

LITERATURE REVIEW

Considerations on the evolution and importance of the olfactory sense and odorous molecules in human history

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ABSTRACT

The olfactory sense and odorous molecules have long been ignored, and the information in human history is limited, especially in the little known early stages. Nevertheless, the olfactory sense and odorous molecules were the first of the sense organs which have been involved in the two fundamental properties of life, survival (food) and reproduction. Isolatedly in unicellular animals, throughout the long history of living things, they have been preserved and have grown under different forms in human history. Therefore, the evolution and importance of the olfactory sense and odorous molecules are present as observations, rarely isolated, but especially together with the other sense organs, at first briefly in the history of living creatures and in more detail in the stages of the homo bipedal species and of the present human being; they are described in relation to the consequences of verticalization (bipedalism, encephalization, language, consciousness), to the environment and the genetic factors, being limited to the African and Mediterranean regions.

KEYWORDS: olfactory sense, odorous molecules, homo bipedal species, encephalization, language

INTRODUCTION

Unlike human history, there was a great scientific interest in the olfactory sense and odorous molecules in the history of living beings, since they were the first sense organs (sight and hearing appeared later) to serve as means of communication of living things with the environment, between the species or individuals of the same species.

The history of living beings began more than three billion years ago, from the first primitive life forms to unicellular organisms, then worms, insects, mammals and the present human being. Both the sense of smell and the odorous molecules have been involved in survival (food) and reproduction in the main stages of the history of living creatures¹. Unicellular organisms used for survival nutrient molecules with odorous properties in different chemical communication (heterotrophic, autotrophic, positive chemotaxis), as well as oxygen through photosynthesis; for reproduction they used division, colonies or odorous molecules with

sexual attraction and a group of molecules able to reproduce themselves (DNA, genes), thereby contributing to the maintenance of life on Earth for over a billion years²⁻⁸.

After this long period of stability and equilibrium of the environment and unicellular organisms, great changes have taken place in the relationship between water and land; inferior plants, fixed in the ground, appeared (ferns, mosses, lichens), oxygen increased through photosynthesis of plants, and the new landforms favoured physical stimuli (luminous radiations for the sight, sound vibrations for hearing).

Inferior plants and oxygen served as food for unicellular organisms from the animal kingdom, which meant the first stage, the main one, in the history of living creatures. The use of plants, oxygen and information from the environment led to the occurrence of some chemical communications at a molecular level, and continued through chains of chemical and physical processes up to the macro-level of tissues, rudimentary internal and sense organs, with differenti-

ated cells. These developments were achieved in relation to how unicellular organisms from the animal kingdom adapted to the changing environmental conditions and in relation to the variation of genes, which led after hundreds of millions of years to the appearance of new creatures - the invertebrate animals (jellyfish, worms, insects). During this stage, the olfactory sense and odorous molecules, together with the other sense organs, were involved in survival and reproduction through relationships between insects and flowers (bees, butterflies), contributing to maintaining life on Earth through the various forms of pollination^{1,2}.

The new conditions of the environment (plants, animals, oxygen, climate) favoured the emergence of new possibilities of food for the invertebrates, increase of oxygen through photosynthesis and of information from the environment received by the sense organs. The use of all the information required a new great leap from rudimentary tissues and organs to the apparatus of internal organs, reproduction and sense organs, the neuroendocrine system and the brain. Metabolism of diversified food and the increasing oxygen was achieved by natural selection and new chains of chemical and physical processes, leading to reception and perception of information from the sense organs to the brain. These developments occurred in parallel with the increased degree of adaptation of invertebrates to the aquatic, terrestrial and aerial environments, and they have been included in the genome and transmitted to descendants; this led after hundreds of millions of years to the appearance of some superior creatures - the vertebrate animals (fish, batrachians, reptiles, birds, mammals). During this stage, the olfactory sense and odorous molecules, together with other sense organs, were involved in the survival and reproduction processes with species-specific differences⁹.

The history of animals and plants continued and developed through the circuit earth - plants - animals, the olfactory sense and odorous molecules being involved in this circuit by union of survival with reproduction, thereby contributing to the continuity of animal and plant life on Earth¹⁰.

Thus, food, oxygen, the sense of smell, odorous molecules and the other sense organs played an important role in survival and reproduction throughout the history of living creatures; these processes were achieved by natural selection and chains of chemical processes and circuits. Everything happened in parallel with the adaptation to the environmental conditions and with the laws of genetics from Darwin's modern evolutionary theory¹⁰.

