The vomeronasal organ—vestigial or functional?

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The history of the vomeronasal organ was reviewed, documenting that the Darwinian doctrine belief has interfered with the drive to understand the function of this important organ in humans. Widely recognized as a functional organ in many animals, its function was assumed to have been lost in humans. Consequently, it was labelled a vestigial organ for many decades. As a result, it was widely touted by evolutionists for over a half century as a useless organ in humans that developed in the embryo, but often deteriorated in adults, thus was an important evidence of evolution. It has now been documented by at least three clinical studies to be a complex system that is critically important in humans. Furthermore, its malfunction can cause disease such as Kallmann's syndrome.

A human organ commonly listed as vestigial is the vomeronasal organ (figure 1). *New Scientist* magazine listed it as the number one example on their list of the five structures humans don't need.[1] One evolutionist wrote, "in spite of some creationist claims, there are genuine vestigial organs and this [the vomeronasal organ] is one of them". As we will document, this conclusion is, at the least, very suspect and likely wrong.

The vomeronasal organ (also called Jacobson's organ, after Ludwig Jacobson, the anatomist who first described it in a paper published in 1811) is a secondary olfactory sensory organ designed to detect pheromones. Pheromones are chemical signals detectable by certain animals. They elicit behavioural, reproductive, and neuroendocrine responses among individuals of the same species.[2] Pheromonal communication is of major importance for many animals to help them manage several aspects of their reproduction cycle.[3]

Often called the sixth sense, the structure is called the vomeronasal organ because it lies close to the two small bones in the nose called the vomer and nasal bones (figure 2). It consists of a patch of sensory cells within a small depression located in the main nasal chamber that detects certain moisture-borne odor particles. Sensitive to a different set of odors than the primary sense of smell, it connects to the mouth through a pair of narrow canals. The system is used by amphibians, reptiles, and even many mammals. Conversely, it was long assumed that 'higher primate' adults lack the vomeronasal organ, the accessory bulbs, and the associated nervous connection to the brain's limbic system.[4] This was assumed because scent marking is not dominant in the so-called higher primates.

Prior to the release of the excellent new detailed research findings discussed below, it was believed the "function and location of the vomeronasal organ in humans remains poorly understood. Indeed, there has been considerable controversy as to whether it even exists" in humans.[5] Nonetheless, the human vomeronasal organ has been a subject of interest in both the scientific literature and "of considerable speculation in the popular science literature".[6]

A common claim was that this organ, although present in human embryos and occasionally found in infants and young children, was less commonly found in adults.[4] Newer studies contradict this, concluding previous studies employing macroscopic observational methods have often missed, or even misidentified, the vomeronasal organ.[7] For example, Trotier *et al.* estimated, of 130 subjects he studied, close to 72% had at least one intact vomeronasal pit, indicating the presence of the organ.[8]

Another study of 27 human septums removed at post mortem were "examined macroscopically, sectioned coronally and examined microscopically. In 70% of these specimens, vomeronasal structures were identified."[9] Won *et al.* found evidence of a vomeronasal organ in almost 60% (13 out of 22) of the cadavers they examined, but others note cadaver research for this very small structure is very problematic.[5] A major problem in this and similar studies is the fact that aging of the human olfactory system commonly results in both loss of both structure and function.[10]

Examination of living subjects has been more fruitful. A study of 410 patients interviewed for plastic surgical procedures detected visible bilateral vomeronasal pits in 93% of the 410 consecutive subjects.[11] The same researchers, using complex modern evaluation techniques, examined 108 fetal specimens, finding every fetus possessed pits leading to prominent vomeronasal organs and "aggregates of nervous terminalis ganglion cells and vomeronasal nerves connecting the vomeronasal organ to the brain".[11] They concluded that

"the vomeronasal system is a universal feature of the adult human nasal cavity".[12]

A third study, of 200 persons, using both macroscopic and microscopic evaluations to complete intranasal clinical examinations, located paired bilateral vomeronasal pits on the anterior of the nasal septum in all of the cases they examined. Furthermore:

> "Biopsies of the vomeronasal pits and surrounding tissues were examined by light and electron microscopy. These studies showed that the vomeronasal pit leads to a closed tube, 2–8 mm long, lined by a unique pseudostratified columnar epithelium unlike any other in the human body."[13]

This study was able to determine much detail about the vomeronasal system, including its nerve connections, using SEM and TEM, which was confirmed by later studies. They also confirmed the presence of "two morphologically distinct cell types in the human vomeronasal epithelium", one of which was of unknown function and which was "unlike any other cell in the human body".[14]

