Scents and Sensibilities

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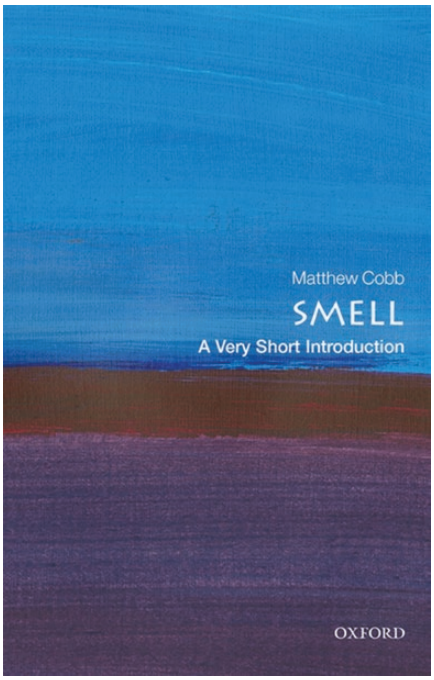
Sometimes we seem to be all ears and eyes. Language is drenched in the audiovisual: we feel blue, admire visionaries, find that an opinion resonates. Yet around us seethes another dimension of the physical universe: the ocean of odors, pulled in with every breath—whiffs of sweaty socks or steaming pho, voluptuous wafts of jasmine, acrid hits of hot tarmac. Smells snap us back to our full senses. Their primal power has inspired olfactory investigations from the lab to the arts.

Odors curl through fiction, evoking mood, unveiling character, and giving immediacy to the distant past. In Joris-Karl Huysman's 1884 novel, *Against Nature*, arch-decadent Jean des Esseintes proves his aesthetic chops by experimenting with scents of lilac, coal oil, rubber, and mildew. Winston Smith, the doomy protagonist of George Orwell's *Nineteen Eighty-Four*, subsists in a reek of "boiled cabbage and old rag mats." And Patrick Süskind's tale of seduction and murder in eighteenth-century France, *Perfume*, immerses readers in an urban jungle of stench emitted by slaughterhouses, rat-infested dwellings, unwashed bodies, and manure-slicked streets.

The quintessence of "smell lit" is probably Marcel Proust's *In Search of Lost Time*, in which a spoonful of madeleine and linden-flower tea becomes the portal for a rush of recovered memories. The intertwined senses of smell and taste, Proust posited, are "more fragile but more enduring" than the physical detritus of a vanished past. And in fact, the brain's hippocampus and amygdala, involved in memory and emotion, are part of the odor-processing olfactory cortex. There is a certain irony in our tendency to forget the power of smell.



Smell: A Very Short Introduction
by Matthew Cobb. Oxford, UK: Oxford University Press, 2020, 168 pp.

In April 2020, the "Cinderella" sense had a moment when the World Health Organization added anosmia—the loss of smell and taste—to the list of COVID-19 symptoms. In one British observational study, 64.5% of over 13,000 people testing positive for the novel coronavirus reported the symptom. Most infected people recover within months (although reportedly, a proportion are left with parosmia, a disorder linked to viral infections that can render familiar odors disgusting). "Noseblindness" can be debilitating in the long term, and the condition has been linked to high rates of depression and anxiety, even to lowered life expectancy.

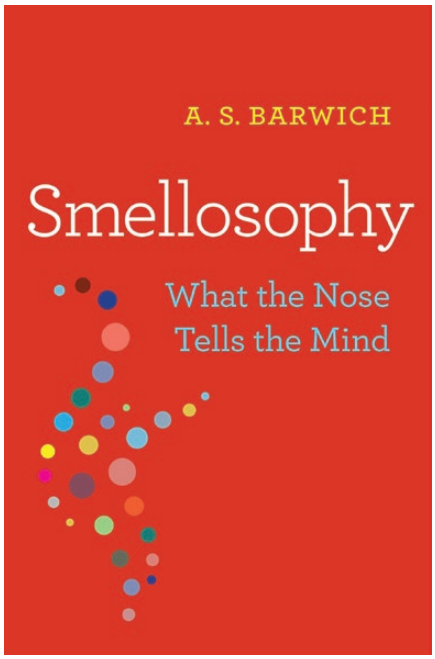
It seems that we take olfaction for granted at our peril. So it's apt that four books published in 2020 offer a collective tour of the world of smell.