The importance of food, olfactory sense and odorous molecules in survival and reproduction, in the history of living beings, increased under different

forms in the stages of human history, but especially in two important moments of the life of the homo bipedal species and of the present human being^{11,12}. The first moment, before birth, is represented by the attraction of the ovule by the sperms, a necessary process for reproduction; the ovule emits some odorous molecules received by the chemoreceptors of the sperm^{1,13-16}. The second moment, after birth, is mutual recognition between the female (the mother) and the newborn, a necessary process for breastfeeding and survival of the latter. In the female of the homo bipedal species, the first stimuli for mutual recognition were the odours emitted by the amniotic fluid from the newborn's skin and the placenta, which the female licks and eats (it is not known if the homo bipedal female had this habit and if so when she gave it up). In mothers, at the present human being, mutual recognition is facilitated by the act of sucking - the odours of milk and breast skin are received and learned by the child who, exposed to a short distance from the mother's breast, is able to recognize and distinguish them from those of other mothers. All these show the importance of the sense of smell and odorous molecules in the complex process of birth^{14,22}.

STAGES OF EVOLUTION OF THE SENSE OF SMELL

The first stage

In the first stage, the longest - 2.5 million years - *homo habilis* lived in the jungles of Africa, with grass and tall trees, a climate with rainy days and nights¹¹. No important differences in comparison to mammals and primates appeared, therefore with any consequences on the sense of smell and the other sense organs²³.

The first changes subsequent to verticalization occurred in the locomotor system - the lower extremities were elongated to adapt to walking upright, the upper limbs began to be used to search for food with the help of smell and to build certain small stone and bone tools. Primary food was the luxuriant vegetation of the jungle, which is why "primitive" people were vegetarians. Regarding the neck and vocal apparatus, the larynx of the *homo habilis* species was highly positioned; that is why breathing and swallowing functioned at the same time. Thus, the *homo habilis* species was able, just like mammals and primates, to always smell and perceive odours emitted from ingested vegetables. The high position of the larynx only allowed emitting howls and different sounds, specific for each species. At the level of the head, facial flattening started by shrinking of the muzzle and increase in cranial capacity (400 to 750 ccm)²⁵.

The second stage

In the second stage, with a duration of 1.5 million years, the *homo erectus* species lived in the savannahs of Africa, with a better climate - small grass and wide areas. During this stage, important events occurred with consequences on the olfactory sense and the other sense organs, as well as on food; these changes were achieved, as in the history of living things, by natural selection, chemical and physical processes and adaptation to environmental conditions^{11,17,25,26}.

Verticalization continued and upright walking became a habit, allowing a better exploration and long-distance reception of odours emitted by animals and plants, while the free hands were used for creating the tools needed for fighting and animal hunters. Verticalization also had favourable consequences on the visual organ, by appearance of binocular and colour vision, as well as on the hearing organ, by emergence of language. The larynx began to lower, while breathing and swallowing functioned separately, together with the action of swallowing and chewing muscles. These changes have allowed the articulation of the first words. Changes also occurred in newborns, but while they took two million years in the homo bipedal species, they took only two years in newborns^{11,27}.

Nevertheless, verticalization had unfavourable consequences on the olfactory organ due to some changes in the relationship between the viscerocranium and the neurocranium. The viscerocranium shrunk by disappearance of the muzzle and facial flattening (the forehead, the nose and the chin appeared), leading to reduced sense of smell at the peripheral level. The neurocranium developed due to the increase in cranial capacity (975 ccm) and the cerebral hemispheres, which covered and reduced the old olfactory structures. The rhinencephalon (considered the "olfactory brain") and the olfactory bulbs appeared, but some of the old structures of the limbic system were also preserved (the cingulate lobe, the amygdala, the hippocampus), but they have acquired other functions - emotions, memory.

Verticalization also had consequences on birth, gestation being shorter and childhood prolonged (only 2-3 years in chimpanzees); this favoured the relationships with the mother and the people around, as well as a slow and complex development of the sense organs and the brain.

A significant event was the discovery of fire, since primitive people prepared the hunting in the wood fire, which produced pleasant sensations to the five senses (light and heat of the fire, smell and taste of the hunting, crackle of burning wood) - the first show of "primitive kitchen" that has been preserved to the present man^{11,16,17,27}. The odours and taste of hunting prepared in the wood fire stimulated the groups of thirst, hunger and reproduction neurons from the hy-

pothalamus and those of emotions from the limbic system, contributing together with the other sense organs to the transition from the physiological need to satisfy thirst, hunger and reproduction, to the unconscious pleasure of drinking, eating and reproducing, manifested through emotional behaviour²⁸.

These developments marked the first differentiations of the homo bipedal species from mammals and primates, which have been included in the genome and passed on to descendants.

