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The Air We Eat

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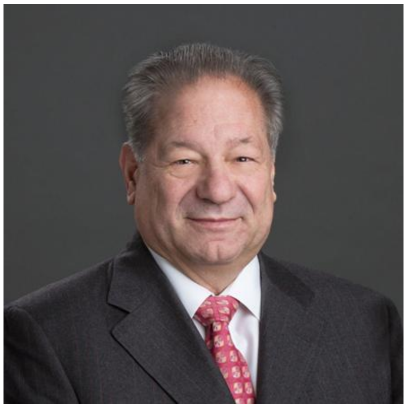

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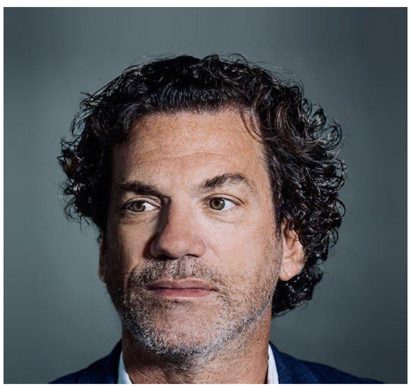

David A. Edwards, Ph.D., a scientist who explores new ways of improving human health and wellness by the air we breathe and the food we eat. Professor of the Practice of Bioengineering at Harvard University (2001-2019), he is a member of US and French national academies of engineering and recipient of many national and international awards and distinctions. His healthcare inventions have led to new pharmaceutical products, such as inhaled L Dopa (Inbrija) for Parkinson's treatment, and consumer health products, such as FEND, for airway hygiene. His food inventions have led to new food companies, such as Foodberry, and innovation restaurants in France and the US, including Cafe ArtScience. He has written several books on the creative process including *ArtScience: Creativity in the Post-Google Generation* (Harvard Press 2008) and *Creating Things That Matter* (Holt 2018), winner of the Nautilus Book Award in the category of creativity. His work has been widely reported in the media, including the *New York Times,* CBS, CNN, BBC, *Le Figaro,* among others. Photo: © Adam DeTour. LinkedIn.

The Air We Eat

Chef Massimo Bottura of Osteria Francescana (Modena Italy) making a cloud of orange over a duck reduction for guests at the conclusion of the Paris Flavor Cloud weekend at Le Laboratoire in 2012. View the video. The Flavor Cloud Weekend invited three of the top chefs in the world — Chefs Massimo Bottura, Ben Shewry (Attica, Australia) and Homaru Cantù (Moto, US) — to experiment with the culinary language of flavor clouds, generated by “Le Whaf,” a commercial version of the original flavor cloud carafe designed by French food designer Marc Bretilot in collaboration with David Edwards at Le Laboratoire, the art, design and science experimental cultural center in Paris founded and directed by Edwards from 2007-2014. Photo: © Le Laboratoire

While the sight of an apple pie or the astringency of the orange peel can each shape the memory of what we eat, our memories of the foods we love are mostly shaped by aroma.

Why this is true gets to how our olfactory bulb interprets scent signals in the up-and-down regulation of metabolism, how electrical signals travel from the olfactory bulb to near the hippocampus, our seat of long-term memory, and a rich exchange of sensory signals between the brain, the gut, and the air we breathe that ultimately shape what we eat and why.

Understanding this cephalic dialog between our guts and the air around us is helping scientists, psychologists, engineers, and chefs reshape the food experience to enhance nutritional value, equity of access, and pleasure.

When children smell fruit, before they eat fruit, they eat more calories of fruit than when they smell nothing at all (Dazeley & Houston-Price, 2015). After smelling fruit, kids are more likely to choose to eat fruit when given a choice between fruit and, say, a French Fry (Shepherd, 2012). Smelling the aroma of dark chocolate inclines us to eat more calories of chocolate, while, after a long while of smelling the aroma of dark chocolate, we can feel satiated (the same is not true of milk chocolate), as if we have actually eaten the chocolate, when we haven't (Bentivegna et. al., 2017). Prolonged exposure to the aroma of roasted coffee beans turns on genes and expresses proteins in the brain associated with sleep deprivation (Seo et. al., 2008). We stay awake longer while when we perceive the coffee aroma in a humid room relative to a dry room, it impacts us even more (Wang et. al., 2013). All of this metabolic wonder of olfaction takes place in our brains essentially without ingestion.

And while we may be familiar with the power of the morning's coffee wafting aromatically up the stairs, it is only today that the science of olfaction is giving us the tools to translate this power beyond aromatic rituals of food into other occasions, and other circumstances, that may help us address some of the tall challenges of our current food system.

Olfactory signals come to us in two ways. You may not think of it this way, but it is very hard to understand why olfaction plays such a fundamental role in our lives without awareness of this dichotomy of smell.

