpoint, a strong prognosis can be made for a trend if it is possible to identify a common background among different gags. This preliminary phase of the trend is termed the 'signal period'. Since social interaction is not a mechanical process, but depends to a significant degree upon thinking, feeling, wanting and primarily upon the perception of the individual, the signal period will usually last for a certain length of time, until people have 'inputed', comprehended, and classified the new happenings. The duration of the signal period depends upon such sociological variables as the age and sex of the target group, the region of the country, product/artist familiarity, the advertising budget and types of media employed, expectations and the need for stimulation.

Further, it has been found in practice that the duration of the signal period will differ for individual aesthetic products or fields. The above-mentioned variables also play an additional role. Accessories, such as fashion jewellery, are located in the field that has the shortest signal periods. On average here the change in perception structure amounts to some three months, while the signal period for fragrances lasts somewhere between three and nine months. In painting the signal period will average between one and one and a half years.

Periods that are characterized by numerous new or relatively new perception structures are usually followed by a 'nostalgia wave', which can, for example, take the form of a classical revival. This phase represents either an inability to develop adequate fashion ideas from the circumstances of the above-mentioned periods, or it signifies that over-stimulation of the sensory organs has produced a state of saturation. Moreover, the return to the classics also has the psychological components of producing subjective security on one hand, and renewed vitality or a new sensory reference through idealization of the past on the other.

10.9 LIFE CYCLES OF AESTHETIC TRENDS

Be it in fashion, art or music, or more recently in fragrance, it is usually among the younger generation that trends are kindled.

Example In the studies that we conducted, in 1981–2, on the fragrance needs of female German perfume users we found that the 'oriental-floral' category had a market significance of less than 10 per cent, lower than any other fragrance category. Since 1983–4 we have been able to observe how younger female perfume users in particular, who up until then had been fascinated either by aldehydic-floral or oriental fragrances, were the group that was leading the way in developing a complex fragrance need for oriental-floral notes. Conservatively estimated, since spring 1986 nearly two-thirds of all young female perfume users have been tending towards these new 'florientals'.

What is even more interesting is the fact that, as a result of this reorientation process on the part of the younger generation, older perfume users tend to prefer this fragrance category too. This trend observation, which we were able to indicate for a number of Western countries, such as Italy, West Germany, France, and the USA, was confirmed empirically for West Germany on the basis of a study of 300 female perfume users,

conducted in 1984–5. For 48.5 per cent of all those questioned, it was possible to identify fragrance preferences that were located in the oriental-floral-powdery range. Moreover, it was found that the majority of these user groups was looking for both fragrance categories in one and the same creation.

In addition, there were also signs of a further trend. Since autumn 1985 most of the perfume shops in West Germany that employ the Colour-Rosette Test have been able to observe how young people were the first to tend towards both florientals and 'fruity-culinary' fragrance notes like 'Giorgio of Beverly Hills' or 'Obsession'. In summer 1986 the fascination for florientals with a fruity-culinary top note then also took hold among older perfume users. 'Clandestine', a perfume that was launched in fall 1986, is already taking into account this growing fragrance need. A tendency toward fruitiness also characterizes 'O Intense', which had its debut on the West German market in July 1986.

It is normally younger groups on the periphery, or subgroups within the younger generation who, as a result of their standing in society and the way in which they experience it, initially respond to social change early on and in a highly sensitive manner. These groups exert an enormous fascination for the other major segment of the youthful population, who appear to be rather 'well adjusted' in comparison with these subgroups.

In the case of 'adults' it is initially a very specific group which then also jumps on to the youth trend bandwagon. This group consists predominantly of women around or over age 40. This is the age at which women have, for the most part, satisfied their family obligations. The woman is now able to think about her own occupational and personal self-realization. However, this involves the search for a new identity – an endeavour that women in this age-group share with young people, who are also searching for their own identity. Now what is interesting is that it is necessary perhaps for a woman in this situation to orient herself towards younger people as the values of her peers or elders would hinder her self-finding quest.

Both groups, young people and women around the age of 40, are thus faced with a common problem: against the backdrop of their social and private experience, they are attempting to establish their own independent identity or to develop a new one that is in line with what they demand from life. This acts as a link between the two age-groups, for they are both experiencing a comparatively similar open phase of life. This also helps to explain why older women are now, to an increasing degree, orientating themselves towards younger people.

So this should be noted in attempting to predict a trend which is currently 'in' among young people, in terms of taste preferences, will with a slight delay and in somewhat weakened form, already be able to be seen tomorrow among the 40-year-olds.

10.10 CHANGE OF SELF-PERCEPTION: THE MAIN PERFUME TRENDS IN RECENT YEARS

There is no doubt that ever increasing numbers of the young regard their actual environment as monotonous and boring. But that is not their only problem. To a much greater extent, they find it increasingly difficult to establish a stable identity in a socially convenient occupation. They feel as though they are being pushed further and further into a passive role. Access to life is being made more difficult. Even when they succeed, they are offered, at best, the opportunity of narrow specialisms. However, in accepting this, only a part of their potential would be used and the other parts would gradually begin to atrophy.

In fact, in a technological and over-populated world, the possibility to experience life in its fullness is only for the few. Here, then, is a dilemma that is common in Western technological societies: on the one hand these societies, in contrast to agricultural societies, promote a complex individuality in the education or training process, while on the other hand only the few are offered an opportunity to make use of this complex individuality in their professions. This is the basic problem for present-day youth. They have a massive need to find their own individual persona but, at the same time, are forced to realize the hopelessness of the undertaking. Hence an escape into fantasy. In 1984 the feeling of resignation among the youth of Europe reached a high point. Since autumn 1986 it has become more apparent that the greater part of the youth is beginning to reorient itself. In the process two typical reactions have become visible, especially among girls and young women, as below.

Classical regression

In a *classic regression* tendency young women adopt classical values but, at the same time, in a positive form of almost self-surrender, they also adopt the role of the child. These young people no longer wish to be burdened with psychological problems. To be loved is their declared objective, and this is exemplified by a tendency towards narcissism. They are searching for a trouble-free life, thus the menacing, real world is shut off or repressed. To them, emancipation has become almost an alien word; they are no longer in opposition to their parents, but instead try to dispose themselves positively, with the hope of being able to lead a carefree life. The classic regression tendency is to be understood as a reaction to the more or less conscious experience of vocational hopelessness. The word 'job' has become a pejorative term.

The preferred perfumes for this type are: aldehydic-flowery/classic (e.g. 'Chanel No. 5') with a pert, playful, fruity top note (as in 'Giorgio of Beverly

Hills'). The affinity, particularly to personality groups D and G (see above), clearly marks their taste. With the help of the Colour-Rosette Test, we have been able to observe that since 1984 the number of women in these two groups has been increasing, and that personality groups D and G have become much more important to the current perfume market.

Androgynous femininity

The second type of reaction to social experience is the development of an *androgynous femininity*. In contrast to the type of woman described above, this new femininity should be understood as an active reaction to the experience of resignation and hopelessness. The androgynous woman apparently goes beyond womanliness by acquiring 'masculine' attributes that will enable her to contend with the environment. That is, this type of woman equips herself with masculine weapons in order to survive psychologically and materialistically. In her very own feminine experience this type of woman has an affinity to personality groups B, C and, above all, E (see above). Her vital dynamic masculine attributes burst the bonds of this personality frame, and this has corresponding effects on her aesthetic experience, and her preference in perfume. In this group we may find many women who have an affinity for masculine fragrances. The androgynous feminine type rejected all fragrances that were very sweet or floral-powdery. The preferred perfumes for this type, are: oriental-flowery with an 'androgynous' character, e.g. new chypre notes ('Paloma Picasso', Jil Sander's 'Woman 3'), or with a 'masculine' character, e.g. leather or spicy notes ('Cacharel pour l'homme', 'Antaeus').

10.11 THE NEW WORLD OF FANTASY AND WHAT IT OFFERS

Although the androgynous woman is better able to deal with the environment than the classically regressed woman (above), in the final analysis there has not been any alteration in the situation of either type. More than ever, the adversities of life are so massive that all that remains for both types of women, as well as for many of the young, is a flight into an ideal world of fantasy, in which their own demands of life can be realized. This leap into a new reality is increasingly observable in youth. They live with and in a fantasy world, which is already offered to them through the media, videos, fantasy books, magazines, etc. Fantasy, then, may be regarded as an outlet that enables one's life to be lived to the full.

It is possible that, in the coming years, the fantasy wave will be the major trend. One needs to think only of the enormous number of unemployed youth. What is more, flight into a fantasy world could conceivably be the only way of overcoming monotony and boredom for such youth. Today we

already encounter both types of women, described above, in the fantasy world: the androgynous type, for example, in the form of Tina Turner in *Mad Max*, or the classically regressed type in the new Walt Disney productions and the rebirth of Marilyn Monroe types. Since autumn 1985 the fantasy wave has spread to the 40-year-olds too, in the form of glittering materials and fashion accessories. The packaging design as well as the fragrance of 'Poison' may be regarded as the first indication that the fantasy wave had gained entry into perfumery. Recently, in Italy a perfume called 'Time' was put on the market – a product in which fantasy is an integral part of its packaging.

Within the perfume industry it is obvious that tastes associated with the fantasy wave must be translated as swiftly as possible. Against this perfume background, it is interesting to note that in the flavours sector artificial fruit and floral notes, such as 'Green Banana' ('Pisang Ambon'), 'Blue Curaçao', 'Kon-Tiki' and 'Kiwiwonder', are already being successfully presented on the market. All of these new artificial fruit and floral notes have one thing in common: they are not one-dimensional. They cannot be readily identified with a single note, e.g. an orange note, rather they are complex; to continue with this example, one may well associate orange blossom with this note yet, at the same time, be aware that there is something more. This is the essential characteristic of the new fantasy flavours; the central figure is somewhat veiled by other components that make it more interesting.

10.12 THE 'FUN-TYPE'

In the last two or three years the fantasy wave has produced its own trend group: the 'fun-type' or 'ultras'. This group stands out in glittering fluorescent colour. On the basis of their presentation of themselves, they can undoubtedly be assigned to personality group D (see above). In their 'get-up' their 'gear', they overdo it, and by bourgeois standards they are 'crazy'. The fun-type loves the fast rhythms of soul-music and 'uppers' (stimulants) of all kinds. Their goal, ultimately, seems to be hyper-stimulation to overcome boredom. One could say that, without their being consciously aware, they live with a 'future-less' mentality, in an 'end-of-the-world' ('eleventh hour') atmosphere. In other words, they are ready to try anything and everything as possible consumers. Fragrance needs are: fantastic, artificial 'crazy' fruit notes, e.g. blue peach, green cherry, and so on; packaging materials: glittering, fluorescent colours with a three-dimensional holographic effect would be appropriate.

A good example of fragrance and colour preferences of the fun-type can be seen in the Limara perfumed-deo series (currently available on the mass market in certain European countries). All versions are packaged in 'fun'

colours – for example, 'American Dream' is packaged in vibrant yellow, with 'fifties' fun comic elements. The fragrance is a fruity note, in the direction of 'Giorgio of Beverly Hills'. Another version is 'Exotic Feelings', packaged in a hot pink, also with 'fifties' comic elements. Its fragrance is a crazy culinary note, in the direction of 'Obsession'.

The true fun-type reached a peak in autumn 1986. Without doubt, the fun-type will have, in the coming years, a noticeable influence on the greater part of the population – until, inevitably, the fun wave becomes meaningless in itself. However, this will have no effect on the general fantasy wave. Already a new movement is becoming apparent: 'magic fantasy', which goes beyond pure, consumer-oriented fun and reaches a deeper, more personal meaning.

10.13 MAGIC FANTASY: THE VIEW INTO THE PAST

People interested in sociological phenomena have been able to recognize that by mid-1986 the fantasy experience had changed its time orientation. Up to the middle of that year fantasy was future-oriented, as in 'Flash Gordon', 'Star Wars' and other science fiction visions. By the second half of the year fantasy had begun to be expressed more as a journey into the past. Especially relevant here is the revival of interest in books about the Middle Ages, such as *The Knight of Avalon* or Umberto Eco's *The Name of the Rose*, both currently best-sellers, while *Mission*, a film in this genre, has won the Golden Palm at Cannes.

What is behind this reorientation, in which needs are fulfilled through involvement in the darker past? Today more and more people believe that quality and meaning in life are being increasingly sacrificed to rational, technological progress (a belief that has led to the New Age movement). Anxiety about the future, a widespread and ever increasing symptom in rapidly developing, high-technology societies, leads to a specific psychological reaction. People seek a kind of 'long-lost wisdom' of past ages that they hope will add meaning to, or change, their lives. In this way, past ages associated with such knowledge or wisdom have become idealized. Another reason for this is that, in industrial societies, the meaning of life and promise for the future are associated only with material goals. For many people, then, this vision of the future becomes one-dimensional and leads to stunting of the personal experience; and the reorientation to the past becomes psychologically understandable as a flight from present reality. Related to this flight is a search for tradition, for past wisdom and a 'one-ness' with the earth – knowledge that is not bound or restricted by rational, formal science – and a preference for natural substances, essences and materials that bring about an expansion of conscious body-awareness, and the desire for the power and ability to influence oneself and others. The rediscovery, especially of the

medieval period, must be viewed in terms of this ever increasing need. This reorientation has already manifested itself in new aesthetic preferences. Three tendencies are observable, as below.