The third stage

In the third stage, the homo bipedal species lived in the Mediterranean regions, with a warm climate, flavoured vegetables and fruits, animals closer to the man, and passed from nomadic life to stable settlements. During this stage, the most important events from the emergence of life on Earth occurred - encephalization (processes of thought and intelligence), language and consciousness - that have determined human superiority over animals (*homo sapiens*)¹¹.

Encephalization and consciousness had favourable consequences on the olfactory sense and the other sense organs, on people's lives, changes that have been achieved not only by natural selection and physical and chemical processes, but also by conscious selection and processes of thought and intelligence.

Odours emitted by the urogenital and skin glands, received and perceived by the olfactory sense, together with the information from the other sense organs and the language, have been processed by the thinking process and people have become aware of their importance in sexual attraction and reproduction^{19,22}. This facilitated the transition from seasonal availability for reproduction in mammals, to permanent availability in the present human being. At the same time, people thought about and realized the importance of food and pleasant odours emitted by the hunting prepared in the wood fire for survival, but also the unpleasant odours emitted by rotting vegetables and bodies of dead animals, associated with mystical tonalities, which led to the emergence of death awareness²⁷.

The information of the olfactory sense, of the other sense organs and the language, processed by the processes of thought and consciousness, have served not only for reproduction and survival (food), but have also determined motor responses manifested by the conscious activity of the hands that, coordinated by intelligence, have forged tools for the new life conditions (habitat, different types of work, clothing). At the same time, the first manifestations of the artistic sense appeared, primitive drawings and paintings from grottos and caves, the use of the right hand for their realization having been proven. The shows of the primitive kitchen became more frequent and have acquired different meanings - labour and love celebra-

tions, religious rituals associated with emotional artistic performances (cries, sounds, words with rhythmic intonations, dances) - flavours specific to each "show" being used (invigorators, aphrodisiacs, myrrh, frankincense).

In this stage, the information from the sense organs and the language, increasingly numerous, has been selected and processed in two directions - for new life conditions and development of language in the left cerebral hemisphere, and for primitive emotional manifestations in the right cerebral hemisphere, thereby contributing to the development and functional asymmetry of the cerebral hemispheres.

These developments have occurred in relation to the favourable environmental conditions; they have been included in the genome and transmitted to descendants 300-400 years ago.

The fourth stage

The fourth stage, the shortest and most spectacular, started 8-10.000 years ago with the rapid evolution of encephalization, growth of intelligence (*homo sapiens sapiens*) and increased psycho-intellectual activity of the brain.

People have discovered wheat, rice, spices, and diversified diet resulted in new methods of cooking (the oven, boiling in water) that produced pleasant flavours and tastes; these stimulated the groups of neurons of appetite and hunger from the hypothalamus, being thus involved in the process of weight loss and gain. Pleasant flavours and tastes, together with the information from the other sense organs, favoured the transition to the conscious pleasures of drinking, eating and reproducing²⁹. This can be considered the last stage of the evolution and importance of the olfactory sense, odorous molecules and the other sense organs, both in survival and reproduction^{15-17,27}. They have intervened in these processes under different forms throughout human history and the history of living things, representing an example of evolutionary systems in biology. At the same time, the molecules with sexual attraction of unicellular organisms, the insect pheromones and the sex hormones of vertebrates, all of them having a role in reproduction, are yet another example of evolutionary systems at the molecular level²⁶.

The pleasures of drinking, eating and reproducing were often followed by unpleasant manifestations, which influenced emotional behaviour, body hygiene and sexual attraction^{30,31}. Under these circumstances, women began to have a preference for the fragrance of flowers and plants³². They produced pleasurable interpersonal sensations and feelings of love, thus facilitating the emergence of perfumes. The first perfumes were used in Egypt, under the Ptolemaic dynasty, to

preserve mummies. From Egypt, the perfume reached the Greeks and Romans, then France, spreading out all over the world and becoming an industry and an art that produces not only thousands of new odours, but also millions of money ("money smells")^{14,15}.

The information of sense organs, always more numerous and more diverse, together with an increasing language, was used not only for better living conditions and primitive artistic manifestations, but also for the intellectual pleasure of knowing and the artistic pleasure of creating. Intellectual pleasure was manifested by pure sciences (philosophy, history, mathematics, logic), while artistic pleasure by the famous Greek sculptures and architectures and by intonation of language in songs and speech.

Nevertheless, the olfactory sense and odorous molecules have been ignored, being mentioned only in a few observations of the Roman philosopher Lucretius and in one of the famous surgeon Galen's experiences (128-200) that investigated the innate preferences of a baby deer born by caesarean for different types of food (milk, honey, wine, fruits, grains).