Two books usher us into the lab. In *Smell: A Very Short Introduction*, Matthew Cobb, a historian of science and olfaction researcher, sums up the basics on the neurophysiology, evolution, genetics, and cultural ramifications of olfaction in a treatment that punches above its size. His primer is complemented by *Smellosophy*, in which the cognitive scientist and philosopher A. S. Barwich examines olfactory science, particularly over the past 30 years, and wrangles vigorously with the field's research challenges.

The other two propel us into smells in the wild. *Nose Dive*, by the doyen of food-science writers Harold McGee, is an epic journey through the "osmocosm" (from *osme*, the ancient Greek for smell). And in *Smells: A Cultural History of Odours in Early Modern Times*, the cultural historian Robert Muchembled explores the pungent sixteenth to late eighteenth centuries in Europe, when plague, patchy sanitation, the rise of science, and shifting moral paradigms triggered ebbs and flows in scents and sensibilities.

Together, these studies form an investigation of smell through many lenses: chemical, neurological, psychological, cultural, even cosmological. But the story really starts when nose meets odor.

As Cobb and Barwich show, there are two ways of smelling: orthonasal (sniffing) and retronasal (while eating). Either way, volatile molecules in the vaporous compounds that waft from an odorous source are pulled up into the nasal cavity to the olfactory epithelium, a layer of skin in which millions of olfactory receptor neurons cluster. Dangling from their lower ends are



Smellosophy: What the Nose Tells the Mind
by A. S. Barwich. Cambridge, MA: Harvard University Press, 2020, 384 pp.

hairlike cilia embedded in a layer of mucus. A volatile molecule reaching the cilia binds to receptor proteins on their surface. That ultimately triggers electrical signals that run along the neuron's nerve fiber, or axon, through channels in a layer of bone into the brain's olfactory bulb. There, in plump tangles of nerve tissue called glomeruli, the axons mingle with those of mitral cells, which shunt the signals into higher brain structures, including a key smell-processing region, the piriform cortex. From there, signals are sent to the hippocampus, amygdala, and other domains. The whole show is over in as little as a fifth of a second.

Two neuroscientists, Linda Buck and Richard Axel, clarified much of this picture. In 1991, the duo identified a family of some 1,000 mammalian genes that encode, or produce, the receptor proteins—research for which they were awarded a Nobel Prize in 2004. Scientists now know that humans have about 400 receptor proteins. Their interaction with volatile molecules is complex: each odorant can activate multiple receptors, and each receptor can be activated by multiple odors. The receptor army thus works in a combinatorial way, by forming a pattern for identifying odors. And the range of smells detectable by humans is mindboggling: estimates range from 10,000 to a (contested) trillion.

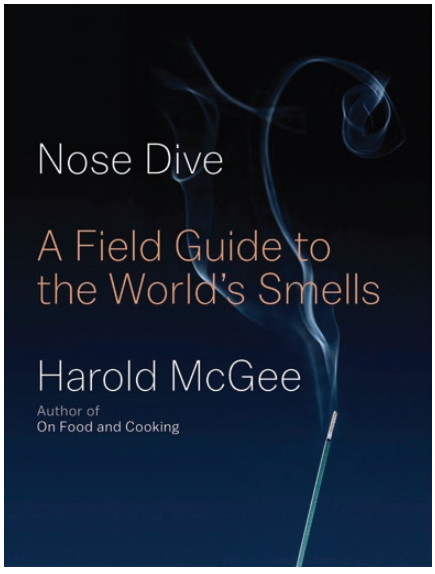
There are other complexities. Researchers don't know how the receptors actually work, Cobb notes. You'd think that the structure of an odorant molecule would connect in some way to how we perceive the odor, but that relationship remains a mystery. Some molecules with almost identical structures give rise to very different odors. One lactone group, for example, produces a diverse range: minty, buttery, and camphorous. Meanwhile musks, Barwich notes, all smell musky despite their dissimilar molecular structures. Odors in nature also tend to be cocktails—there are 650 volatile molecules in the aroma of coffee, and 400 in a tomato's.

Cobb offers more on genetics in *Smell*, and delves into the science of odor in memory, navigation, and evolution in humans and animals. He delivers intriguing findings in the ecology of smell: *Orphrys sphegodes* orchids, for instance, lure the male pollinating bee *Andrena nigroaenea* into a "simulacrum of sex" by mimicking hydrocarbons emitted by female bees. There's also a nifty overview of smell in culture, from the wealth of specific terms for taste in Farsi to John Waters's 1981 movie, *Polyester*, first screened to audiences given patented "Odorama" cards. (I well recall the scratch-and-sniff patches, including oregano-laced pizza and dirty shoes.)