In the largest study involving over 400 adult human subjects, vomeronasal pits were observed "in all individuals except those with pathological conditions affecting the septum".[15] The researchers completed electron microscopy evaluations, finding

> "… two potential receptor elements in the pseudostratified epithelial lining: microvillar cells, and unmyelinated, intraepithelial axons. In addition, unmyelinated axons are common in the *lamina propria* surrounding the organ. They appear to constitute the components essential for a functional chemosensory system, and may thus provide the basis for a pheromone detection system as in other animals."[15]

Some evolutionists, although accepting the conclusion that all healthy humans have a vomeronasal organ, claim it is an evolutionary remnant based on the belief that the genes which code for its cell surface receptors are mutated in many subjects.[16] Neuroscientist Michael Meredith of Florida State University commented to *New Scientist*: "If you look at the anatomy of the structure, you don't see any cells that look like the sensory cells in other mammalian vomeronasal organs", nor do you "see any nerve fibers connecting the organ to the brain".[17] This claim simply indicates the organ is non-functional in humans, but is not evidence it was inherited from a non-human ancestor. It may have had a function in previous generations of human beings and may have a function in today's human adults which we will discover with more research.

As Stoddart concluded, if the putative vomeronasal organ has "any function, and what that might be, must await the outcome of future research".[18] The need to determine its function, if any, is important because

> "… many nasal surgeons are unaware of this organ and its potential physiologic significance… [and] by recognizing its prevalence and location, nasal surgeons will be more likely to identify and possibly preserve this mysterious organ until its function is more clearly understood."[5]

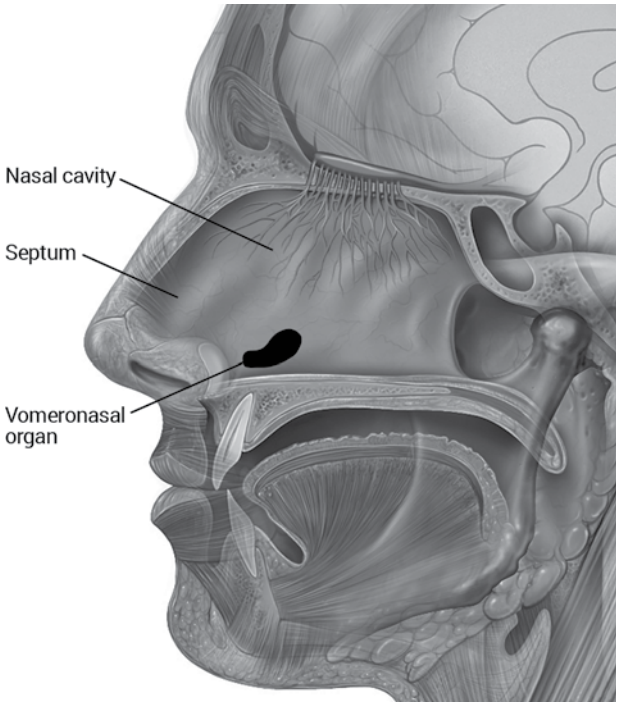

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Figure 1. The vomeronasal organ and other structures of the human peripheral olfactory system.

Research finds several important functions

Other studies have supported Won *et al.*,[7] concluding that the belief that the human vomeronasal organ is "generally considered to be vestigial or non-functional" is incorrect. When steroidal pheromones called vomeropherins are applied to the human vomeronasal organ, many autonomic function changes have been detected, including "pulsatile release of luteinizing and follicle-stimulating hormones, autonomic and electroencephalogram activity".[19]

Thus, researchers concluded their "data demonstrate, for the first time, the existence of a functional vomeronasal-pituitary pathway in adult humans".[19] In addition to the effect on gonadotropin pulsatility, the vomeropherin hormone also produces "decreased respiratory frequency, increased cardiac frequency, and event-related changes of electrodermal activity and EEG pattern", providing "evidence for functional connections between the VNO [vomeronasal organ] and a variety of hypothalamic areas in adult humans".[19]

In one of the most extensive studies on this topic, measurements by the detection system, called

