KEY WORDS: OLFACTION, AGING, ODOR-RECEPTOR, GENETICS

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• L'industrie cosmétique a étudié de façon approfondie les propriétés et le traitement du vieillissement de la peau, mais n'a que peu prêté attention aux changements dans notre sens olfactif en fonction de l'âge. Les changements dans la réponse olfactive humaine impliquent plusieurs facteurs à côté du processus de vieillissement naturel.

• Die kosmetische Industrie hat die Eigenschaften und die Behandlung von älterer Haut umfassend behandelt, aber die Aufmerksamkeit auf das Abnehmen des Geruchssinns im Alter wurde nur wenig berücksichtigt. Außer dem natürlichen Alterungsprozeß, hat die Veränderung des menschlichen Geruchssinns auch noch viele andere Faktoren.

• La industria cosmética, ha examinado las propiedades y tratamientos de piel envejecida, pero he prestado poca atención a los cambios con la edad en nuestro sentido del olfato. La cambiante respuesta olfactoria involucra muchos factores además del natural proceso de envejecimiento.

The Effect of Age on Olfaction

Olfactory acuity decreases with age, and products for older users should reflect this

Stephen J. Herman
drom International, Towaco, NJ, USA

When H.L. Mencken said, "For every complex question, there is a simple answer—and it's wrong," he probably wasn't thinking about olfaction, but the phrase certainly applies. From molecular biology and the genetic coding of odor receptors to gross anatomy, physiology and psychology, smell is our most complicated and least understood sense. The effect of aging on the human olfactory response involves many factors besides the natural aging process; this only increases the difficulty of analyzing the changes with age.

The cosmetic industry has extensively examined the properties and treatment of aging skin, but little attention has been given to what happens to the sense of smell as we get older. It is common knowledge that vision changes with age; people who have always had normal vision often require reading glasses. Once they reach their 40s, a physician can easily measure individual sight compared to an absolute standard and prescribe corrective lenses. It isn't as obvious when a person's olfactory acuity deteriorates; no such standards or corrective measures are available for smell. If the cosmetic industry is going to serve the senior market by using its scientific resources, olfactory aging must be considered.

Declining Acuity with Age

The effect of age on the sense of smell has been noted by many researchers.[15,20,25,27,28] Venstrom and Amoore calculated the decline in olfactory acuity for 18 odorants (Figure 1-1).[33] The result was tabulated along with corresponding changes in the other senses (Table 1-1). In this study, the minimum value of odorant concentration for detection doubled every 22 years.

Two points should be noted about the data to avoid misunderstanding: it is logarithmic and denotes a threshold value. First, consider the convenience of a logarithmic scale: the test was conducted with samples

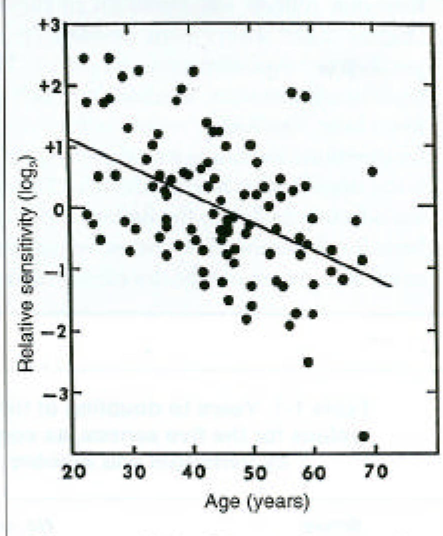

Figure 1-1. Decreasing odor sensitivity with age

The Olfactory Anatomy

The anatomy of the olfactory system is well-understood.[15] The hair-like cilia in the roof of the nasal cavity contain odor receptors. The cilia connect via axons to glomeruli in the olfactory bulb, which lead directly to the limbic system of the brain.

Other receptors in the nasal cavity include the trigeminal nerve, which reacts to chemical irritants, and the vomeronasal organ. The vomeronasal organ would theoretically respond to pheromones but is vestigial in humans and because of this probably serves very little purpose.[19] A fruit fly may very well find a mate via pheromones, but a human uses far more sophisticated information in making a choice of a life partner, such as sight, reason and social conditioning. Human evolution has desensitized the importance of pheromones as sexual messengers, emphasizing instead a selective process promoting stable families and social structures.[29]

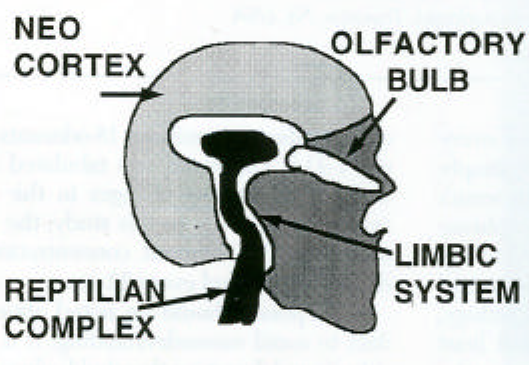

Figure 2-1. The triune brain

Structure and function: The brain has a triune structure that reflects the evolution of the human intellect (Figure 2-1).[26] Every fetus develops in a sequence that parallels our evolutionary development. The reptilian cortex controls automatic mechanisms, such as breathing and heart beat. The limbic system is the complex responsible for emotions, including sexual feelings, and the neocortex is the site of higher rational thought. The direct route from the olfactory bulb into the limbic system is the anatomical basis for the emotionally evocative nature of our sense of smell and, consequently, the effects of aromascience.[13]

Olfaction Mechanisms

A useful rule of thumb in science holds that the more theories and terminology exist concerning a subject, the less is known about it; this is certainly true of olfactory receptor sites.