In *Smellosophy*, Barwich takes us deeper into the human stories, key advances, and dead ends of olfaction science, interspersed with philosophical theory. She interviewed over 40 scientists for the book—among them the neuroscientist Stuart Firestein, the psychologist Linda Bartoshuk, and the food chemist Terry Acree—to build a comprehensive picture of the current state of research, while offering rich historical context.

Plato, she notes, presciently understood smells as emerging "from the physical movement of fine particles." By the medieval era, smells were thought to bridge the physical and metaphysical, communicating what Barwich calls "a world of concealed meanings." That dualism persisted into the early modern period with ideas such as the "spiritus rector" theory championed by the eighteenth-century Dutch physician Herman Boerhaave, which held that an invisible vital force adhered to odorous particles.

Gradually, theories swung toward the mechanistic and causal. In the nineteenth and early twentieth centuries, chemistry became the field best placed to study odor, in part because of its ties to industries such as perfumery. But interest in the biology grew. In 1882, the Austrian scientist Eduard Paulsen devised a clever, if grisly, physiological experiment: cutting a human corpse's



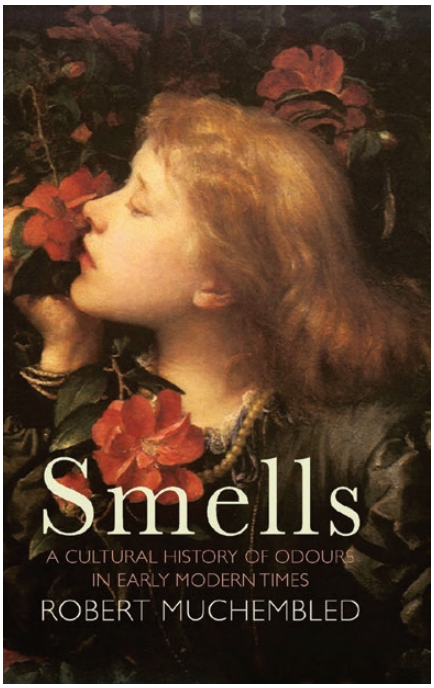
Nose Dive: A Field Guide to the World's Smells
by Harold McGee. New York, NY: Penguin Press, 2020, 688 pp.

head in half, he lined the nasal cavity with strips of litmus paper, inserted a breathing apparatus, and clamped the halves back together. Using ammonia, he traced airflow to the epithelium. Work on the psychology and biochemistry of olfaction followed, and by the 1980s, systematic investigation of the olfactory system's molecular foundations had begun.

Barwich's discussion of progress since Buck and Axel's breakthrough reveals a mosaic with many missing pieces. The biggest hurdle to a better understanding of the olfactory system, she asserts, is the fixation with vision as a sensory paradigm. It's a poor fit with olfaction. Researchers can measure a visual stimulus such as color in terms of wavelength, but the olfactory stimulus is a molecular melee. The visual brain map is straightforward, with areas of the retina projecting onto regions of the visual cortex. The olfactory pathway might seem a clear route "from the air to cortical core," Barwich writes, but in reality the information transferred by mitral cells to the piriform cortex seems to get scrambled there. As she notes, "It is baffling to see this neat clustering in the bulb discarded in the sensory cortex," while Terry Acree calls the connection between the two an "Enigma machine."

With scent so hard to pin down in the brain, an olfactory map may never be possible. Barwich suggests an alternative: recasting the olfactory brain as a "measuring instrument" calibrated by context, psychological state, and genetic mutations, such as one that makes cilantro smell soapy to some people and fruity to others. That may enable researchers to fill in the rest of the mosaic. *Smellosophy*, despite a tendency to stray into overly technical language, is a timely dispatch from the research trenches, surveying a field in flux.

Leaving behind lingering mysteries of the nose-brain nexus, McGee's *Nose Dive* hinges on another body of



Smells: A Cultural History of Odours in Early Modern Times
by Robert Muchembled, translated by Susan Pickford. Medford, MA: Polity Press, 2020, 260 pp.

research: the vast catalog of molecular odorants that combine to make specific scents, built up since the 1940s through gas chromatography. McGee's 600-plus-page field guide is a paean to that "invisible nimbus of flying molecules," beautifully contextualized by a narrative mingling memoir, history, and findings from the lab.