Fascination for magic and the supernatural

The need for magic, the supernatural and magic power was first reflected in fashion accessories and in fabric design. Innovative impulses in perfume and cosmetics by Dior, for example, can be seen in the packaging, advertising and in the entire marketing campaign of the perfume 'Poison'. This new trend can also be seen in the 1986 fall/winter make-up style, which creates a 'diabolical' effect (darker green, crimson and violet in all shades). The flacon for 'Poison' resembles a magic fruit filled with belladonna, created for women who want the power of witchcraft. In fact we can see that a growing subgroup of women like to identify themselves with witches. This tendency is often combined with the desire for supernatural power over others. A woman will seek appropriate aesthetic products, through which she can attain the feeling of a supernatural power. The properties of certain fragrances will give her the power to influence others; in the discussion of aromatherapy in the past year fragrance users were always eager to know if there were any substances with which one could attain such power.

The new fragrance need for a new generation of complex-sensual-oriental notes must be viewed against the backdrop of the desire to experience magic and the supernatural, and to rediscover spiritual/occult powers. Because of its complexity, fragrance becomes a medium for expanding consciousness, offering access to exotic, far-away worlds. 'Extasy', the new occult fashion drug, is a good example of this.

The search for security and meaning through tradition

In the aesthetic sector the first companies to begin mixing the fun wave with traditional elements were Esprit and Swatch. In particular, the watch design by Swatch (the new plastic watch with traditional coats-of-arms insignia on the watch face) constitutes a 180-degree turnabout. The return of traditional values began in recent years with the 'fifties' revival. Since winter 1985–6 the old classic elegance of the fashion houses of Chanel and Hermes has been in great demand. And this wave is already being inspired by symbols and ornaments that are highly reminiscent of the traditions of the seventeenth-century French court. The Swiss psychiatrist C. G. Jung expressed the relationship between humans and the primal symbols of our collective cultural history by the term 'archetype' in explaining the enormous power that such symbols hold for the individual.

Idealization of the earth and natural landscape

In all these points, correlating with the rediscovery of the past, the search for a new connection with the earth itself is the central aspect. It is this factor which will have the greatest impact on the aesthetic field during the coming years. In the past few years the greater part of our technological society has become aware of the ecological problem, the serious threats to our environment have been widely recognized. However, this awareness stands in direct opposition to the fact that our standard of living (and employment level) is often secured by the very factors which, directly or indirectly, pose the greatest threat to the environment. An increasing number of people feel trapped in this paradoxical situation. From a psychological viewpoint it is a 'double-bind' situation. The tension increases because individuals are no longer able to evaluate the degree to which their environment is being destroyed (e.g. people cannot be sure whether the lettuces they eat are radioactively contaminated, and even if they are sure, they may have no clear idea of what level is actually dangerous).

The feeling of helplessness, as a result of living with a continual degree of danger in a technological world, has led to the wish for a comprehensible, harmonious environment, and this includes the body. This wish, then, leads directly to an idealization of the relationship that existed between humankind and nature in earlier ages as the present and future reality offer no chance for the fulfilment of this life wish. This tendency of orientation to the past could first be seen in a renewed interest in American Indian mythologies, in Eastern natural and religious healing, and so on. Going hand in hand with it is a search for a natural life orientation (e.g. homoeopathy, plants and herbs for healing, aromatherapy, relaxation through deep-breathing, natural foods, fasting, etc.). This trend involves psychological experiencing and a need for clarity, objectivity and a restriction to essentials albeit in a stylish form. The wish to live in harmony with the world and the universe – as many believe that humankind used to – already is becoming an important message in advertising. Fernet Branca (Italian herb liqueurs and bitters) and Louis Vuitton (handbags and luggage) were the first to incorporate this 'mystification' and idealization of the earth, of landscape and nature in their advertising.

Finally, in the cosmetic and perfume areas we can also see the first indications of interest in this new trend: natural cosmetics, earth colours in make-up, the depiction of nature in the advertising for 'Etruscan' by Aramis and the appearance of a perfume with a natural, aromatherapy image by Avon. Earth, plant and fresco colours are always used in the packaging of these products, while the idealized and sensual aspects of the trend are emphasized by pastel tones. It is not merely by chance that fashion has tended strongly towards the 'proud natural life', as demonstrated perhaps by the film *Out of Africa*.

11

Perfume, people, perceptions and products

J. BYRNE-QUINN

11.1 INTRODUCTION

Over the years of creating, developing and selling fragrances a perfumery house necessarily amasses information on perfume and its effect on the way consumers perceive and accept a product or a brand. In the day-to-day use of this information we are rarely concerned with the academic 'hows' and 'whys'; we need to take practical action and this can involve establishing principles of the psychology of fragrance.

I have been reviewing the data we in Quest International have accumulated, with the theme of the psychology of perfume in mind. Obviously the studies we have conducted arise from the commercial needs that we have and were not designed in a rigorous academic mould; nevertheless, they provide some extremely interesting pointers for our topic.

11.2 SMELL MARKS PEOPLE

My first conclusion was that *smell marks people*, and people recognize that it does. That is not to say that they are willing to talk about it at the drop of a hat, but once the social situation is seen as permitting such discussion, some very frank statements are made. In a Japanese study, for example, a woman talked about the smell of her mother; another spoke of the smell of her mother's hands: 'I remember the warm wistful fragrances of my childhood like the smell of my mother's hands after she had cut the children's hair. These were not the fragrances of perfumes or cosmetics, just the fragrances of day-to-day life.' Yet another, referring to incense, stated that it reminded her of her grandmother, and contrasted this with the remembered body odour smell of others.

In an American survey we asked nearly 800 women which two of a number of

personal attributes they noticed about people on first meeting. To our surprise, 43 per cent indicated 'smell'; slightly more indicated 'face', 'eyes' and 'voice', but fewer talked of 'hair', 'dress', 'skin' and 'hands'. So it is hardly surprising that motivational research reveals that women are very concerned with the messages they send out about themselves when they use perfume. This data comes from a series of group discussions and in-depth interviews held in four different countries, concerning perfume and fragrances in cosmetics and toiletries; the countries were the USA, the UK, France and Germany. From the material we were able to draw up a structure of the way women use fragrance.

The results showed that the use of perfumes evoke a clearly hedonistic response, 'I like it'; in fact it is very difficult, in direct questions, to get women to say very much more about the perfume they wear other than this. It is also apparent that women treat perfume as an aesthetic experience; however, they are not quite so free in discussing the sensual excitement they experience from it. This excitement appears to be at least as strong an anticipatory factor as the actual sensual experience. The ritual of 'getting ready', whether for an evening out or in bed, is important.

I feel that these sensations arise directly from the perfume stimulus. However, it is also clear that perfume is used as a means to an end. Perfumes convey messages that give the user confidence in obtaining a certain level of basic gratifications. Such gratification may be social or biological-psychological; this point has also been raised by Mensing in Chapter 10.

In a social setting a woman may be setting out to reinforce her position in her reference group; she may be seeking maintenance of her position among peers; or she may be striving for acceptance in a group she aspires to. We find perfume being used to give the wearer confidence that the desired sexual gratification will be attained. This is rather different from the excitement reached in the direct response to the perfume, it comes closer to and intermingles with the anticipation of excitement. The direct response is concerned with the effect on the wearer. But the effect being striven for in the perfume 'message' is the effect of the wearer of the perfume on someone else – this is something that is widely promoted by advertising.

Another key concept is the establishment of individuality and supremacy and, finally, the concept of oneself, both actual and aspirational. The kinds of message which give women confidence are varied and concern aspects such as: good taste; wealth; status acceptance; display; success; and identification. Choosing a fragrance is therefore very much to do with what is socially acceptable. Both the pricing and advertising position of personal fragrance products are used by consumers to learn about the messages such products convey. Some companies have become particularly successful by focusing their distribution, sales, advertising and public relations (PR) activity on 'natural' social groups and capitalizing on the consensus experience of the

messages promoted by the fragrances. However, this awareness of 'smell marking people' extends to clothes and to homes. In Japan we found recognition of personal odours on clean clothes. As one woman said, 'Even though I wash summer clothes and the like before I store them away, they still smell and the colours change. The smell seems to be like that 'personal odour' everyone has, so before people wear the clothes, I'll wash them again.' Two quotes from qualitative work in the UK illustrates the extension of personal odour to rooms: 'The bedroom smells stale when you have just got up in the morning when the bed clothes fall back and everyone's perspired' and 'I don't like the smell of bodies which I have smelt in bedrooms'. Thus it is not surprising that the smell of products used to clean, store and enhance clothes and houses can be critical. In fact 'smell marks brands' too.

11.3 SMELL MARKS BRANDS

In a survey carried out in Brazil we found that people noticed smell in the most ordinary products, and placed some importance on these smells. Interestingly, men were almost as good as women in noticing the smell cues. When we asked American women about the smell in toilet soaps, the majority claimed that not only did the brands smell differently, but they could be put off buying brands by the smell. In the USA smell also featured highly across a range of toiletry products when women were asked what was important in purchasing their brand. This was found over and above the actual function of the product.

Table 11.1 Responses of toilet soap and detergent bar users to the smell of the product they use

	Toilet soap users (%)	*Non-soap detergent bar users (%)*
'Each brand has its own particular smell'	85	88
'You can tell from the smell, it's right for you'	90	82
'The smell of some brands puts me off completely'	56	64

Similarly, when we asked 700 toilet soap users in the Far East, and a further 700 users of detergent bars, about the products they use, it became abundantly clear that the smell of the brand was important (Table 11.1). When we asked them which of a list of factors was important to their choice of brand, over and above actual function, smell featured highly. The effect was stronger than in our USA survey, and in fact smell was ranked above texture and price.

11.4 PEOPLE DO DIFFER

In the way that they use their sense of smell, people differ. Some enjoy it, some deny it and others are unsure about it. So, for example, in a study of American women's attitudes towards perfumes and fragrances we found four basic types, each with recognizable personalities and attitudes towards perfumes and fragrances. They form four archetypes whom we named Ellen, Anne, Diane and Betty. Each one represents an extreme reaction to perfume in terms of liking it or not liking it, and in terms of her discernment. Do these archetypes feel that fragrance tells something about a product? Remember, these personality types are of course a synthesis of 800 women's opinions.

Ellen

She is relaxed and almost absent-minded about life. Ellen does not notice fragrance in her personal products or feel concerned about it one way or the other. A tomboy in her youth, Ellen is confident and affectionate. She has had a good education, and together with her husband enjoys an affluent life-style in the Mid West. Ellen does not go out of her way to avoid perfumed products, but she does not need them to 'boost' her spirits or enhance her personality.

Anne

She is not very happy with life. Anne tends to feel trapped and insecure about herself and her ideas. Her income and education are below average. She is from the South. Typically, Annes are under 25 or over 50, the 'ages of anxiety'. Anne is highly conscious of the appearance of others and of being feminine in the traditional sense. Therefore, she has a high discernment of smell and a liking for highly perfumed products and fragrances that last. Perfume and fragrance brighten Anne's day.

Diane

She is a real 'no-nonsense' girl. Middle-aged, Diane lives with her husband in the East where they enjoy an average income. Confident of herself and impatient with artificialities, Diane is highly conscious of perfume in toiletry products, but tends to choose unperfumed products or those with a light natural scent.

Betty

She is less conscious of scent, but nevertheless welcomes it in her personal

products as long as it is not too overt. Middle-aged, Betty shares a comfortable standard of living with her husband. She may supplement her income with a part-time job. All-in-all, Betty holds to the general opinions of 'middle America' but remains 'her own woman' and is generally carefree in her dealings, although she lacks a total self-assurance. Fragrance for Betty, who most closely reflects the feelings of the majority of American women, is a pleasant, spicy addition to life.

Now if we turn from toiletry products to products used to clean and fragrance the home, again we find that people differ in their responses. In a study of 1800 women in the USA, UK and Germany we found six basic attitudes towards fragrance in the home. All respondents were given twenty-eight attitude statements from which they selected those that they agreed with. These statements covered attitudes to the family, cleanliness, hygiene, tidiness, smell and creativity and were derived from our earlier qualitative studies. A cluster analysis was carried out to group the women according to their attitudinal characteristics; and using the data from all three countries, six types of women were identified. Two groups predominated in the UK, and three others were most common in Germany. In America there was an even wider spread of attitudinal types. It should be remembered, when referring to these attitudinal groupings, that although members of any particular cluster tend to hold similar views, some will be more typical of the way the cluster can be described (i.e. nearer its centre) than others. Further, it should be remembered that the types are characterizations of women, with similar attitudes about their families, their homes, cleanliness and smell – they do not exist as individuals, but as consumer types.

Helen

She is very enthusiastic about household chores and about household products and their smells. It is important to Helen that her house is neat and tidy at all times; the opinion of visitors is important and they must not find her house in a mess. Fragrance has an important role in Helen's home. She likes to notice a nice smell when she enters a room, and believes airfresheners can provide this atmosphere. Helen is over 45, married with teenage children, and is somewhat 'downmarket'. As a type she is most likely to be British, although she is also found in the USA. As might be expected from her attitude, Helen uses more cleaning products than average and she uses them more often. In particular, she uses a lot of disinfectant, bleach, airfreshener and spray polish.

Diana

She is in her late thirties, married but with no children. Typically, Diana

works full time and has very little interest in household chores and products. She is not looking for any type of fragrance input from her products and is neither in favour of airfresheners nor against them. Diana, in contrast to Helen, uses less products than average and is less likely to use airfresheners, disinfectants or bleach. The group she represents is the least aware of product fragrances. Diana is a frequent attitudinal type found in Germany and the USA, but is less commonly found in the UK.

Annette

She shares many attitudes in common with Helen. Annette wants her home to be neat and tidy at all times. Her family is very important to her. However, her attitude to smell is very different from Helen's. Annette prefers natural smells; she thinks perfume is unnecessary in household products and that any perfume present should be subtle and unobtrusive. She would rather put up with the natural odours in her home, such as cooking smells, than camouflage them with airfresheners. Annette is in her thirties with young children; she is more 'up-market' than Helen and is more likely to be German or American than British.