The smell of the roses, which we perceive from molecules that drift from the roses through the air around us and into our noses, is what scientists label as orthonasal scent. The smell of chocolate, which we perceive while we eat chocolate, and our brains interpret as "flavor," i.e., as if the signal were coming from our mouths, as we chew, comes from the air exchange between the backs of our mouths and our noses. Scientists call this form of olfaction, retronasal scent. Dogs are especially good at perceiving orthonasal scent, not least of all because dogs have many more olfactory receptors than we do. Beyond this, the anatomy of dog noses is particularly suited to sniffing out the smells around them. Meanwhile, we humans actually perceive retronasal scent better than dogs (one of the reasons why a dog happily eats the raw meat we easily find revolting). Why? The anatomy of the human mouth and nose makes flavor perception extremely precise.

You've probably had the experience of pinching your nose while you eat, say, a banana, and only perceiving sweetness. Release the nose pinch, and almost immediately, you know you are about to swallow banana, and not, say, marshmallow, which may have tricked you with a similar mouth texture. Why should the human nose and mouth have developed this excellent olfactory dialog?

Here's a hint. While we can perceive at least five tastes —sweet, bitter, umami, sour and salty being the principal ones — we seem to perceive as many as a trillion scents or flavors (Bushdid et. al., 2014)! So even while de facto, relative to a hyena, we rely quite little on our noses for the perception of orthonasal scent, there seems to have been a strong human evolutionary reason to develop an incredibly sensitive olfactory ability.

Olfactory sensations are indeed the only sensory sensations with direct access to the brain. Taste sensations, for instance, being triggered by the binding of certain molecules in our food and taste receptors in our mouths, are not directly delivered to the brain. Flavor images in our brains, which science indicates are at least 80% olfactory (Shepherd, 2012), help us remember, and crave, the best foods, and have aversions to the foods that can hurt us, helping us to survive, and thrive, long before we had anything resembling the food guidelines of today.

For most of human history, our brains figured out what foods we needed and guided us to eat the right things at the right moments, by the power of olfaction.

Clearly, the air we eat matters. How can we design it in our restaurants, cafes, cafeterias, and hotels to help the most people eat in ways that benefit them the most, and to go on benefiting long after they have left us?

These are questions that have long been pondered if in ways less cognitively connected to the science of flavor. In many meaningful and highly effective ways, the design of the air we eat is the craft of the chef, the food scientist, and even the farmer …

The evolution of our food system in the direction of fresh, organic, regenerative, local produce is, beyond being a very smart move for the sustainability of our environment, a great choice when it comes to delivering the best food signals through the air and into the minds of consumers. Diversity of natural colors, diversity of dishes, and small portion sizes can again be seen as design choices that favor the best food signals and signal duration. There are many good reasons why small portion sizes, and fresh organic foods, provide the best nutrition, while we understand today they are also smart when it comes to flavors that get remembered for the best reasons and encourage people to eat the foods that will nourish them most and longest.

Recognizing the deep learning that is inherent in the history of food and hospitality, here are a few rules from the science of flavor that might help us build on this learning new experiences and benefits.

A first rule is dose control. When we design a scent or a flavor from which anyone is to receive the benefit we should bear in mind that after around 10 minutes of perceiving a particular scent or aroma our olfactory receptors “saturate,” meaning we no longer smell or experience the flavor. We’ve all had the experience of walking into a hotel lobby and smelling a lovely (or not so lovely) scent, and a little while later losing track of the scent completely. Where did it go? Why did we care so much when we first walked into the lobby, and not at all by the time we checked in? The same is true of food — eating a bite of chocolate cake tends to be far more exhilarating than eating a pound of chocolate cake over an hour of sitting around. Because of this issue of saturation (or olfactory “blindness”), for great foods and scent-associated experiences to be most remembered, scent and flavor need to be carefully dosed to move us. Ellen Langer writes more of this in her article on Mindful Chocolate.

A second rule is diversity. Scent and flavor signals can be thought of like notes of music — and linked together into songs that transport us or drive us mad. The design of a scent and flavor experience is not only good cuisine (and interior design) — it is essential to shaping human experience, memory, and even human wellness. How this works science and technology are still figuring out — the fascinating topic that Nancy Rawson and Rachel Field write about in their article.

A third is water. This may surprise you. That we perceive scent and aromas more powerfully when the air is moist than when it is dry (Wang et. al., 2013) gets to what happens to the dialogue between odorants and olfactory receptors as your nose dehydrates. In normally hydrated conditions, the interface between the air in our noses and the olfactory receptors on our olfactory neurons is a watery layer (called airway lining fluid) that contains on top of it a layer of mucus and below it cilia that move the mucus toward the mouth, where we swallow it. This role of mucus is critical to respiratory health as it helps captures inhaled contaminants and remove them before they make us sick. When an odorant (which typically is rather water-averse) arrives from inside our mouths or the outside air it contacts this water, some of it remains at the surface, and some of it diffuses through the water layer to get to the olfactory receptors. Since the odorants are not too excited to become all watery, they do better when they can bind to what scientists call “olfactory binding proteins” that carry the odorants to the olfactory receptors where they can jump off and deliver a scent signal. When our noses become dry, the olfactory binding proteins can denature, and the olfactory receptors be hard to reach — meaning we perceive scent and flavor less well! How this works and what it means to the design of food and fair access to nutrition are topics we take up with Touré Roberts — and Marty Kolewe and Stefan Catsicas take up in their article on the future of food.

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