Nose Dive is an imaginative as well as a scientific feat. From stardust to seaweed, McGee makes the smellable universe relatable. He invites us, too, to wonder at our own porosity—the fact that as we sauté garlic or sniff lilac, we are drawing physical molecules into our heads, an act connecting us "directly and intimately with the substances of the world." It's not just the human microbiome that makes each person a community, part human and part bacterial; it's the molecular neighbors that come and go too. And all the while, what McGee calls the "actively editing, synthesizing brain" attempts to make sense of this molecular minuet. The experience of smell, as Barwich too explained, is in large part subjective and relative.

The arc of *Nose Dive* is the biggest there is: the evolution of odorants from the Big Bang through primordial molecules, early single-celled life, animals, plants, waters, soils, and the products of culture and industrialization. McGee relates how stars, after developing in the early cosmos from hydrogen, helium, lithium, and the action of gravity, became "billion-degree ovens" cooking up the bulk of remaining elements—including life's central players, oxygen and carbon. Among the first molecules to emerge in dusty interstellar space were hydrogen sulfide, reeking of rotten egg, and benzene, with its gasoline whiff. "Lighter fluid or stove fuel, scorched oil, a vinegar dressing, a devilled egg": McGee's infant universe smelled like a barbeque.

He is enlightening on animal pong, which arises from the generation of power in protein-rich bodies: excreted protein and purine remnants with nitrogen or sulfur atoms are strong stuff. Cresols (phenol rings with a methyl branch) carry a "barnyardy" whiff, featuring in animal manures as well as smoke and petroleum products. Add an atom of nitrogen (the amino element) and the smell becomes putrescent.

As for the human animal, indole, skatole, hydrogen sulfide, nitrogenous ammonia, and other molecules in feces are the stuff of a "standard stink bomb." Yet other human smells are comforting, McGee notes, and may have been a reference point for early hominins, recognized "in roots and fire-scorched foods and aromatic seeds." Intriguingly, he suggests that the first farmers might even have cultivated human scents in foods. Cheese, for instance, is a "solid concentrate of proteins and fats" similar to human bodies, and attracts the same bacteria:

it may be no accident that varieties such as Époisses and Appenzeller distinctly whiff of "toe cheese."

It's the library of land-plant odors, however, that make up most of *Nose Dive*. As stationary organisms, their need to lure or deter led to "the unparalleled invention and manufacture of carbon chains and rings" in the thousands. McGee shows how volatile molecules emerge on byways off "metabolic highways," the biochemical reactions that transform sugars into (say) chlorophyll, allowing plants to build and maintain themselves. But he circles back soon enough to the sniffable and edible components of garden, basket, and cupboard.

The rich, heavy, fruity, woody aroma of damask roses, for instance, results from a torrent of volatiles, such as phenylethanol and rotundone. Strawberries have surprisingly buttery, cheesy, sweaty notes, while papaya whiffs of radish and violet, and yogurt of ocean air—the gift of dimethyl sulfide. Radicchio boasts waxy, minty notes; brown rice, fruity, vanilla, clove, smoky, caramel, and fenugreek aromas arising from aminoacetophenone, vanillin, vinyl guaiacol, and sotolon; and sweet potatoes are awash with mushroomy, fatty, cocoa, almond, and honey scents. If a glass of sauvignon blanc beckons, be prepared for the whiff of boxwood, blackcurrant, and cat urine (all courtesy of mercaptomethyl pentanone).

There is much more, from fermented foods to perfumes, but perhaps most compelling is McGee's breakdown of terra firma. I was curious about petrichor, the earthy smell that surges up when rain hits dry stone or earth. Except it turns out that what's activated isn't the minerals, but a volatile layer on them, emitted by animals, fungi, microbes, technologies, and humans, and modified by nitrogen, oxygen, and sunlight. It's yet another moment where McGee expertly reels the reader back to earth from his grand olfactory odyssey.

Muchembled's *Smells* is a dizzying ride of a very different kind, taking readers through one of the most odorous eras in European history. As he announces with grim finality, the stench in the early modern period "was dreadful and omnipresent, the air saturated with nauseating emissions and dangerous pollution."