Alison

She has a similar attitude towards fragrance as Annette's but her views on household chores are very different. Alison has more important things to do than housework and is not worried about hygiene or dirt hidden in corners. Alison considers that the only way to make her house smell fresh and natural is to open the windows. And her affluence allows her to live in an area where this is possible and desirable. Her dislike of artificial smells means Alison is not likely to use airfresheners, and, in her mind, an acceptable alternative is candles. When asked what scents she found acceptable in airfresheners, Alison cited only subtle and natural ones, not sweet or floral scents. Alison is a member of the group which considers product-smell least important. Alison is 'up-market', under 35, with young children. This attitude type is the smallest of the six groups and is predominantly found in the USA.

Karin

She is typified by her concern for an immaculate home. Karin is the least likely to say that she has more important things to do than clean the house. Despite her fastidiousness and concern with her home's appearance, Karin expresses little interest in the smell of cleaning products. With the exception of airfresheners, Karin uses with great frequency most of the products in the survey. She is most likely to agree that guests might think she is covering up

something if she uses an airfreshener; she believes that because her home is always spotless, she has no need for airfresheners. Karin, at 55 to 64, is the oldest of our women, she is also least likely to have children under 16 and represents the third biggest group in Germany, but is less significant in the US and UK markets.

Marion

She is about the same age as Alison (25–30) and is likely to have very young children. Marion tends to be 'down-market', and almost exclusively British. She is in fact the largest attitudinal group in the UK. Her family is the central factor in Marion's behaviour. She is concerned with hygiene, but not with tidiness, because she doesn't want to nag her family all the time to keep the house tidy. Marion's attitude to fragrance is very positive. She particularly enjoys the smell of polish in a room. She uses more products than average including bleach, disinfectant and cream scourers as well as such fragrant products as spray polish and aerosols scented with floral perfumes. The idea of matching aerosol and solid airfresheners have particular appeal for Marion.

11.5 PERCEPTION DIFFERENCES

Perception differs according to the context in which perfumes and fragrances are experienced. We carried out a study in the Far East among a sample of 1500 women in four large urban areas. All were aged between 16 and 50 and we got them to assess odours, simply as odours. We used a non-odiferous plastic rod as a substrate for the odour; this had the advantages of precise dosage and longevity and was easy to handle. We then divided the sample in half and asked one half to test the odours in toilet soaps in their own homes in the way that they would normally use them; the other half tested the

Table 11.2 Odour characteristics associated with code names

Code name	*Description*
T.72	Woody floral
U.67	Spicy oriental
Q.64	Tabac
Y.14	Floral lavender
W.58	Pine needle
J.49	Wintergreen
E.35	Citronella

odours in detergent bars. However, to ensure that the data was pertinent to their needs we made certain that the people testing the toilet soaps were users of the main brands of toilet soaps, and with the bars of detergent that they were women who actually did the washing themselves; we also spent a considerable amount of time ensuring that the resulting odours were comparable when placed in the two different products.

First of all, we examined the odours *per se*, and looked at how much the women liked them and for what products they were thought suitable. For ease of assimilating the data, I have put these into point vector maps. In Fig. 11.1, based on toilet soap users' assessment, it is clear that they differentiate the product fields into personal and household areas, and within these two areas I have placed the perfumes which as odours *per se* they claimed that they liked. These are T72, U67, Q64 and Y14, falling in this order in the area of the personal products. Three perfumes were not liked. However, W58 is seen as acceptable for shampoo, while J49 has been pushed away from both areas; and E35 was perceived as being suitable for certain products in the

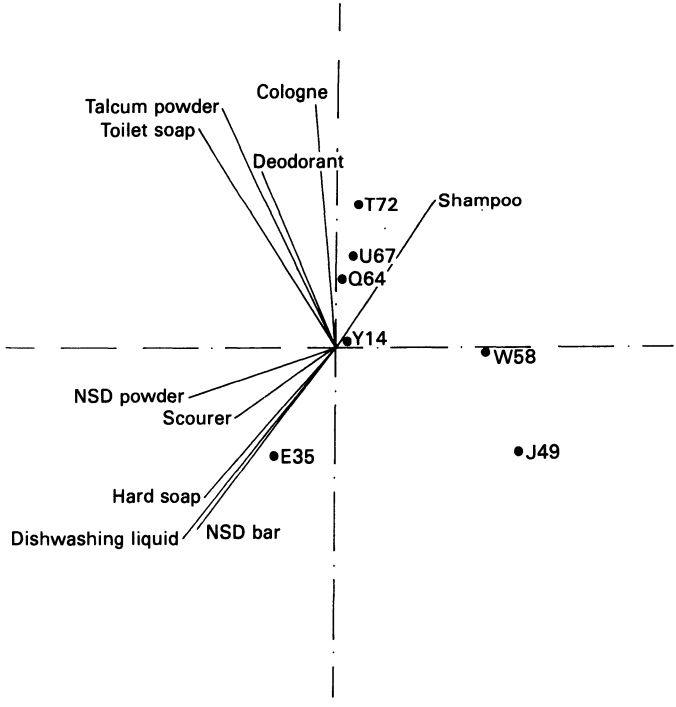

Fig. 11.1 Vector map showing toilet soap users' assessment of the odours T.72, U.67, Q.64, Y.14, W.58, E.35 and J.49. The last three odours are perceived as non-personal cosmetic smells, although W.58 is acceptable for a shampoo (cf., Fig. 11.2).

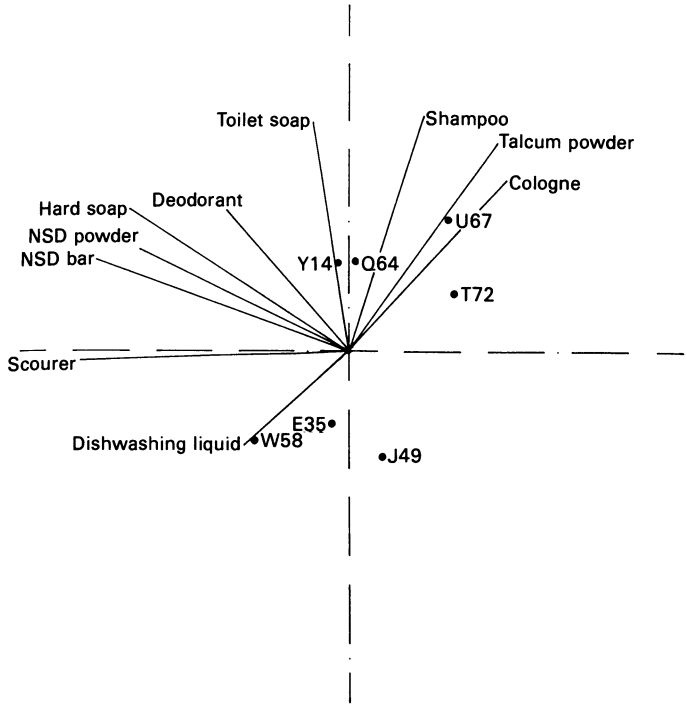

Fig. 11.2 Vector map showing detergent bar users' assessment of the odours T.72, U.67, Q.64, Y.14, W.58, E.35 and J.49. Overall the assessment shows that the last three odours are not perceived as personal cosmetic smells. (cf., Fig. 11.1).

household cleaning area. The odour characteristics of these odours are shown in Table 11.2.

In analysing the results of the detergent bar users (Fig. 11.2) we must remember that we are identifying a culture where there is extensive use of servants, and that we are dealing with a sample who actually do their own clothes washing and are used to using detergent bars to do so. They have a smoother perception of the change from personal products to household ones. Only dishwashing liquid does not fit, probably because these subjects are unlikely to be using such a product. This sample too claimed to like the same odours but there is a somewhat different view of the products for which they are thought suitable; U67 is perceived by this sample to be more suited to the cosmetic products, and W58 is no longer thought to be suitable for shampoos, but it is thought to be suitable for a scourer or even a detergent bar.

Thus people in themselves differ in the way they actually perceive the odours. Now let us look at what happens when we put them into a real context in terms of toilet soaps and detergents. The two groups differ in their

responses. Among the toilet soaps used there were three different ways in which one could actually achieve a good toilet soap by use of the perfumes. First, through its being naturally fresh; secondly, through its being fragrantly cool; and thirdly, because it is creamily feminine. The perfume Y14 is perceived as naturally fresh and T72 and Q64 are seen as fragrantly cool, while U67 does not appear anywhere in the running. Here there are a large number of new perfumes, perceived as being suitable for toilet soap. However, if we turn to the detergent bars, again we have three different ways of approaching them through perfumes: the cosmetic, the functional and flowery-feminine approaches. Again, we find different perfumes highlighting different aspects of the product, with T72 and Q64 once more together and this time conveying flowery-feminine; Y14 and U67 fail to come up as being the sort of odours which people find good in a detergent bar. However, some of the more disliked perfumes are seen as delivering functional characteristics. This shows that judgements about products can be affected by smell. Moreover, the context in which people actually use those products can alter the judgements; and further, these judgements may be different for different types of user. So what is happening?

11.6 DIFFICULTY OF EXPLAINING RESPONSES TO PERFUME

When one asks consumers about perfume, the replies are usually found to be in terms of 'It was nice, pleasant', 'It was clean, fresh' or 'It wasn't sickly'. These responses are difficult for perfumers to interpret. Trying to use this type of data to create and develop perfumes requires almost a dictionary-type operation. There appears to be a limited vocabulary that people use about perfume. This is true everywhere in the world, although in some languages there are more words that can be used than others. On the whole however, one gets only so far in terms of a straightforward description. There is, then, a need to push people further, so that they begin to associate the odours with products or things in nature, with occasions, people, and so on. For example: '. . . that reminds me of a talcum powder', '. . . that reminds me of cut grass' or '. . . that reminds me of my mother'. Certainly odours do evoke very sharp memories. In the Japanese study we conducted someone said: 'When I was young, I lived in one of the major green tea producing areas of Japan, so whenever I smell fresh green tea it brings back memories of my old home.' For someone else it was the smell of mould and mildew: 'It brings back memories of sleeping under a mosquito-net in the summer when I was little'; or the smell of fresh young grass: 'It reminds me of going out into a field of lotus flowers when I was young, spreading out a mat and eating a boxed lunch' or to another: 'A whiff of the scent of buds and mustard flowers borne on the breeze seems like the smell of spring.'

We have tried to use this evocative resource in a more disciplined form. Working on perfumes for fabric conditioners, we conducted some synectic-type groups among our own experts and consumers and developed a rather unusual questionnaire. This was piloted and tested in three locations. One hundred fabric conditioner users were recruited. We exposed them to a brief training session, so that they were able to answer – fairly happily – the questionnaire. We then asked them to smell eight fabric conditioners. They were of course the same fabric conditioners but with different perfumes, and we asked them about what kinds of fabric conditioners they would like manufacturers to produce. These are the types of question we asked:

1. Where was the fragrance born?
2. What types of clothing would this fabric conditioner be most likely to wear?
3. What activities or interest would it have?
4. What are the best personality aspects?
5. What are the worst personality aspects?

The resulting data gave us some strikingly different responses evoked by the fragrances. I was left to speculate on what might lie behind the ways in which perfume and odour work. Do people react to odours *per se*, or because odours signal some other factor?

11.7 CONCLUSION

I believe that the data we have suggest that people use smell much more frequently than is normally supposed; moreover, that people use odours as signals, whose precision probably relies on the odours having accompanied satisfaction of needs in the past. It may be that some odours act directly (this possibility is discussed by Dodd in Chapter 2); however, over time association of odours with events builds larger and more complex patterns. Thus the differing experiences of people from different social, cultural, economic and geographical backgrounds results in differing patterns of association. This accounts for the fact that people differ in their perception of an odour, a point which has been discussed by Engen in Chapter 4. Furthermore, the recall of those experiences can be more or less vivid – it is likely that a person's specific mental set will trigger off the associations and expectations closest to it. This may help us to explain the differing perceptions of odour messages within different contexts. If certain odours do act directly and can be identified, and used creatively within the pattern of associations, then a very powerful tool will be available for practical perfumery.

Finally, let me leave you with two quotations – from the UK and Japan

respectively – to ponder whether the attitudes revealed are examples of a direct response to an odour or to its associations:

This baby smell gives the feeling of a clean, sweet place and I like it.

Whenever my husband practices Zen meditation at home, he burns Indian sandalwood. My son says that [the fragrance] has an emotionally calming effect.

12

Selling perfume: a technique or an art?

S. LE NORCY

12.1 INTRODUCTION

This chapter describes the problems we face in training people to sell perfume. It will offer a number of subjects for reflection, covering the psychological implications of creating an active mode of communication between seller and buyer. Other chapters in this book deal with the psychology of the fundamentals of the sense of smell.

Selling a perfume involves a subtle interaction between the consumer and the representative of the producer company. It has never been the case, nor is it likely to be so in the future, that fine perfume is sold on a self-service basis. The success of the seller–buyer interaction depends heavily on the quality of the training given to sellers. My task at Nina Ricci is to understand the psychology of this transaction and to apply this understanding in training programmes for our representatives around the world.

Above all else, there is a simple fact: it is of crucial importance to motivate the sellers and make their job interesting. We can hardly expect bored and passive salespersons to communicate effectively the vitality and spirit surrounding our fragrances, so the major key to success in this area is adequate training.

I believe that a historical approach to the problem can help us understand some of the subtleties. History tells us that the motivations in the different strata of society for using, buying or wearing perfume have changed over the centuries. Yet the primary forces remain constant; they are money, power or seduction. Something of this is seen in Chapter 1, where Stoddart argues that incense was not only a peace offering to the gods, designed to please them so that they would not unleash their destructive powers (thunder, lightning, etc.), but that probably it was also intended as a tool of seduction.