Receptor theory: Amoore proposed the classic description of a lock-in-key mechanism of odor recognition.[1] The Amoore model, based on stereochemistry, has been challenged by Luca Turin's vibrational theory,[6,31] derived from the work of Wright.[35] It appears likely that both theories have their strengths and weaknesses. Both explain certain phenomena but fail to describe others.

For example, the stereochemical theory successfully provides a consistent shape and size for caphoraceous smells: nearly spherical and slightly less than one millionth of a millimeter across. However, the stereochemical model fails with many small molecules: HCN fits into every proposed receptor site but smells of bitter almonds. Acetophenone and deuterated acetophenone, which certainly have the same shape but differ in odor, pose another problem for the stereochemical model.

The vibrational model can account for the different odors of deuterated and non-deuterated acetophenone or vanillin and isovanillin. However, it fails to explain the difference in odor between (+) and (-) carvone, which have identical vibrations.

Each model focuses on individual receptors rather than combinations. Because there are approximately 1,000 receptors to detect at least 10,000 odors, individual odor molecules clearly must interact with multiple receptors.

Receptor genes: Buck and Axel have published their recent work on isolating odor-receptor genes.[2,9] The genetic identification will hopefully be a tool for establishing a more precise pathway for odor recognition. By altering individual genes and analyzing the consequences, a precise structure/function correlation can be determined. Despite recent advances, a lifetime of work may be required before the complex sensory combinations are decoded.[3] Our ultimate goal is to be able to predict odor sensations based on molecular structure so that we might also create molecules with specific odor characteristics. This could lead to staggering creative and economic possibilities in perfume technology.

Table 1-1. Years to doubling of threshold values for the five senses, as compiled by Venstrom and Amoore

Sense	*No. of years*
Sight (night vision)	13
Sound (125-500cps)	15
Smell (18 odorants)	22
Taste (sugar and salt)	29
Touch (cornea)	60

that were diluted in half for each evaluation, so a logarithmic scale was the logical choice for plotting linear data. The fact that threshold values were determined means that everyday odor perception does not drop at the rate that Venstrom and Amoore's study seems to imply because nearly all odors encountered in normal life are far above threshold levels.

Physical aging factors: As cilia die, they are replaced, but if the efficiency of replacement is imperfect, a slow loss of reception occurs. Likewise, loss of neurons in the olfactory bulb can have a negative impact on neural transmission.

Deep in the brain, where the sensory input is processed, a gradual decline in the number of synapses can affect odor recognition. If all of these factors occur together, a healthy individual could sustain a gradual, almost imperceptible, sensory loss.

However, the physical changes due to aging alone are perhaps the least important factor in the decline of olfaction. Pollution, disease and medication are the primary culprits in olfactory deterioration for most people.

Pollution: Pollution exists in the ordinary environment; in certain workplaces, it can be more concentrated. Chemical companies are an obvious source of airborne irritants, but many other industries create hazardous atmospheres. Working in these industries or living near this environment generates risk for individuals.

Disease and medication: Disease and medication are more properly dealt with in the medical literature, but one example illustrates the general importance of sensory perceptions. Alzheimer's disease affects memory, which is necessary to identify odors. Thus, an odor-screening test to identify a statistically significant decrease in odor recognition can be a useful diagnostic tool to provide early detection of the onset of Alzheimer's or other conditions. Many diseases show similar loss in odor response, including AIDS, Down's syndrome and Huntington's disease. The literature of the past few years is full of references to odor-screening techniques,[19,24] and several suppliers provide appropriate evaluation kits to doctors.[22]

The Psychology of Fragrance

The psychology of fragrance perception has been investigated extensively.[32] The olfactory connection to emotive centers makes feelings toward odor reactions more important than rational thought. Olfaction originated as a survival mechanism — to alert us to unhealthy conditions by producing negative feelings toward rotten or putrid odors. The newborn finds its mother's breast by odor, and recent research indicates that sperm have a simple odor receptor for locating the ovum.

Smell is a very basic and instinctive sense, but the modern world has put many new twists on our natural sense. A lifetime of exposure to marketing has created indelible impressions in most consumers — lemon is "fresh," and baby powder has clear associations. It is hard to know where natural responses end and conditioned ones begin.