Smells, he shows, both drove and were driven by shifting norms in urbanization, industry, the arts, medicine, and religion. Before 1620, poetry and literature were gripped by a Rabelaisian celebration of "joyous matter"—human secretions and excretions. Soon enough, Catholics and Calvinists were associating them with the devil, a belief that would shift only with time, advances in science and medicine, ideas of human rights, and improvements in sanitation.

Paris, long Europe's biggest city, was an epicenter of stench, with swelling populations of people, domesticated animals, and stray dogs. Many urban trades were malodorous, from the rotting waste of butchers to the use of feces, putrefied urine, and other noxious-smelling substances for processing by potters, painters, tanners, and fullers. Even in the nineteenth century, public health reformers noted that peasants piled dung heaps outside their doors as proof of wealth. Excreta also found its way into medical and beauty treatments. The 1689 book *Secrets of Beauty and Health* by the surgeon Nicolas de Blégny recommended distilled urine for wrinkle reduction.

Sewerage, where it existed, offered another source of revenue. By the late eighteenth century Paris had 70 sewers, but they frequently overflowed, offering financial opportunities in sludge clearance until the installation of mains drainage in the 1800s. Workers in sister trades were not so lucky. Latrine-scrapers were vulnerable to a potentially fatal condition called mephitism, caused by exposure to sewer gas; in 1777, Louis XVI appointed a commission of chemists to study its impact.

Fetor was inevitable in societies that monetized its sources so intensively. But moral arbiters were quick to craft olfactory taboos. During the sixteenth and seventeenth centuries, women were demonized for body smells, real or imagined: in his 1511 *In Praise of Folly*, the humanist Erasmus called postmenopausal women "stinking carcasses" who exhaled a "sepulchral odor." A reflection of the brutal misogyny of the period, this sheds light—as Muchembled asserts—on the era's witch hunts, which culminated in the deaths of many thousands of women.

The horrors of Europe's plague pandemic, stretching from the fourteenth-century Black Death through periodic eruptions in the late 1700s, added the odor of putrescence to urban fugs. Caused by the bacterium *Yersinia pestis*—spread by fleas or, in the pneumonic form, aerosols—the disease was thought by some to arise from "venomous vapours" linked to the toxic breath of Satan. That idea coexisted with the medical doctrine of contagion, which held that disease was spread through "corrupted" air, contact, or clothing.

Fighting fire with fire, physicians battled the pestilence by holding clumps of the foul-smelling, toxic herb rue in the mouth with garlic. Houses were fumigated using elaborate systems involving straw bales, vinegar, dishes of arsenic, turpentine resin, and sulphur, put on a slow burn. Rich citizens sniffed gold pomanders filled with concoctions of angelica, sandalwood, ambergris, musk, and nutmeg; the poor might carry clove-studded lemons. In the seventeenth century, the physician Charles Delorme devised a "hermetic" costume for plague doctors, including a nightmarish birdlike mask, its beak packed with herbs and perfumes, a wide-brimmed hat, and head-to-toe hide garments, gloves, and boots rubbed with camphor, ambergris, and balsam.

Thus European perfumery

partly originated in scent-soaked "prophylactic" clothing. But the animal notes of ambergris, civet, and musk began to lose favor by the 1700s, when what Muchembled calls a "new, powerfully hedonistic culture in celebration of the body" arose. From bathing to fresh floral scents, smell became associated with life—even ideas of progress. Yet revolutionary rhetoric masked ongoing inequity, and smells still reflected social and economic stratification: by the twentieth century, as the cultural historian Constance Classen has noted, it was workers and non-Europeans who were vilified for "smelling."

From our deodorized perspective, this human stew might seem unimaginable. But that has simply spurred some researchers to plunge back in. For instance, the $3.4 million "Odeuropa" project, slated in begin in January 2021, will bring together historians and artificial-intelligence researchers to re-create early-modern miasmas, while at University College London the heritage researcher Cecilia Bembibre has chemically extracted the scents of old books and leather gloves. Smell is an irrevocable part of the human story.

Indeed, if there's anything these four books tell us, it's that olfaction, ancient and unruly, is a sense that brings us back to ourselves, orients us, grounds us. As the biologist Lewis Thomas noted in a famous 1980 essay, the act of smelling is immersive, "remarkably like the act of thinking itself." He went further, writing that as a life science, olfaction "contains, piece by piece, all the mysteries."

They may be cracked at some point. In the meantime, wherever you are, stop for a moment and breathe deep. Take it from there.

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