It is recorded that Rameses III in ancient Egypt burnt 3 million blocks of

incense (they must have been small blocks, I cannot imagine a giant pyramid of incense burning up to the sky), and we should ask ourselves why he did this. Was it because he had sinned greatly as a king and so had much forgiveness to crave or was it, more likely, that since he was so prodigiously rich, he wished to demonstrate the extent of his wealth by publicly burning part of it? We should, of course, recollect the huge value of incense in past times. Because of its rarity, it was more valuable than gold or any kind of money. Remember the precious gifts which the Magi brought to the infant Jesus. They carried the costliest perfumes of the East – frankincense and myrrh. We find here, as nowadays, perfume as an expression of money and power.

As to perfume as a symbol of seduction, we have all heard of Cleopatra. As she set sail one day to meet Antony, to make sure of charming him she perfumed the sails of her ships, and legend has it that even the winds fell in love with the delightful Queen of Egypt and brought her safely and rapidly to the encounter. Clearly this ancient civilization must have perfected to a fine art the use of perfume as an instrument of seduction.

In Renaissance times it is as if the previous perception of perfume, as a way to power and seductiveness, had been forgotten. Perfume was then used chiefly for masking unpleasant odours. Intriguingly, we find that in France the glove-makers were the first guild to obtain exclusive rights to manufacture perfume. The answer is that they had been looking for a long time for some way of hiding the unpleasant smell of the products they used in the treatment of leather. They therefore cornered the market in perfumes, which provided an effective solution to their problems; and the small town of Grasse in Southern France where they were established remains the heart of the highest quality of essential oils.

At this time, there was also the delicate question of personal hygiene. Even the Sun King, Louis XIV, in his splendid palace at Versailles had a problem in this regard. And we know that he used much eau-de-toilette to make his presence more agreeable to the court and his feminine entourage.

12.2 SELLING A PERFUME

During the seventeenth century we find that perfume, already perceived as a status symbol, starts to become an instrument of psychological influence. I can do no better here than allude to a passage from Patrick Suskind's novel, *Perfume: The Story of a Murderer*. This tells the convincing tale of a fabulous perfumer called Grenouille (The Frog), who has the peculiarity of having no personal odour. Grenouille lives only through smells and odours and becomes one of the most terrifying murderers of all time in his quest for the perfect perfume that will make others see him as handsome, charming and

incapable of evil. The book has the most wonderful description of the technique of selling perfume. Grenouille enters one of the famous perfumeries in Paris. The owner, Baldini, an ageing perfumer, stands behind the counter. He wears a silver, powdered wig, a blue and gold embroidered coat and stands stiffly to greet the customers. A cloud of frangipane, that mysterious smell of the tropical isles, envelops him and he stands quite still as if in a trance. It is only when the door-chimes ring, and the silver herons in the entrance spout violet-scented water, that he springs into life. He becomes animated, greeting the customer with many courtesies, and hopping around so nimbly that the cloud of frangipane can hardly keep up with him. He then bids the customers sit down, so that they may be regaled with the costliest perfumes. I can think of no finer description of the art of fine fragrance selling.

In Paris, in the time of our great grandparents, the 'Golden Age of Perfumery' still lived on. Our great grandmothers would consult with their perfumer. He would make, exclusively for them, a special perfume. The formula was a secret and our great grandmothers would never tell anyone what their delightful perfume was, so much was it part of their personality. This tradition of having one's personal perfumer lives on, for a few discerning customers.

Contrast the graciousness of personalized perfume-making with the retail reality of today. For the first time ever, perfume is available to everyone, regardless of their income. In many countries throughout the world women, whatever their level of education or position in society, have access to fine fragrance. Within our lifetime perfume has changed from the luxury for the few to an everyday consumer product. Indeed the market has become inundated with an immense variety of perfume (more than 800 lines coexist today). Think of the problems which the twentieth-century customer is faced with. Imagine that you are just beginning your career as a buyer of perfume and you walk, for the first time, into a big perfumery department. Imagine the confusion, the medley of conflicting smells, the babble of voices each proclaiming that their perfume is the best. We can easily imagine that the noise and confusion of the stores and the assertiveness of the sellers would be enough to make a virgin consumer turn tail and flee.

Well-informed consumers have come to hold great expectations of sellers. They expect knowledge of perfumery and they look for comfort and helpful advice on their needs. The perfumery industry has the job of training the sellers, so that they give what consumers want. This job is not as easy as many would suppose, especially where the market is invaded by an enormous quantity of lines and launches of new fragrances are constant. Many people, then, may think that there is little in selling a fragrance beyond dabbing a little perfume on the back of the wrist of the customer, who either likes the fragrance or does not. Why, they might ask, should we bother with any of

the psychological niceties treated in the other chapters of this book? However, it turns out that selling a perfume is really much more difficult than selling cosmetics or make-up. In the case of these latter products the customer is looking for such features as a matching colour or some easily perceived benefit. She will know that the product enhances the look of her skin, and she will come back with great delight to buy more. Or, it must be said, sometimes she will easily see that the cosmetic does not produce the expected result and will not purchase more. The important point here is that the consumer has obvious ways of testing the efficacy of the product.

A perfume is a more intangible, even baffling, product for consumers. Even if we were to list all the constituents on a bottle, it would help the consumer little, for here we are dealing with the world of emotions and sensations, with aesthetics. Everything that is presented to the user – the shape and colouring of the packaging, the design and form of the bottle and the precious contents – are symbols. Part of our role, and the job of the seller, is to decode these symbols and make them comprehensible.

We can be sure that master perfumers know exactly what they want to say with their fragrance. The appeal will be to the heart, to the world of sensations, to dreams and memories. Whether it be an evocation of the rustling intensity of early summer blossoms or an expression of the happy/sad moods of sun-filled woods, the fragrance itself will speak the message. A key question for us is: how we impart the perfumer's vision to the consumer? When we grasp this, we begin to understand the difficulties involved in training our sales assistants.

12.3 TRAINING A PERFUME SALES ASSISTANT

One of our Parisian saleswomen recently wrote to me as follows:

> Each sale is a unique adventure where you are alone. Although our training, our knowledge and our aptitudes are essential for success, the most precious gift we have is our open-mindedness.

I believe that she has identified one of the key factors. Open-mindedness means keeping your eyes and ears open to the message that the consumer is telling you. But there is a further problem, time. In academic studies, such as those of Mensing in Chapter 10 and the detailed market research interviews described by Byrne-Quinn in Chapter 11, there may be plenty of time both to interview and test the subject. But now think of the sales assistant's task. In our schools we tell her that to proceed correctly, one must go through various stages in succession. She has perhaps half a minute to analyse first impressions of the customer and then, on average, between three

and five minutes to talk to her, to ask questions sufficient to form an impression of her life-style, her personality, her social status and other pointers towards her choice of fragrance. Typically, in a store ten minutes would be a long time for a conversation with a customer. Is it really possible to appreciate someone's true perfume likes in these few minutes?

There is a further problem, especially in connection with expensive fragrances. The average salesperson in Europe is aged between 17 and 25 and her (for it is still predominantly 'her' at this level in the industry) vocabulary is what one would normally expect from soneone with an average school background. It is obvious that our major role in training is to act as an intermediary between the information presented at the level given in this book and that which is appropriate for the consumer and is presented through the salesperson. My training programme is made considerably easier by the several perfume genealogies which are available from companies such as Givaudan, Quest International and Haarmann & Reimer, although their classifications do not always coincide. The new results such as those presented by Mensing and the staff of Haarmann & Reimer (see Chapter 10) are also highly interesting in this respect. Nevertheless, many problems remain unresolved.

Suppose that I quizzed 100 saleswomen throughout France, Germany, Spain and the UK on the subject of a chypre perfume. You would find that only two or three of the girls understand this basic term clearly enough to explain it. This situation persists despite our best attempts to inform them. Why is this? One reason is that we are expecting the saleswomen to memorize quite abstract definitions. The situation does not improve if we try to explain to them that this type of perfume will contain oakmoss, patchouli and ambergris among other oils. Such dry technicalities only give rise to even further difficulties. They probably have a hazy idea of what a gardenia smells like, and though they know that good perfumes will contain jasmine and rose, they possibly have never seen a jasmine flower. Thankfully, they will all know and recognize the rose notes.

If we start an ambitious training programme and give the girls a basic notion of perfumery composition, they will remember a maximum of only 20 per cent of the information we supply. Also there is the impracticability of retraining all staff constantly. For example, in the past decade I have given training courses to over 10 000 girls in many countries of the world. Despite trying various combinations of the several perfumery schools that have been tested, we know that the saleswomen can remember very little of what we teach them. In fact we continually run into basic difficulties in the training courses, problems which should really have been solved by the perfume industry long before now. Vocabulary is an example. Take an innocuous term such as 'floral'. You will find that in the UK about 50 per cent of the public will perceive this term as a negative attribute. A typical customer in

this country, if told that a particular perfume is a floral perfume, will often protest that they 'do not like sweet perfumes'. So what does the poor saleswoman do when confronted with such dilemmas as floral = sweet = negative/derogatory response. In both the UK and USA there are additional problems with such adjectives as 'floral'. Pictures of 'little old ladies' in tea-rooms, who buy floral sachets to perfume their chests-of-drawers will tend to be evoked. The adjective 'floral' is considered old-fashioned and inelegant. My saleswomen often ask me: 'How can we describe floral perfumes without mentioning the word "floral"?' The answer is of course that we cannot do this at the moment without learning a whole new vocabulary. This is just one example of the many aspects of the training programme which require further research into the psychology of perfumery.

We invent mnemonic devices to help the saleswomen. For example, the French word for client, i.e. CLIENTE. Here 'C' stands for *convenience*, i.e. is the customer buying the perfume for a trip abroad or will she use it in her car or on the beach?; 'L' stands for *luxury*, that is easy to understand; 'I' stands for *imitation*, this alerts her to the fact that the customer might be choosing the perfume in order to be as chic or elegant as her best friend; 'E' stands for *economy*, and notwithstanding the luxurious nature of the product, the customer also looks for value for money and is increasingly interested in special offers or in a gift with the purchase; 'N' is for *novelty*, this reminds the assistant that some customers crave novelty and may search ceaselessly for a perfume which they feel will render them fashionable; 'T' is for *tranquillity*, which explores the opposite domain, and it refers to perfumes which will without exciting the customer perhaps comfort and give a feeling of security; and finally, there is the letter 'E' for *efficiency*, this prompts the assistant to check that the perfume will actually suit the skin and, even further, match the customer's personality.

Even with these aids, the problems are not solved. If the sales assistant works exclusively for the House of Nina Ricci, she will have over forty women's items or references at her disposal. If she has a wider brief, she may have over 200 items to sell. So what should she do? Should she spend the tiny amount of time available trying to assess the needs of the customer or must she, as is often done by less well-trained girls, simply give up, select at random three perfumes she thinks might sell (or which might give her a good commission) and try her luck?

Selling perfume also means proposing a concept – and the importance of packaging has been known for a long time. In the context of the sale, the packaging can serve to confuse rather than simplify the issues. In 1986 an important experiment on packaging was carried out in France. In part of this experiment the American perfume, 'Oscar de la Renta', not on the French market at the time, was used. The customers were asked to judge the perfume when it was presented first in the original 'Oscar de la Renta' bottle.

Then they tried it in a very modern type of bottle, made of black plastic shaped like a stone. Finally, the perfume was presented in a classical, diamond-crystal cut bottle. The labels were of course taken off the original bottles. Adequate time to overcome the effects of olfactory saturation was given. The results of the experiment were striking. Not one of the forty people tested realized that all three bottles contained the same perfume.

Even if we know that the test was sponsored by a bottle manufacturer who presumably wanted to emphasize the importance of the container, nevertheless the fact that this assertive perfume appeared to be different when smelt in association with each of the bottles, testifies to the point that, at least in some cases, the colour and form of the presentation may influence the sale more than the smell of the perfume. With these results in mind, how do I instruct my saleswomen? Nowadays, in contrast to the former aloofness, we let the customer handle both the bottle and packaging, for we realize that they also 'speak' to the customer.

12.4 THE CUSTOMER'S ATTITUDE

The international dimension of the industry has also brought to light new aspects of the training of salespersons. In Italy, for example, smelling 'nice' is part of the way of life. Italian women attach importance to appearance, to an image of quality, and have a liking for brand names evoking France. Consequently, selling a Nina Ricci perfume should be relatively easy in Italy, yet it often sounds too Italian. An interesting contrast is Spain. An important factor for the Spanish market is that the Women's movement has come much later than in the USA and Northern European countries. In recent years the sophisticated young Spanish woman has had a wish to break free from the traditional, heady, floral perfumes synonymous with well-behaved, discreetly elegant and pampered housewives. They have shown a preference for frankly masculine, herbal-woody fragrances, which betokened a liberation from the traditional stay-at-home female values. Our training has to take account of such national cultural idiosyncrasies. To give another example, in Germany it is quite impossible to use the perfumery adjective 'animal' (*tierisch*). In this culture anything linked to animals is perceived as unclean or dirty or primitive or even a breach of ecological behaviour. So when dealing with the popular 'musk' perfumes, one must be cautious. Even though it is well known that the natural musk is an animal ingredient, it is better to avoid reference to this aspect of the phenomenon when one is selling a perfume in Germany. However, at the same time, the 'hippy' population made a success of musk perfumes.