Fragrancing for the 65+ Consumer

Older people may have impaired smelling ability; they also have specific social and psychological traits. Therefore, cosmetic products and marketing must be specifically designed for their needs.[10] Fragrances must be stronger than for the youth market, and of the types preferred by this age group (see "Olfactory Preferences by Age and Gender"). Classic fragrances, such as Chanel No. 5 and Calandre, trigger favorable responses. For skin care, Nivea scores well, but we cannot say whether this is due more to its classic status or its lavender and rose notes.[11]

Target products: A logical choice of product types is also important. Seniors do not often use purple gel to spike their hair. Bath products, skin care, and aftershaves and colognes are the main cosmetic articles purchased by seniors. Older men, conditioned by a lifetime of associating perfumes and colognes with women still liberally use aftershaves. Denture products are another major category of senior consumer spending. The aging market is growing and will continue to do so for many years.

Fragrance for effect: Certain aromatic chemicals have noted stimulating or relaxing properties,[30] and these effects can be psychological or physical. In a test of concentration (Brickenkamp d/2 Test),[7] results improved in the presence of lemon oil and declined with armoise. In a test of physical performance on computerized exercise machines, training

Odor Preferences by Age and Gender

Preferences and age: Moncrieff considered differences? in odor preference based on age, sex and personality in a classic early study.[17] In a central section of his book, *Odour Preferences*, approximately 500 subjects ranked the attractiveness of 10 odorants (Figure 3-1). Some of his results are commonly accepted today, such as young subjects preferring fruity aromas while older subjects prefer lavender. However, closer scrutiny soon reveals serious flaws in Moncrieff's study. Of his approximately 500 subjects, nearly all were from the same region (the British Isles) and only three were not Caucasian. In the search for subjects, Moncrieff went to several schools and inadvertantly created a highly skewed population of young people in his study. The "elderly" group consisted of anyone over the age of 40, and the study includes only 32 individuals in this age-bracket.

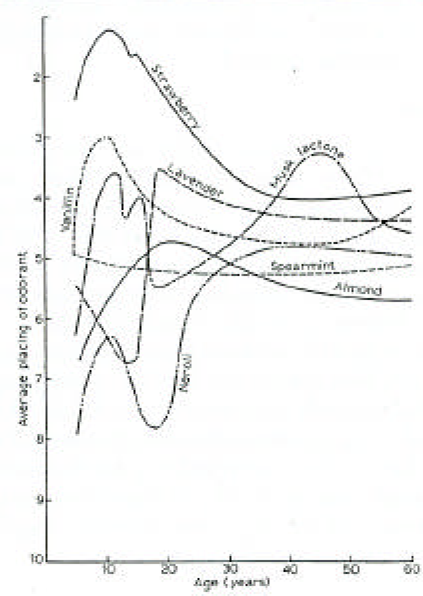

Figure 3-1. Changing odor preferences with age

Preferences by gender: As an example of sexual differentiation, women aged 12 to 42 greatly preferred almond. Women showed two peaks for enjoying musk, one at puberty and one at menopause; the timing of these was attributed to the sexually provocative nature of the particular odor. The general structure of Moncrieff's study would probably yield valuable results if the test group were more representative of the world's population, but, as it stands now, the conclusions must be viewed with considerable caution.

efficiency (time spent exercising) similarly increased with lemon and decreased with armoise.

Obviously seniors at different times or moods can benefit from the effects of essential oils, such as improving the quality of sleep,[4] enhancing vigilance and reducing stress.[34] Nevertheless, aromascience results must be applied with caution. The effects of single materials cannot be projected into mixtures. The vehicle is important; a fragrance may be calming in a bubble bath but not in a cologne. If a fragrance is not liked, it will not have the desired effect. This does not mean that the effects of aromascience are not real, but leaping from a hard experimental result to a conjectural application should be avoided.

> A recent report on the "The Graying of the Globe"[16] summarized a demographic study of the aging of populations worldwide. In 1994, the world's population over the age of 65 totaled 357 million; this figure is expected to increase to 418 million by 2000. At this rate, the population of elderly (those older than 65) is growing by 800,000 a month. As a consequence of low birth rates during World War II, followed by the Baby Boom and then a sharp drop in births during the 1980s, industrialized countries are experiencing the highest proportional growth rates in the older population. Older consumers have special needs, substantial disposable income and a willingness to spend for quality goods, creating a significant potential for properly designed products.[5,12,21]

Conclusions

Olfactory acuity decreases with age for a variety of reasons. In addition, odor preferences change, and self-perception of age does not correlate with chronology. One study found that German women say they feel 9 years younger than their chronological age, and men say they feel 6 years younger.[10] Other populations are problaby similar in this regard. Seniors want to feel young, not old.

Consumers over 65 need products formulated and marketed to satisfy their real or perceived physiological, psychological and social needs. Aromascience (or Aroma-chology)[14] can help us develop products tailored to the needs of seniors. Many tests have been constructed to quantify the effects of odorants on physical parameters.[9] Positioning, marketing and advertising such products must all stress a happy, active and intergenerational mood.[36]

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