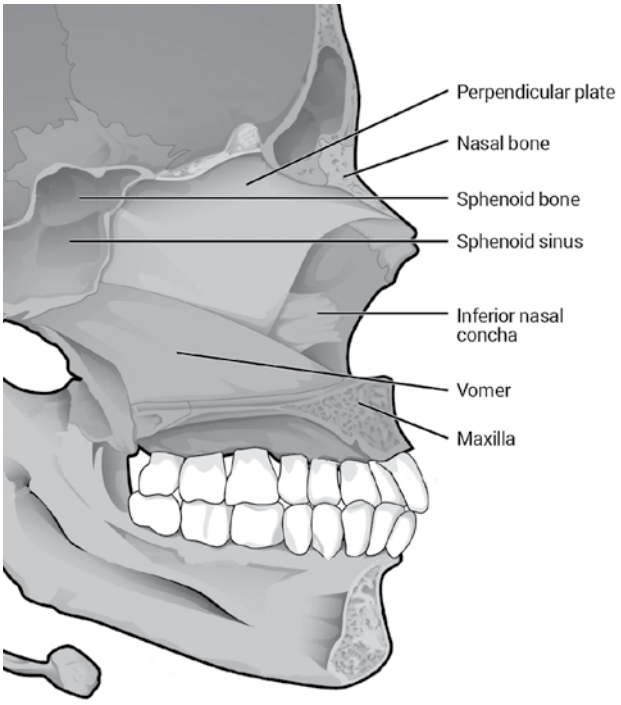

Figure 2. Vomer and nasal bones

electrovomerograms, found the vomeronasal organ's local response included "gender-specific behavioral changes, modulation of autonomic nervous system function, or the release of gonadotropins from the pituitary gland".[20] They used the most sensitive system currently known to measure brain activity, functional brain imaging (fMRI), to reveal that vomeronasal organ stimulation caused "consistent activation of the hypothalamus, amygdala and cingulate gyrus-related structures" in adult humans.[20]

This methodology has effectively dealt with the previous problems in the research on the function of the vomeronasal organ, and powerfully supported the existence of a functional vomeronasal system in adult humans. It is not vestigial but an important functioning system in human adults. An important discovery was that the vomeronasal organ caused gonadotropin-releasing hormone secretion, a role necessary for proper growth and development, and its lack causes disease and malformation of the body.

Monti-Bloch *et al.*, in a review of 86 studies, concluded the human vomeronasal organ "is found as a bilateral structure in all normal human adults", and lack of gonadotropin-releasing hormone cell migration from the vomeronasal organ "to the brain during fetal life results in severe developmental disorders such as in Kallmann's syndrome".[21] Kallmann syndrome is a rare hormonal condition more commonly diagnosed in males characterized by a failure to begin or complete puberty. It is also accompanied by a lack, or highly reduced, sense of smell (anosmia and hyposmia, respectively).

Furthermore, they concluded the careful research using the new technology has shown the "vomeronasal system is functional in the adult human, and is able to mediate autonomic, psychological and endocrine responses". It also shares both "structural and functional properties seen in other mammalian chemoreceptor cells".[22] They also documented that the claim the organ is vestigial by evolutionists has caused researchers to ignore the human vomeronasal organ both in the anatomy, histology, and physiology textbooks and also, tragically, in the research laboratory.[23]

Unfortunately, some studies published after the Monti-Bloch *et al.* study either ignore the studies reviewed above, which find good evidence for a function for the vomeronasal organ, or rely on earlier, cruder studies. Trotier *et al.* write "to our knowledge, the existence of functional vomeranasal receptor neurons that connect to the brain is doubtful in adult humans".[24] This requires replication of the technique used by researchers such as the studies referenced by Monti-Bloch *et al.* review. The most recent review stresses that more research needs to be done to understand this neglected organ and to better deal with the current lack of more detailed research on its function.[16] Watson, who earned his Ph.D. in zoology-ethology under Desmond Morris, has concluded the evidence for vomeronasal function is forcing a revolution in biology which is at odds with those

> "… who want more concrete evidence, preferably from humans willing to have dyes injected into their systems, so that their brains can later be scanned to see where the tracers end up. Such foot dragging in the face of facts has a familiar feel to it. The last time I saw anything like it was in the 1960s when diehard geologists made last-ditch stands against the tide of continental drift."[25]

This is no different than Haeckel's (fraudulent) embryos continuing to appear in the textbooks for many decades after Haeckel was exposed, or results of research that proved the functionality of the appendix and pineal gland taking decades to filter into the biology textbooks.

Research on the vomeronasal organ has now been extended to primates, finding evidence of the organ in New World monkeys, prosimians, and the chimpanzee, which is almost identical to that in the human.[26]

Conclusion

The evidence is now fairly persuasive that the vomeronasal system is not a vestigial organ nor non-functional in adult humans. Rather, it is a critically important system required for proper development and health.[27] Research problems, as well as use of limited techniques, such as visual analysis

and morphological observations rather than experimental evidence, have handicapped past scientists who have attempted to research its many possible functions.