Japan has its own special rules with regard to the retailing of perfume, rules which reflect its cultural values. This is a culture in which the

individual takes care not to draw undue attention to himself or herself by way of dress or smell. One is encouraged to be discreet, to veil the deeper parts of the personality and to retain a certain mystery about the way one presents oneself to the world. So we can expect that strong, definitive perfumes which make an unmistakable statement about the wearer will not be popular. My sources tell me that although we sell millions of bottles of perfume in Japan, the perfume is seldom worn. Most of the bottles are bought as gifts and are exhibited in the home and shown to friends. But they are rarely used for their primary purpose. Here, obviously, sales techniques will insist on the art of the presentation rather than the fragrance itself.

The Japanese attitude towards perfume contrasts with what is found in Saudi Arabia. In this country one's power and riches are exhibited by buying prodigious quantities of extremely expensive and strong perfumes. We would not dream of trying to sell a light body splash or a fresh eau-de-toilette in this part of the world.

In South America and in parts of the USA we find yet more problems, where a puritanical and chauvinistic attitude towards perfume is found. Women may be perceived as potentially evil and dangerous, hence heavy and heady perfumes, associated with women, are regarded as sinful, yet at the same time, coveted and bought by thousands for the reason that being 'sinful' makes them dangerously attractive.

One of the latest cultural developments which adds to our difficulties in preparing salespersons to evaluate customers' preferences and sell perfume is the 'Yuppy' phenomenon in the USA and UK, which is spreading further to many countries. In France they are called 'Nappies' (for Neuilly, Auteuil and Passy, three exclusive districts of Paris where having an address is a must). These ambitious, intelligent and responsible high-achievers are determined to succeed with all of the forces at their disposal. Fragrance is one of these forces.

The international dimension, then, adds a degree of variety and complexity to training programmes. We must allow for the special needs of the individual countries. Yet we do our best to incorporate the distinctive message about perfume in general, and our brands in particular, so that the image of a perfume house and its products is maintained as clear, bright and recognizable.

Part of our difficulty of communicating is because we are 'selling dreams'. Just think of the dream evoked by the advertisements for 'L'Air du Temps', a well-known Nina Ricci perfume! Through the pictures of David Hamilton, you have a romantic, dream-like woman. One shows a ballerina, another a veiled, virginal beauty floating by the sea. The doves ensure an impression of purity and yellow hues, symbolizing the sun, provide the proper warmth. In these images we have love and wisdom, movement, intensity, high spirits and a multitude of impressions for our perfume. Symbolism and the arts succeed where our impoverished olfactory vocabulary fails. Our efforts in

providing efficient training for our saleswomen all centre on the problem of language. How should we teach them to evoke the warmth and sensuality shown so eloquently in the mute paintings? How should we give a message which is clear and easy to memorize?

On a more practical note, there are other problems. How do we explain to consumers that in perfumery the relationship between price and quality is not always clear? How can we train saleswomen to deal adequately with the multitudinous daily questions ranging from why we do not put more fixatives in the perfume to make it last longer to why we do not increase the concentration of the perfume, so that it will give a stronger smell? Salespersons have to cope with a daily round of technical questions which require the detailed knowledge of a perfumery technologist.

12.5 CONCLUSION

Much of the information in the other chapters of this book may give us some insight into new ways of training. Above all else, we realize that very little attention has been given by the perfume industry to the fundamental problem of the psychology of perfumery. The industry spends a great deal of money on discovering new fragrance chemicals and on market research but almost none on basic research of the kind described here. And yet we must find new ways of maintaining consumers' interest in perfumes. Annette Green warns us (see Chapter 13) of the danger of diluting the 'image' of the perfume by giving 'gifts with purchase'. We should let perfumes speak for themselves. Our job is to train the saleswoman to interpret the language of the perfume for the customer, so passing on the enthusiasm and passion of the perfume creator.

For the first time ever a perfumery conference has been held at a university in the UK. This serves as a timely reminder of the importance of fragrance education; our industry must work hard to communicate with the consumer, through simple messages and perfumes that remain true works of art in their creative spirit. It is also interesting to note that the University of Warwick has pioneered perfumery courses for the public; the classes include simple practical work and give a basic understanding of the subject. These courses have been taken by some perfume salespersons, who report that they have greatly increased their knowledge of the subject. The time available in these courses exceeds that in most basic training courses for saleswomen; it is an experiment that has certainly proved successful.

So we end with many questions and few answers. But we have some clues. We must persuade perfumers and psychologists to come to our rescue and help to give our consumers the necessary 'critical' understanding of the product. If it is the mark of a cultured person to be knowledgeable about

those arts associated with some of their senses – food, sculpture, music – why should the sense of smell be an exception? We must encourage fragrance education, even at an early age when our curiosity and our senses are not yet dimmed by habit or spoiled by overexposure. Maybe the secret of selling more and better in this field lies simply in a re-learning of the lost art of touching, feeling, listening and smelling with the open-mindedness and enthusiasm of children?

13

Fragrance education and the psychology of smell

A. GREEN

13.1 INTRODUCTION

All around the world there is a growing awareness of the importance of fragrance. Odour signals help our feelings of well-being and assist both our ability to judge others and also help others to judge us. The physical fitness revolution of today has helped women and men to recognize, for the first time in modern history, the potential of all their senses. To those of us concerned with perfumes, it is exciting that the most surprising revelations of this recognition process are olfactory phenomena.

My role in perfumery has been largely that of an educator. I have been fortunate in being Executive Director of the Fragrance Foundation for the past twenty-five years. I have thus been enabled to dedicate the work of the Foundation to providing an ever increasing awareness and appreciation of the role of fragrance and the role of the sense of smell in each of our lives. More recently, as one of the founders and Vice-President of the Fragrance Research Fund, I have been able to encourage the perfumery industry to support research on the underfunded topic of the sense of smell – the foundation sense of this prestigious industry.

13.2 THE FRAGRANCE FOUNDATION

The Fragrance Foundation was born in America in the late 1940s. At this time, there was little interest in fragrance except as a status symbol. There were in fact few perfumes available and, in any case, these precious products usually sat in unused splendour on dressing-tables. Scent was considered a luxury to be saved for special occasions.

In those days the goal of the Fragrance Foundation was simply to educate the consumer to wear fragrance. When I became Director of the Foundation

in the early 1960s, it was a floundering organization without a sense of purpose or direction. I soon realized that it was not simply the consumer who needed fragrance education. The perfumery industry needed it too. At this period many of the famous fragrance houses were being absorbed into large pharmaceutical companies and these organizations had little or no knowledge of the highly unusual appeal of fragrance products.

Unlike almost any other kind of product on the market, the appeal of fragrance is predominantly psychological. Over and over again, I have been asked: 'why do people feel so strongly about fragrances?' This is an understandable question and it raises some interesting points. Fragrance does not make anyone younger, or richer or thinner, but the need for a fragrant stimulus persists.

13.3 FRAGRANCE EDUCATION

I began to direct the attention of the Foundation towards the analysis of this need. I created seminars for the industry which brought together psychologists, sociologists and a spectrum of authorities from diverse fields related to the fragrance industry. The experts gradually led me to a clear conclusion: fragrance is an experience which is an outgrowth of life-style trends, of fashion, of the world of entertainment, and of social and cultural pressures. A fragrance has never existed in a vacuum, as it were. I have always been convinced that if it is to attract the attention of the consuming public, a fragrance must either be a reflection of its time or have the ability to recapture with fidelity the imagery of another memorable period. The recent work on the development of smell preferences, discussed by Engen in Chapter 4, provides some support for my views.

In the following years we have published basic information on fragrances for a variety of people – the industry, the retailers, salespeople, students, researchers and of course the consumer. Everything we have produced has been designed to provide greater understanding of the reasons why fragrance is a necessity which can influence how we feel about ourselves; how we feel about others; and of course how they respond to us.

The psychological appeal of odours has long been a tool of the fragrance industry. A perusal of the perfume advertisements of the past fifty years shows that they 'talk' both visually and verbally to the psyche, the inner self, and offer fulfilment of almost every fantasy which man or woman has ever conceived. The industry has depended on the effectiveness of alluring slogans, provocative imagery, tactile packaging and scintillating perfume names. But always of course there is the fragrance creation to fulfil the promise. There can be no separation of these elements. The consumer only responds in the appropriate way when all the elements work together in perfect harmony to express the inexpressible. The studies of Mensing

reported in Chapter 10 support these notions.

However, in recent years there has been a dramatic increase in perfume messages. Huge numbers of fragrances have been introduced into the market-place. The result has been unhappy in several respects. The consumer has become confused by the sensory profusion, and it has become abundantly clear that the psychological techniques of the past will be effective no longer. They have had their day, and now, in this sophisticated age of instant information, fragrance messages have often become superficial and unacceptable.

We have of course seen astonishing exceptions in the past few years, but the cost of achieving international awareness has been extraordinarily high. Furthermore, in responding primarily to novelty long-lasting sensory commitments are not being made. There has been a development in the American fragrance world which has had an enormous negative impact on the perceived importance of fragrance. To attract the attention of the customer, amid the bustle of the busy, noisy stores, non-perfumery gifts, without any fragrance, have been offered to the consumer. These non-fragranced gifts create a psychological displacement/backlash and place the emotional value of the fragrance in jeopardy. This unfortunate and developing practice has unfortunate consequences for the appreciation of fine perfumes.

There is another serious problem. At one time, the fragrance salesperson had fidelity to a brand. But today he or she reflects the transitory world we live in and their long-term devotion to a particular company cannot be relied upon in many cases. These difficulties are compounded by the further difficulties in providing the necessary training of the salespersons. And even in those companies which have an active training programme little or no emphasis is given to the psychological impact of fragrances.

So, after we have educated the industry, ourselves and the transient salespersons, the next question is: 'who else should we educate?' I became convinced that we must address the consumer directly. Just as fragrances travel directly to the brain without any interpreters, the fragrance industry, with the help of the scientific world, must send new and more emotionally motivated messages directly to the men and women to whom fragrances can bring great happiness, self-confidence and heightened self-awareness.

One of the most successful functions, which the Fragrance Foundation has mounted over past years, has been the annual Fragrance Week, held each June, in New York. We assemble a group of perfumers, magazine editors, sensory specialists and perfume manufacturers, who are charged with the organization of smell educational activities. The events have a special theme and are held in all of the city's department and speciality stores. For 1987 the theme was 'A celebration of unspoken emotions' and the presentations focused attention on the psychological impact of fragrances. Each retailer featured a different emotion – passion, whimsy, love, etc., and created a series of fragrance activities to highlight the emotion.

Perhaps the most important feature of the week is an event which we call 'Test your sense of smell'. The test invites customers to sniff a variety of unmarked scent strips and then to identify each one as quickly as possible. At the end of the test, each participant is characterized as having either a 'good' or 'needs improving' nose. The Foundation has prepared educational materials for each person tested including a series of exercises which concentrate on improving and enjoying the sense of smell. These exercises are reminiscent of those used with the special smell kits developed by the Warwick Olfaction Research Group, in conjunction with both the Royal National Institute for the Blind and Avon, for the olfactory education of visually handicapped children (see Part I).

The response to the smell tests is extraordinary. People will stand in queues for over an hour, so that they can have their sense of smell tested. The idea of testing people's sense of smell occurred to me several years ago when I was travelling down Fifth Avenue in New York. When I reached 59th Street, I noticed a large crowd of people standing in line. Like everyone else in the vicinity, I was eager to find out what was happening. There was a mobile unit parked near the kerb with a sign inviting people inside to have their hearing tested. It dawned on me that if so many people were prepared to stand in line to learn more about their hearing, about which most of us know quite a bit anyhow, how much more ready they would be to know more about that more mysterious faculty, the sense of smell.

It turned out that my guess was correct. In fact so much interest was generated that we developed 'do-it-yourself' kits which can be ordered by stores and schools across the USA. I had hit the 'jackpot' with this fragrance concept. The Fragrance Week in New York has become a feature which other cities have copied. It has proved to be such a success that Fragrance Weeks have become annual events for learning about the delights and importance of fragrance and the sense of smell.

Slowly we are learning about how to communicate the pleasures of perfume. I believe that the society of the future will be a sensory-directed one. The inner, personal rewards of the mind and body will have priority. This will be especially important as we strive to humanize what will surely be a super-technological environment. The arts – and I consider perfume creation one of the fine arts – will become a focal point of our lives. This focusing will help us to find a meaningful place for ourselves in what appears to be becoming an increasingly alien environment.

13.4 FUTURE DEVELOPMENTS IN THE FRAGRANCE FIELD

The role of the sensory psychologist will become crucially important in the development of fragrances. The extraordinary revelations emerging from

laboratories around the world will bring new definitions and a new sense of purpose to perfumery. Of especial interest is that the consumer's demand for scientific substantiation of the advertising claims for fragrances must and will be met. Now is the time to open up the sensory universe in which scientists so naturally move. This would allow everyone else, both those in the industry and the consumer, to benefit from their years of dedicated exploration. A note of caution is warranted. Scientists and researchers, including sensory psychologists, must not confine their work to the cloistered world of the laboratory if we are successfully to educate people to the pleasures of the sense of smell and the delights of the fragrance experience.

In 1982 the board of directors of the Fragrance Foundation took a most important innovative step. They established the Fragrance Research Fund, a charitable, tax-exempt organization and the only one of its kind in the world. The Fund is dedicated to supporting the research of olfactory scientists around the world. To date, we have provided grants to the Medical Centre at Duke University, to the Yale University School of Medicine, the John B. Pierce Foundation at Yale University, the San Diego State University Foundation, the Monell Chemical Senses Centre, the Weizman Institute of Science, Israel, and to the City University of New York.