People's concerns for food continued with the use of appetizers with spicy flavours and tastes, by the habit of smelling and tasting food before being eaten - for health protection (boiling kills microbes, but not toxins). Through modern methods of food preparation and presentation, primitive kitchen has become an industry and a culinary art after three million years^{28,33,34}.

Intellectual pleasure continued to manifest through extraordinary development of applied sciences (physics, chemistry, biology) and the first scientific observations on the importance of the sense of smell and odorous molecules appeared first in insects, then in people. Artistic pleasure manifested in the Renaissance painting and architecture, by emotional intonation of language in oratory and songs, which contributed to the communication and cooperation between sciences and arts through the corpus callosum, intelligence being used in the arts and artistic sense in the sciences.

In this stage, the information received by the sense organs from the external environment, increasingly numerous, and the constantly growing language have become specific food of the human brain compared to mammals and primates, together with the nutrient arterial blood and the information from the internal environment of the body.

The stage of the present human being

In the stage of the present human being, sensitivity and scientific interest for the olfactory sense and odorous molecules have increased, especially in relationships and mutual recognition between individuals, in emotional behaviour and health protection, while encephalization continued.

Relationships and mutual recognition between individuals is achieved, together with the other sense organs, through the odours emitted by skin and urogenital glands specific to each person (a kind of olfactory aura). Studies have shown that in humans and some mammals (mice), the olfactory sense and odorous molecules are controlled by the genes of the major histocompatibility complex. As there is immunological individuality proven by graft rejection, so there is an olfactory individuality necessary for mutual recognition and partner choice. We cite Helen Keller's case who did not see and hear from birth, but she recognized her friends and distinguished women from men with the help of smell^{35,36}.

The importance of the olfactory sense and odorous molecules explains the closeness between people with the same profession, in an environment with specific odours, and marriage, but also the rejection of certain people.

People are all the time, unconsciously, in contact with odours from the environment, odours that influence emotional behaviour and produce sensations of pleasure or aversion. The olfactory sense and odorous molecules play a significant role in health protection (food, drugs, toxic gases) - "the sense of smell does not sleep"^{16,25,27}.

Scientific interest for the sense of smell and odorous molecules was manifested in the deodorants industry and that of synthetic food flavourings, which although stimulate appetite and hunger, are not metabolized as the natural ones and do not participate in the process of weight loss and gain. Recently, three areas of neurogenesis have been identified, one of them being near the olfactory bulbs. Neuroblasts, neural progenitors, migrate into the olfactory bulbs and explain epithelium and olfactory bulb renewal every 80 to 90 days. At present, research is made to identify certain odorous molecules from tissues and organs (biomarkers), as the test for prostate cancer, and on odours emitted in diabetes, hepato-digestive diseases and airways pathology³⁷⁻³⁹.

Encephalization also continued by rapid growth of information that surrounds us (TV, computer, internet, phone). Received by the sense organs, they become the universal food of the current and future human being. The present human being is able to intervene in the environment, animal and plant life, with negative effects (acid rain) or positive ones (diversified food). Genetic manipulation led to prolonged life and new varieties of animals and plants with different volumes, shapes and colors, all to the detriment of smell and taste. These effects included in the genome would mean the beginning of an unpredictable new phase in the history of animals and plants. Moreover, the importance of consciousness as a means to control what we think and do - responsibility awareness - has increased.

CONCLUSIONS

These developments, during four million years of human history, have led to the anatomo-functional development of the brain (the other tissues and organs remained similar to those of chimpanzees) and to the progress of science, culture and life of the homo bipedal species; they have been included in the genome and passed on to descendants.

The olfactory sense and odorous molecules were involved in the attraction of the ovule by the sperms for reproduction and in mutual recognition between the female (the mother) and the newborn for survival of the latter.

The decrease in the olfactory sense at the peripheral and central levels was partially compensated by the reception, perception and conscious discrimination of odours.

The olfactory sense and odorous molecules, together with the other sense organs and the food, played the main role in survival and reproduction, in the emergence and evolution of the primitive kitchen and the perfume, in the pleasure of satisfying thirst, hunger and reproduction, in the pleasure of knowing and creating, in the process of weight gain and loss.

The importance of food, the olfactory sense, the odorous molecules and the other sense organs in survival and reproduction have been preserved throughout history and have grown under different forms in relation to the consequences of verticalization, the environment and the laws of genetics.

Moreover, the history of living things and human beings represents an example of the importance of sense organs together with the brain, the evolutionary systems at macro- and molecular level in the continuity of life, within the modern theory of evolution.

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