Although much has yet to be learned, when past problems were overcome with new technology, the analysis has enabled researchers to better document the organ's importance in health and life. As one book-length study concluded, the vomeronasal organ is part of "the pheromonal mechanism necessary for … feeding the area of the brain that affects our awareness, emotional states, and sexual behavior".[28] It also likely has several other functions which await more research to determine.

References

1. Spinney, L., Five things humans no longer need, *New Scientist*, newscientist.com/article/dn13927-five-things-humans-no-longer-need/, 19 May 2008.
2. Witt, M and Hummel, T., Vomeronasal versus olfactory epithelium: is there a cellular basis for human vomeronasal perception? *International Review of Cytology* **248**:209–259, 2006; p. 209.
3. Trotier, D. *et al.*, The vomeronasal cavity in adult humans, *Chemical Senses* **25**(4):369–380, 2000; p. 378.
4. Stoddart, M., *The Scented Ape*, Cambridge University Press, New York, p. 37, 1990.
5. Won, J. *et al.*, The vomeronasal organ: an objective anatomic analysis of its prevalence, *Ear, Nose & Throat J.* **79**(8):600–605, 2000; p. 600.
6. Meredith, M., Human vomeronasal organ function: a critical review of best and worst cases, *Chemical Senses* **26**(4):433–445, 2001; chemse.oxfordjournals.org/content/26/4/433.full; Watson, L., *Jacobson's Organ and the Remarkable Nature of Smell*, Norton, New York, 2000.
7. Bhatnagar, K. *et al.*, Number of mitral cells and the bulb volume in the aging human olfactory bulb: a quantitative morphological study, *The Anatomical Record* **218**(1):73–87, 1987.
8. Trotier *et al.*, ref. 3, p. 369.
9. Johnson, A. *et al.*, Clinical and histological evidence for the presence of the vomeronasal (Jacobson's) organ in adult humans, *J. Otolaryngology* **14**(2):71–79, 1985.
10. Bhatnagar, *et al.*, Number of mitral cells and the bulb volume in the aging human olfactory bulb: A quantitative morphological study, *The Anatomical Record* **218**(1):73–87, 1987.
11. Stensaas, L. *et al.*, Ultrastructure of the human vomeronasal organ—part 2, *J. Steroid Biochemistry and Molecular Biology* **39**(4):553–560, 1991; p. 554.
12. Stensaas *et al.*, ref. 11, p. 559.
13. Moran, D. *et al.*, The vomeronasal organ in man: ultrastructure and frequency of occurrence—part 2, *J. Steroid Biochemistry and Molecular Biology* **39**(4):545–552, 1991; p. 545.
14. Moran *et al.*, ref. 13, p. 550–551.
15. Stensass *et al.*, ref. 11, p. 553.
16. D'Aniello, B. *et al.*, The vomeronasal organ: a neglected organ, *Frontiers in Neuroanatomy* **11**, article 70, pp. 1–2, 2017
17. Quoted in Spinney, ref. 1, 2008.
18. Stoddart *et al.*, ref. 4, p. 38.
19. Berliner, D.L. *et al.*, The functionality of the human vomeronasal organ (VNO): evidence for steroid receptors, *J. Steroid Biochemical Molecular Biology* **58**(3):259–265,1996; p. 259.
20. Monti-Bloch, L. *et al.*, The human vomeronasal system: a review, *Annals of the New York Academy of Science* **30**(855):373–389, 1998; p. 373.
21. Monti-Bloch *et al.*, ref. 20, p. 384.
22. Monti-Bloch *et al.*, ref 20, pp. 384–385.
23. Monti-Bloch *et al.*, ref 20, pp. 372–373.
24. Trotier, D., Vomeronasal organ and human pheromones, *European Annals of Otorhinolaryngology, Head and Neck diseases* **128**:184–190, 2011; p. 222.
25. Watson, ref. 6, pp. 9–10.
26. Smith, T. *et al.*, The existence of the vomeronasal organ in postnatal chimpanzees and evidence for its homology with that of humans, *J. Anatomy* **198**:77–82, 2001; p. 77.
27. Bhatnagar, K. and Smith, T., The human vomeronasal organ—III, postnatal development from infancy to the ninth decade, *J. Anatomy* **199**(3):289–302, 2001.
28. Smith, T. *et al.*, ref. 26, From the book jacket.

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