The Fragrance Research Fund has as its main objective the function of financing the study of the sense of smell and the investigation of human reactions to odours. The Fund has a broad, multi-disciplinary approach to the research issues. Current work includes studies using anatomical and ultrastructural observations, physiological and biochemical studies, and behavioural and psychological reactions to fragrance. The Fund is establishing a Scientific Review Board and an Industry Review Board, which will work together to help the board of directors identify areas of special interest for the Fragrance Industry. And I believe the Fund's establishment of a new science which I have identified as Aromachology[sm] will open up frontiers to the study of interrelationship of psychology with the latest in fragrance technology.* The results will encourage the development of fragrances which will transmit a variety of specific positive feelings.

To accomplish these goals the Fund is embarking on a major programme which will provide grants for studies on the effects of odour on human behaviour and well-being. Proposals will be accepted from researchers in the fields of clinical, developmental, personality, social and physiological psychology. Innovative approaches that integrate olfactory perception with current issues in developmental, social psychology and related disciplines will be encouraged.

It is imperative that we must heighten the awareness of the public to the

* [sm] – service mark, belonging to the Fragrance Research Fund Ltd.

sense of smell, including the historic, contemporary and future roles of this neglected sense. We must therefore take steps to expand the awareness of fragrance and its use at every level of human activity. We can accomplish this aim by consolidating and continuing our efforts to educate the public. This educational aim will be pursued by the placement of appropriate articles in magazines, by selected TV and radio appearances, by seminars on fragrance, by printed material and also community activities. In addition, I believe that every effort should be made to encourage a symbiosis of the fragrance business with the scientific community. We must remember that in the 1990s the success of many of the new fragrance products will depend on how effectively these seemingly disparate worlds come together and act in concert. It is of interest that the organizing group of this meeting on the psychology of perfumery is, so far as I am aware, the only academic olfactory research group to have a perfumer on its staff.

To encourage this kind of collaboration the Fragrance Research Fund presents its annual 'Sense of Smell' awards. These awards recognize the contribution which scientists have made to the attainment of these aims and also the effort which a member of the business community has contributed to the achievement of the goals. It is hoped that these awards will play a major role in providing the opportunity for the general public to become aware of the roles of odours and the sense of smell in their lives. Dr Lewis Thomas and Dr Trygg Engen, both distinguished scientists, have been recipients of the scientific award. Marvin Traub, Chairman of Bloomingdales, New York, and Philip Miller, President and Chief Executive Officer of Marshall Fields, Chicago, have received the industry award. We intend to expand our commitment to uniting the interests and goals of the industry and the scientific community through the publication of newsletters. These will report on olfactory research around the world and, more important, will provide a critical analysis of the possible commercial applications of these discoveries.

13.5 CONCLUSION

Dr George Dodd and Dr Steve Van Toller are to be congratulated for uniting the academic world and the industrial world through the first ever Conference on the Psychology of Perfumery, held at the University of Warwick, 22nd–25th July, 1987. The fact that that timely conference was held holds great promise for this burgeoning new area of scientific interest. I would like to remind you of what Dr Lewis Thomas said at the 'Sense of Smell' luncheon in 1984 when he received his award: 'If I were a young researcher interested in making a career in science, especially in the area of neurobiology and the mechanisms of the human brain; and if I was looking

around for a field about which nobody now knows much of anything, and if I was ready, as all good researchers must be ready, to gamble on a career in science, I would pick the problem of olfaction – and I would count on a professional lifetime of one surprise after another.'

Two years after these seminal remarks, the Psychology of Perfumery Conference placed the world of perfumery within the scientific context of sensory psychology and biology. It is thrilling to speculate on the breakthroughs in fragrance know-how which will follow on from the ideas generated at that meeting.

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Author Index

ACHEMS (American Chemoreception Society) 40
Adrian, Lord 123
Aguilera, D.M. 188
Alberts, J.R. 84
Aldridge, V.J. 108
Ali, S. 173, 178
Allen, G. 16
Allison, T. 107
Alsing, W. 54–6, 59, 60
Amelang, M. 188
Amoore, J. 36, 40, 41, 43, 44, 63, 65, 66, 68
Andresen, O. 57
Anholt, R.R.H. 22, 41, 44
Aramis 204
Arctander 158
Aristotle xiv, 7
Armond, A.D. 158
Arora, R.B. 167
Arvey, A.D. 92
Ash, K.O. 40
Ashton, H. 108, 115, 116, 148
Atchley, E.G.C.F. 12
Atanassova-Shopova, S. 173
Attili, G. 49
Aujla, R. 44
Avon 204, 230

Bacon, F. 28, 160
Baker, J.R. 4
Baldini 219
Baldwin, B.A. 73
Ballantine, J.A. 9
Balmain 30
Balogh, R.D. 82
Bannister, L.H. 43
Barker, J. 21
Baron, R.A. 91–104, 124
Bartlett, P. 21
Bartussek, D. 188
Bate-Smith, E.C. 131
Baxter, R.M. 167, 173
Beary, J.F. 149
Beauchamp, G.K. 63, 64, 65
Beaux, E. 38
Beck, C. 185–204
Beethoven van, L. 162
Beets, M.G.J. 63, 66
Beistl, H. 188
Bekesy von, G. 139
Belardetti, F. 44
Bell, E.A. 13
Benson, H. 149
Benton, D. 69
Berridge, M.J. 43, 44
Berscheid, E. 92
Bhargava, A.K. 173
Bicknell, D.C. 68
Bieber, I. 7
Billing, A. 25, 27, 30, 32, 129
Binz, C. 170
Bird, S. 49, 54, 55, 56, 57, 59, 68
Biron, C. 69
Black, S. 69
Blass, E.M. 83
Bloch, I. 131
Bolzoni, D. 47, 49
Bonsall, R.W. 9
Boot, L.M. 10
Booth, D.A. 69, 124
Booth, W.D. 73
Borda, R.P. 108
Bortz, J. 188
Bossert, W.H. 72
Boyd, E.M. 174
Boyes, T. 121
Brake, S.C. 84
Brandl, U. 134
Braun, D. 65
Brigham, J.C. 92
Brill, A.A. 15
Broca 126
Brody, B. 49
Bronson, F.H. 9
Brooksbank, B.W.L. 54, 56, 59, 67, 68, 69
Brown, R. 54, 56, 59
Brown, R.E. 19

Bull, N. 130
Bushman, J. 115
Byrne-Quinn 205–16
Byrne, D. 91, 93, 96

Cabanac, M. 129
Cagan, R.H. 41
Cain, W.S. 34, 127
Callaway, C. 65
Carlisle, D.B. 7
Carol, M.P. 149
Carroll, D. 69
Cash, T.F. 96
Cayola, R. 169, 171, 173, 175
Cernoch, J.M. 82
Chance, M.R.A. 6
Chandhoke, N. 173
Chanel 38, 203
Charlwood, B. 13
Chauhan, C.S. 173, 178
Cheal, M. 80
Chen, Z. 44
Christie, M.J. 70
Cialdini, R.B. 91
Cibicciotti II, D. 84
Clark, E.V. 89
Clark, P.J. 88
Clark, T. 69, 70
Claus, R. 54–6, 59, 60
Cleopatra 218
Clore, G.L. 93, 96
Cole, J.O. 115
Cooke, G.M. 73
Cooper, R. 108
Corbin, A. 185
Coty, F. 30
Cowley, J.J. 69
Cox, C.E. 92, 94, 103
Craib, A.R. 135, 138
Crocker, E.C. 131
Crook, C.K. 83
Crook, C.R. 81, 83
Cullumbine, H. 167, 173
Curtis, R.F. 9
Cutler, W. 70

Dale, N. 44
Daly, C.D. 5, 16, 131, 132
Dandiya, P.C. 167, 173
Darwin, C. 84
Davey, M. 43
Davies, P. 69
Davis, C.M. 81
Davitz, J.R. 131
Descartes, R. 123, 124
Dickey-Bryant, L. 92, 103
Dickinson, K. 44
Dillon, F.N. 131
Dior, 32, 203
Dipboye, R.L. 92
Discorides, 168
Dodd, G.H. 19–46, 65, 67, 71, 72, 73, 74, 75, 123, 124, 129, 132, 156, 159, 162, 185, 215, 232
Doty, R. 63, 68, 69
Douek, E. xiii–xvii
Downing, D.T. 56
Drake, M.F. 92, 94, 103
Dravnieks, A. 50, 59
Duffy, F.H. 139
Dupont, B. 65

Eco, U. 202
ECRO (European Chemoreception Research Organisation) 40
Edwards, D.A. 45, 46
Edwards, G. 149
Ellendorf, F. 75
Ellis, H. 4
Empson, J. 134
Endo, S. 108
Engen, T. 19, 36, 79–90, 123, 129, 157, 186, 215, 228, 232
Ewer, R.F. 15
Eysenck, H.J. 187, 188
Eysenck, S.B.G. 187, 188

Fahrenberg, J. 187
Fallon, A.E. 89
Faredin, I. 54, 59
Farr, J.H. 131
Ferguson, S.M. 73
Fernet Branca, 204
Fillion, T.J. 83
Finnegan, L. 83
Firmenich 32, 159
Fiske, S.T. 100, 103
Forrester, M.J. 63, 65, 66, 68
Forsythe, S. 92, 94, 103
Foster, D.R. 160
Freud, S. 15, 86, 154
Frost, J.D. 108
Fukuda, H. 107–20

Gaillard, W. 135
Gamble, T. 115
Garland, H. 91
Gasparini, F.J. 61
Gatti, G. 169, 171, 173, 175
Gauger, M.E. 81
Gelder, M.G. 149
Gellhorn, E. 156
Genders, R. 160
Gennings, J.N. 75

Gesner, C. 168, 173
Gesteland, R.C. 40
Getchell, M.L. 40
Ghatak, B.J.R. 173
Giersch, I.O. 67
Girard, P.R. 44
Giu Ching Ting 170, 173
Givaudan 157, 159, 221
Godfrey, D.K. 91, 100
Goff, W.R. 107
Gower, D.B. 4, 24, 36, 47–76, 132
Gray, J.A. 187
Green, A. 126, 165, 227–33
Grenouille 121, 218
Grès 32
Griffiths, N.M. 63
Groupy 127
Guerlain 188
Guillot, M. 67
Gunther, R.T. 168, 173
Gustaffson J.A. 56, 59

Haarmann & Reimer (H&R) 186, 194, 221
Hacke, W. 185, 186
Hafez, E.S.E. 9
Haldane, J.B.S. 9
Halder-Sinn, P. 186, 188
Hallstrom, C. 149
Hamauzu, Y. 107–20
Hamilton, D. 224
Hancock, M.R. 75, 76
Handa, K.L. 167
Hanski, E. 44
Harder, U. 130
Hardisty, M.V. 7
Harper, R. 131
Haslewood, G.A.D. 67, 68
Heath, R.G. 129
Heilman, M.E. 92
Heiss, R. 186, 188
Hendriks, A.P.J. 68
Henion, K.E. 157, 161
Henning 88
Hermes 203
Hertling, E. 47, 49
Hill, I. 28
Hill, O. 160
Hillyer, G.M. 9
Hinds, R. 125, 131, 167
Hines, D. 167
Hochberg, R.B. 61
Hoelzle, E. 55
Hofmann 24
Hold, B. 47, 49
Hooguin, C.A.L. 151
Horander, H. 43
Hori, T. 113
Houbigant 24
House, F.R. 50
Howard, R. 115
Howarth, E. 115, 188
Huggins, G. 70
Hughes, P.E. 73
Hume, D. 124
Hummel, Th. 135
Hurley, J. 49, 50, 51

IFF 160

Jackman, P.J.H. 52, 53, 54
Jacobson 149
Jager, G. 131
James, S.P. 153
Jasper, H.H. 109, 110
Jellinek, P. xv, 19, 157, 160, 178, 179, 185
Jenner, J. 45
Jessee, J. 154
Jesus 218
Johns, E.E. 123
Johnson, A.L. 69
Johnson, L.C. 108
Jones, E.E. 91, 100
Jung, C.G. 203

Kandel, E.R. 44
Kanemoto, H. 107, 120
Kanti Kapila, 167
Kaplan, J.N. 84
Kare, M.R. 41
Karlson, P. 72
Kawasaki, M. 107, 120
Kellaway, P. 108
Kemper, T.D. 129
Kerjaschki, D. 43
Keverne, E.B. 9
King, J.R. 22, 122, 147–65
Kipling, R. 154
Kirk-Smith, M.D. 69, 72, 124, 132, 162
Kirkwood, R.N. 73
Klages, J. 185
Klages, W. 185
Klaiber, E.M. 63
Kligman, A. 52, 53, 55
Kloek, J. 13, 67
Kobal, G. 107, 134, 137, 139
Koelega, H.S. 63, 68, 185, 188
Kostelc, J. 70
Koster, E.P. 88
Koyama, N. 40, 44
Kraft, A.R. 151
Kreitler, H. 188
Kreitler, S. 188
Kudrzycka-Bieloszabska, F.W. 173
Kuo, J.F. 44

Kurihara, K. 40, 44
Kurioka, Y. 107

Labarca, P. 44
Labows, J.N. Jr. 50, 52, 54, 56, 59, 60, 61, 66, 69
Lader, M. 149
Laing, D.G. 88
Lancet, D. 41, 44
Land, D.G. 131
Lastowski, Z. 167, 173
Lautenschlager, G.J. 92, 103
Lautie, R. 119, 120
Lawless, H.T. 34, 35
Lawley, H. 70
Lawrence, B. 26
Lawson, R.H. 156
Le Gros Clark, W.E. 123
Le Magnen, J. 67
Le Norcy, S. 23, 36, 217–26
Le Nouene, J. 174
Leshner, A. 99
Lewis, A.C. 84
Leyden, J. 52, 56
Lieberman, S. 61
Lindsley, D.B. 111
Linsenmeier, J.A.W. 91
Lipsitt, L.P. 81, 83
Lombard, J. 132
Loofbourrow, G.N. 156
Lord, C.G. 91, 100
Lovejoy, C.O. 10
Loveless, N.E. 135
Low, M.D. 108
Lubin, A. 108
Lucretius xiv
Luscher, M. 72, 186, 188
Lyman, B.J. 123

Macdonald, D. 10
MacFarlane, A. 47, 82
Macht, D. 170, 173, 174
Mack, G.E. 22
MacLeod, N. 75
Madan, B.R. 167
Main, C.J. 164
Maj, J. 167, 173
Malec, D. 167, 173
Males, J.L. 7
Mallet A.I. 4, 47–76
Maranon, G. 128
Marks, L.E. 157
Marples, R.R. 53
Martin 151
Mather, R. 29, 45
Maurer, B. 67
Maurer, E.S. 159
Maury, M. 175
Maxwell, M. 124
McAulty, G.B. 139
McBurney, D. 87
McCallum, W.C. 108, 117
McClintock, M. 10, 70
McDaniel, M.A. 123
McGinley, K. 52, 56
McLaughlin, F.J. 82
Meichenbaum, D. 164
Meinbresse, J. 117
Meister, P. 63
Melcher 189
Melrose, D.R. 73
Menco, B.P. 43
Mendoza, J.L. 92, 103
Menevse, A. 40, 44, 45
Mensing, J. 20, 30, 126, 130, 178, 185–204, 206, 220, 221, 228
Meyer, E. 174
Michael, R.P. 9
Michell, R.H. 44
Millaman, J.E. 108, 115, 116
Miller, P. 232
Millot 32
Minor, A.V. 40, 44
Miyanchy, R. 107–20
Miyasita, A. 113
Moncrieff, R.W. 34, 40, 41, 85, 134, 160
Monroe, M. 201
Montagna, W. 47
Montagner, H. 47, 49, 82
Montagu, A. 174
Montague, W. 4
Montaigne, M. 30
Morris, A.F. 30
Moskowitz, H.R. 87
Most, M. 135, 138
Moyse, A. 47, 49
Muller, J. 185
Mumby, S.M. 44
Murphy, K.M.M. 22

Naarden 159
Naito, P. 108
Nelson, K. 89, 90
Nichols, A.C. 51
Niimi, Y. 113
Nina Ricci 158, 217, 223, 224
Nixon, A. 4, 47–76
Noble, W.C. 52, 53, 54
Nordstrom, K.M. 52
North, W.R.S. 165

Ohloff, G. 13, 32, 33, 39, 63, 66, 67, 73
Ottenberg, P. 86

Pace, U. 44
Parakkal, P.F. 47
Parquet, P. 24
Parry, B.L. 153
Passebecq, A. 118, 120
Patel, C. 165
Patterson, R.L.S. 63, 73
Pavlov, I.P. 79
Pearson, G.L. 174
Pechey, J. 168, 173
Pelosi, P. 41, 63, 65, 66, 68
Penwick, P. 115
Perkin, W.H. 24
Perry, I. 115
Persaud, K. 21, 41, 73, 74, 75
Peto, E. 88
Piomelli, D. 44
Plattig, K.H. 107, 134
Pliner, P. 89
Plutarch, 167
Polak, E. 41, 44, 45
Polge 22
Pollak, M.S. 65
Popplewell, J.R. 68
Porter, R.H. 82
Poynder, T.M. 40, 44, 73
Pratt, J. 5
Prelog, V. 63, 67, 73
Preti, G. 70
Price, K.H. 91
Proust, M. 79, 154
Puhwel, S. 50
Punter, P.H. 68

Quinchon, A. 47, 49

Rachman, S. 165
Radmacher, K.G. Jr. 188
Rameses III 12, 217
Randolph, T.G. 156
Rasmussen, K.G. 100
Ray, W.J. 131
Redican, W.K. 84
Reed, H.C.B. 73
Reinhardt, W. 75
Reisner, R. 50
Reynolds, V. 10
Ritter, W. 135
Robert, 22
Robinson, C.J. 44, 45
Rochas, 32
Rock, J. 67
Rohrbaugh, J.W. 111
Rosenthal, N.E. 153
Rothman, S. 49
Roudnitska, E. 22, 46
Roulet, N. 86
Roure Bertrand Dupont 32
Roussinov, K. 173
Rovesti, P. 30, 169, 170, 173, 175
Rozin, P. 89
Ruckmick, I. 125
Russell, M.J. 10, 44, 47, 49, 70
Russell, Y. 44
Ruzicka, L. 40, 63, 72
Rytina, E. 73

Sachs, O. 122
Sack, D.A. 153
Saibil, H. 44
Saito, Y. 108
Sakamoto, M. 50
Sakina, N.L. 40, 44
Salamon, Y. 44
Savignano-Bowman, J. 115, 117
Schaal, B. 47, 49, 82
Schachter, S. 128, 129, 139
Scheff, N.M. 107, 117
Schleidt, M. 47, 49
Schmidt, R. 185
Schneider, R.A. 7
Schultz 149
Schuster, M. 188
Schwartz, J.H. 44
Schwartz, M. 185
Schwartz, R.K. 164
SCI (Society of Chemical Industry) 251
Sellers, E.A. 167
Sharma, P. 50
Shehadeh, N. 53
Shelley, W. 49, 50, 51
Shepherd, G.M. 9, 16
Shepherd, M. 149
Sheppard, E.P. 174
Shih-Chen, L. 168, 173
Shipochliev, T. 167
Shirley, S. 44, 45
Short, R.V. 5, 6
Siegelbaum, S.A. 44
Signoret, J.P. 9
Simon, S.A. 44
Singer, J. 128, 129
Sleight, D. 139
Smith, F.V. 121
Snaith, R.P. 164, 165
Snyder, S.H. 22, 41, 44
Solomon, M. 92
Solomon, R.C. 130
Sprinkmeyer, L. 173
Squirell, D.J. 37, 38, 41, 45
Stein, M. 86
Steiner, J.E. 83
Steiner, W. 185
Stelmack, R.M. 187

Stern, R.M. 131
Stieve, H. 41
Stoddart, D.M. 3–17, 123, 129, 132, 217
Stoffers, D.A. 44
Stopeck, M.H. 92
Strauss, J.S. 52, 56
Sumner 27
Sundulko, K. 111
Suskind, P. 121, 218
Switz, G.M. 10, 70
Synarome 159

Tarrier, N. 164
Taylor, S.E. 100, 103
Tecce, J.J. 107, 115, 117
Teichner, M.H. 83
Telford, R. 108, 115, 116
Terpstra, D.E. 92
Theimer, E.T. 63, 66
Thomas, L. 232
Thommen, W. 67
Thompson, J.W. 108, 115, 116, 135
Thomson, K. 10, 70
Threws, F. 185
Tisserand, M. 118
Tisserand, R.B. 20, 23, 24, 27, 30, 127, 167–81
Tonoike, M. 107
Torii, S. 107–20, 134, 139, 173
Toth, I. 54, 59
Townsend, J.L. 7
Traub, M. 232
Treasden, I. 149
Turner, T. 201

Uttal, W.R. 21

Valnet, J. 173
Vandenburgh, J.G. 10
van der Lee, S. 10
Van Toller, S. 21, 22, 25, 27, 30, 32, 35, 36, 46, 65, 66, 70, 71, 72, 121–43, 149, 156, 162, 163, 169, 175, 185, 232
Vashist, V.N. 167
Vierling, J.S. 67
Volterra, A. 44
von Furstenberg, D. 32
von Meyer, F. 174
Vuitton, L. 204

Wagner, H. 173
Walk, H.A. 123
Walter, W.G. 107, 108, 117
Watts, G.O. 125, 126, 127
Webster, G.F. 52
Wehr, T.A. 153
Weston, B. 81
Whissell-Buechy, D. 68, 235
White, R.S. 5, 16, 131, 132
Wieland, P. 63
Wilde, O. 147
Willhan, B. 67
William of Occam 20
Williamson, P. 53
Wilson, E.O. 3, 72
Wilson, G.T. 165
Winter, A.L. 108
Winter, B. 67
Woerdemann, M. 7
Wolfram, S. 21
Wolpe, J. 164
Wood, M.A. 45
Wood, N. 36, 132
Wortman, C.B. 91
Wright, R. 40, 41
Wysocki, C.J. 63, 64, 65, 66

Yahr, P. 16
Yamamoto, T. 108
Yfrantis 49
see also Hold; Schleidt
Yoshida, J. 63
Young, P.T. 81

Zechman, J.M. 52
Zubay, G. 28, 41
Zuckermann, M. 188

Subject Index

Abietic acid 13
Abnormal olfaction xix
Accord of odours 38, 46, 162
Acetic acid xiii
Acupuncture 168
Adenylate cyclase 44
Adoxal 159
Adrenalin 51, 128
Advertising 93, 203, 206, 224, 228
Aesthetics 19–20, 23, 46, 129–30, 170, 191, 196–7, 203–4, 206, 220
Age-group 198
Aggression 73
Airfresheners 209–11
Aldehydic-floral 188, 190, 196, 199
Algenone 159
Allergies 129
Alliesthesia 129
Allosteric mechanisms 40
Ambergris 36, 147, 159, 221
Ambre 150B. SA 159
American 12, 49, 93, 204, 205, 207, 210, 229
Ammonia xiii, xiv
AMP, cyclic 40, 43
Amygdala 175
Amyl acetate 74, 83
Amyl salicylate 160
Anais Anais 188, 190
Androgens, pig 75
Androgynous femininity 200
Androstene steroids, 16–androstenes 9, 13, 24–5, 51, 54–72, 72–6, 90, 132, 133
Angelica 169
Anglo-Saxon 22
Anisaldehyde 160
Anise 80, 86
Anosmia, specific 63, 65, 66, 68, 70, 133
Anosmia xx, 65, 66, 67, 72
Antaeus 200
Anthropologist, 10, 13
Anti-bacterial 51
Anti-depressants 168
Anti-perspirant 53
Anxiety 72, 147, 153, 162, 164–5, 169, 186
Aphrodisiac 168
Apocrine/sweat gland 4, 47, 48, 49, 50–52, 54, 55, 56, 57, 59
Arachidonic acid 44
Archetype 203, 208
Argentina 195
Armani 194
Arm-pit 49
Arnobius 12
Aromachology (sm) xxv, 231
Aroma disc 165
Aromatherapy 20, 24, 27, 28, 29–30, 34, 127, 156, 169, 173–4, 176, 180, 203
Arpège 162
Art 19–20, 22, 188, 224
Artificial smells 210
Asafoetida 80, 88, 169–73
Asarone 167
Ascending reticular activating system (ARAS) 187
Association, odour 79, 123, 215
Assyrians 12
Asthma 168
Attitude 194, 208–210, 223
Attractiveness 95, 98
Attributes 206
Attributional theory, of emotion 129
Aurantiol 71–72
Australid 4
Autogenic training 149
Autonomic nervous system 127, 156, 164
Aversion, odour 79
Avon Cosmetics 126
Axilla 4, 47, 51, 53–6, 62, 64, 66, 75, 76
Axillary gland 9, 10
Axillary hair 59, 60, 69
Axillary odour 60, 75–6
Axillary secretion 13, 68, 75

Babies 82
Bacteria 48, 51–2, 55, 62
Balsam 12
Basil 168, 176

Belladonna 203
Benzoic acid 13
Bergamot oil 160, 170, 176–8
Beta-blocker 149
Binding protein 73
Binding site 22
Biochemistry 40–45
Blind children 131
Blue book 40
Boar 72
Body odour 4–5, 47–76
Bonding, odour xix, 83
Brain electrical activity mapping (BEAM) 46, 139–40, 141–3, 164
Brands, odour 207
Brazil 195, 207
Breathing rate 70, 148, 151
Brevibacterium 52
British 210
Broca speech area 143–4
Bromidrosis 49
Brut 160
Butyl acetate 73
Butyric acid 83, 84, 85, 86

Cacharel pour l'homme 200
Cachet 82
Cafeteria feeding experiments 81
Calamus 167
Camphor 88
Carbochard 32
Carbol 88
Carbon dioxide (trigeminal) xiii, 135, 137–8
Cardamom 168–9, 178
Carnivores 14
Cassia 12, 178
Castoreum 4
Caucasian, 4, 50
Cedar 12, 159
Cerebral cortex, 126
Cetonal 159
Chamade 188, 190
Chamomile 168–9
Chanel 30, 38, 188, 190, 199
Children, odours 80, 84–9, 186
China 168
Chloe 194
Cholesterol 51, 56
Christians 12
Chypre 25, 30–32, 186, 188, 191, 221
Cinnabar 188, 190
Cinnamon 169, 178
Cis-hexenyl salicylate 160
Civet 4
Clandestine 198
Clary sage 173, 176–7
Classic regression 199, 200
Climatic factors 192
Clove 169
Cluster analysis 190, 193, 209
Cocci, Gram positive 52
Cognitive aspects 121–3, 124, 131, 139, 149, 170
Cognitive-style therapy 149
Colour preference 190
Colour-Rosette Test 192, 194–5, 198, 200
Contingent negative variation (CNV) 107–20, 134, 139
Contre-coup (head injury) xx
Coryneforms 52–3, 62
Costus 168
Coumarin 159–60
Counter-vibration 179
Crêpe de Chine 32
Cue (olfactory) 7, 9
Culture 4, 17, 213
Cypress 170

Damascenones 26, 32
Deodorant 52–3
Detergent bars, 212–14
Diaper 90, 244
Diethyl phthalate 84
Dihydrocoumarin (melilotin) 159
Dimethyldisulphide 83
Dimethylhydroquinone 160
Directional ability 139
Directional detection, odours 139
Discrimination, odour 49, 82
Dress mode 94

Eastern 204
Eating 125, 129
Eau de Courreges 188, 190
Eau de Guerlain 188
Eccrine glands 48
Ecology 5, 223
Ectoderm 7
Egyptians 12, 38, 167–9, 217
Eidetic imagery 122
Electrodermal response (EDR) 70, 71, 110, 113, 114, 115, 132, 151
Electroencephalograph (EEG) 107, 109, 110, 132, 134, 137–8, 140
Electromyography (EMG) 109, 110, 164
Electro-olfactogram (EOG) 74–5
Emotion xxi, 15–16, 89, 93, 100, 124–7, 139, 153, 156, 162, 174–5, 185–7, 190–92, 195, 216, 220, 229
Enhanced relaxation 148, 157
Enzymes 42–3, 50
Epilepsy, temporal lobe xxii
Epiphenomenon, odours 81, 90
Erotic, odours 191

Essential oils 12, 24, 28, 115, 117, 118, 179–80
Esters 37–8
Etruscan 204
Euphorics 168
Europe 199, 201, 223
Evil spirits 167
Evoked potential 135, 139
Evolution 3–5
Exaltolide 68
Extasy 203
Extroversion 186–91
Eysenck Personality Inventory (EPI) 189

Fabric conditioners 215
Facial expression, infants 83
Fantasy 200–202
Female, body odour 63–5
Femme 32
Fennel 169
Feral children 131
Fidji 188
Firmenich 38
Flight or fight 49, 148
Floral-fruity, perfumes 188, 190
Floral-powdery, perfumes 186, 188–91, 193, 198, 200
Florientals, perfumes 197–8
Flouve 160
Fougère Royale 24
Fragrance education 226–8
Fragrance Foundation xv, 127, 227, 229, 231
Fragrance wheel 161
France 197, 206, 218, 221–4
Frankincense, 12, 147, 167, 171, 176, 218
Freiburger Personality Inventory (FPI) 189
French 169
Fresh-green (odour) 186, 188, 191
Frontalis muscle 163–4
Fruity top note 199
Fruity-culinary 198
Fun-type, perfume 201

Gags, cultural 196
Galbanum oil 12, 27, 33
Gamma-undecalactone 30
Gardenia 29, 221
Garden of Eden 161
Gastronomy 22
Genetic, olfaction 10, 11, 65, 68
German personality test (PSS 25) 189
German 49, 169, 192, 196, 197, 198, 206, 209–11, 221, 223
Giorgio of Beverly Hills 198–9, 202
GLC/MS 39, 51, 54–7, 58, 59
Golden Age of perfumery 23, 25, 158, 219
Grapefruit 176, 178
Grasse 218
Greek 12, 167–8, 177–8
Green Banana ('Pisang Ambon') 201
Green note 27, 169
Gregariousness 5–6, 10, 11, 15
Gum benzoin 12

Habituation 82, 193
Hair follicle 4, 47–8
Hallucination, olfactory xxi, xxii, 186
Heart rate 107, 115, 116, 117, 148–9, 151
Hedonic 13, 34, 35, 72, 79–90, 96, 127, 141–3, 154, 161, 169–70
Heliotropin 160
Hemisphere, cerebral 135, 137–8, 140–43
Hepatotoxicity 170, 173
Herbal-woody fragrance 223
Hexanol 68
Hippocrates 177
HLA haplotype 65
Homeopathy 175, 204
Homo sapiens 121, 123–5, 129
Hormone 9, 26, 41, 127
Horn oil of oxen 88
Hydrogen sulphide 135, 137
Hyperosmia xxii
Hypothalamus 7, 9

Idealization 204
Impression management 91–103
Imprinting 36, 38, 121, 123
Impurity, odours 25, 27
Incense 3, 11–13, 15, 205
Indian 167
Infants 80, 82–4
Ingratiation 91
Inhibitions, olfactory 45
Intensity, odour 80, 153, 161
Introversion 186–92, 194
Isovaleric acid 51
Italian 49, 223

Japanese 49, 207, 214, 215, 223–4
Jasmine 108, 112, 114, 116, 117, 134, 170, 176–7, 179, 221
Jean Louis Scherrer 194
Jicky 188, 190
Jil Sander's 'Woman 3' 200
Jontu 81
Jungle Gardenia 94

Kenopodium 88
Kiwiwonder 201
Kon-Tiki 201
Korean 4
Kouros 38
Kyphi 167–8

Ladanum 12
L'Air du Temps 81, 224
Lavender 83, 108, 114, 116, 117, 119, 134, 170
Lee-Boot effect 10
Lemon, odour 88, 169–70, 174
Life-style 189, 191–2, 195, 228
Limara 201
Limbic system 22, 123, 126–7, 155, 174, 185–6, 188
Lime, odour 170
Linguistics 86
Lipid profile 50
Louis XIV 218
Luscher Colour Test 186, 189

Madame Rochas 188
Magic Fantasy, perfume 202, 203
Male, body odour 63–4
Mammary areolae 47
Maritima (IFF) 158
Marjoram 168, 170
Market research 195, 205–16, 225
Maximi 81
Melissa 169
Memory, olfactory 16, 34–5, 80–81, 123, 154, 185, 205, 214, 221
Menstruation 10, 68, 70
Menthol 135, 137–8
Methoxy-isobutylpyrazine 27
Methylacetophenone 160
Middle East 168
Miss Dior 32–3, 188, 190, 194
Mitsouko 30, 39, 188, 192
Molecular mechanisms (olfactory) 21, 23, 36, 41
Molecule, perfume 19–21, 23, 26, 29, 36, 45, 156
Moleleuka 88
Mongolian races 4, 49
Monogamy 5, 7
Mood 19, 22, 36, 39, 69, 76, 147, 156, 176–7, 179–81, 187, 190–93, 195, 220
Mother–infant relationship 47, 84
Muscle activity 148, 150, 163–4
Music 20, 22, 26
Musk 4, 24–5, 36, 38–9, 44, 63, 67, 68, 69, 90, 147, 223
Must de Cartier-Parfum 188, 190
Myrrh 12, 167–8, 218

Nahema 38, 186, 188, 190
Nappies 90, 224
Narcissism 199
Nasal obstruction xx
Nasal turbinates xiii
Naso-hypothalamopituitary-gonadal link 7, 10
Natural juices 24
Natural selection 13
Neonate 47
Neroli 84, 86, 169–70
Neurobiology 7, 45
Neuroendocrine 72
New Age Movement 202
Nicotine, odorant 46
Nina Ricci 222
Non-verbal cues 99, 101, 102
Novelty, odours 85, 229

O Intense 198
O Lancôme 186, 188, 190
Oakmoss 221
Obsession 198, 202
Oceano NB 123, 159
Odorants, key impact 39
Odourama movies 79
Odour kit 126
Odour perception 83, 175
Odours, described as
  citronella 211–14
  floral lavender 211–14
  floral 63, 68, 221
  fruity 63
  musky 63, 67
  perfume-like 65
  pine needle 211–14
  pleasant 63, 71, 83
  spicy oriental 211–14
  sweat-like or sweaty 63
  sweet 65
  tabac 211–14
  unpleasant 63–5, 71, 83
  urinous 63
  wintergreen 211–14
  woody floral 211–14
Odours (personal) 47–76, 207
Odour–structure relationship 34, 38
Oestrogens 9
Oestrus 6, 11, 14, 73
Off-note, odour 65
Oils, natural 25–8, 30, 39
Olfactometer 137
Olfactory ability, acute 67, 122
Olfactory awareness 122
Olfactory brain/smell brain, 155
Olfactory bulb xiii, xx
Olfactory ecstasy 168
Olfactory epithelium 73–4
Olfactory evoked potentials (OEP) 135
Olfactory fatigue 153
Olfactory hallucination xxi, xxii, 186
Olfactory mechanisms 40
Olfactory nerve 175
Olfactory physiognomy 122
Olfactory receptor xxii, 186, 188
Olfactory sense organs 171

Olfactory system 16, 80
Olfactory testing 80
Olfactory threshold 61, 66
Olfactory transduction 40
Olibanum 159
Opinion poll 85, 86
Opium 188, 190
Opoponax 169–70
Orange, odour 85, 170
Orange blossom 170, 201
Oriental, perfume 186–9, 188–91, 193, 194, 196, 200
Oscar de la Renta 188, 194, 222
Osmatic 63, 66
Osmic 67
Osmotherapy 30, 156
Ovulation 67

P-450, enzyme 45
Paired comparisons 86, 87
Paloma Picasso 200
Paris 219, 224
Parosmia xxi
Parure 186, 188, 190, 192
Patchouli 159, 221
Peppermint 168, 179
Performance anxiety 148
Personal grooming 92, 103
Personality 178, 185–90, 194–5, 208, 215, 221–2, 224
Petitgrain 169–70
Phenotype 82
Pheromone 13, 46, 59, 72–3, 76, 132
Phobia 164
Phosphoinositide 44
Phospholipid 40
Phylogeny 7
Phytosterol 13
Pig 9, 60, 61, 63, 75
Pine odour 88
Piriform region 175
Pituitary gland 9, 72
Placebo 128, 164
Poison 38, 193, 201, 203
Polygyny 5, 7
Polysulphide 88
Preference, odour 67, 85, 88, 189–91, 228
Primary odours 46
Primates 4
Progressive relaxation 149
Propanoic acid 51
Proteus vulgaris 52
Psychiatric patients 175
Psychiatrist 147, 149, 151
Psychoaromatherapy 170
Psychometric scale 94, 96, 97, 101, 128, 132, 140, 142, 189, 191, 212, 213, 214, 223
Psychophysiology 70, 132, 134, 162, 169, 172, 185
Psychosomatic disorders 149, 165, 176
Psychotherapeutic 164, 173, 178
Puberty 72, 88
Public relations 206
Purity, odour 24, 26
Pyramid Test (CPT) 186, 189
Pyridine 64, 65

Quest International 205

Radioimmunoassay 57
Rapeseed oil 84
Reaction time 115
Receptors, olfactory xxi, 19, 36, 38–41, 44, 46, 186, 188
Reciprocal inhibition 164
Relaxation therapy 149, 150, 152, 157, 161, 162, 164–5
Renal toxicity 173
Repression, olfactory 5, 11
Resenes 12
Resin alcohols 13
Rhinencephalon 155, 185
Rive Gauche 188–90
Romans 12
Rose oil 33, 160, 168, 170–71, 178, 221
Rosemary 168
Royal National Institute for the Blind (RNIB) 230

Safrol 84, 85
Sales techniques 217, 221, 222–3, 224, 225, 228–30
Salicyl aldehyde 160
Saliva 69
Salivary gland 9
Salivation reflex 73
Sandalwood 12–13, 25, 36, 170, 216
Saudi Arabia 224
Scherrer II 194
Schizophrenia 186
Sea fragrance 157–9
Sea-squirt 7
Seaside 147, 152–3, 157
Sebaceous gland 4, 47, 48
Sedation 170, 174
Sedative 168, 171–3
Seduction 217
Seller–buyer interaction 217, 218–20
Sense of Smell Award 232
Sensory psychologist 230–31
Sex attractants 14–15, 72
Sex difference 63, 67–8
Sex hormones 9, 13
Sex behaviour 5, 7, 49, 73, 125, 132, 185
Shalimar 186, 188, 190, 192

Signal period 196
Signoricci 158
Skin 4
Skin potential level (SPL) *see* Electrodermal response
Skunk odour 79
Smell, abnormalities of xx, xxii
Smell recital 162
Smoker/non-smoker 63, 65, 68
Social acceptability 206
Social context 95
Social environment 195
Social interaction 69, 70
Social status 221
Social/cognitive theory of emotion 128
Sociobiographical data 189, 192, 193
Sociobiology 3
Somatosensory sense xxii, 135
South America 224
Spain 221, 223
Staphylococcus epidermidis 51
Steroid, odorous 47–76
Steroid hormone 10
Steroid xxi, 13, 51, 54, 64–6, 70, 75
Sterol 13
Stomach meridian (acupuncture) 168
Stress 147–9, 154, 164–5
Structure–activity relationships 39, 67
Style of dress 92
Styrax 12
Subconscious mind 15
Sucking behaviour 81, 82, 83
Sweat 4, 47, 49, 51, 57, 66, 70
Symbiosis 232
Synergism 152, 157
Synthetic, odorants 26
Syrian 12

Tabula rasa 90
Tar 88, 93
Taste xxi, 81, 83
Tatiana 32
Testosterone 13–14, 55, 60, 62, 75
Therapist 149, 151–2, 161 162
Thophee 194
Threshold, olfactory 33, 36, 64, 133
Thyroid 81
Time 201
TMA-2 167
Toiletry products 207, 211–14
Tonka absolute 159
Tosca 188
Toxic dosage 171
Tragacanth 12
Training 217, 220
Traits 3, 91
Transduction 41, 43–4
Trends 195–6, 199
Trigeminal sense xxii, 22, 32, 39, 83, 90, 135, 137, 140, 156
Trimethylamine 88
Trimethylundecylenic aldehyde (TUA) 72
Triplal (IFF) 160
T-shirts 49

Ungulate 5
United Kingdom 195, 206–7, 209, 211, 215, 221–2, 224–5
United States of America 195, 197, 206, 209, 211, 222–3, 224, 230
Urinous 36, 54, 63, 65, 66, 68

Vaginal secretions 9
Valentino 188, 190
Valerian 88, 132, 169–70
Vanilla 135
Vanillin 137–8
Vent Vert 30
Verbena 170
Vetivert 159
Vibrations 20, 28
Violet leaf 170
Viral infection xx
Visual evoked potential (VEP), 137
Vitalism 27–8
Vocabulary 214

Warwick Olfaction Research Group xv, 46, 126, 230

Ylang-ylang 169–70, 176
Ysatis 194

Zoology 3, 7
Zoomorphism 84