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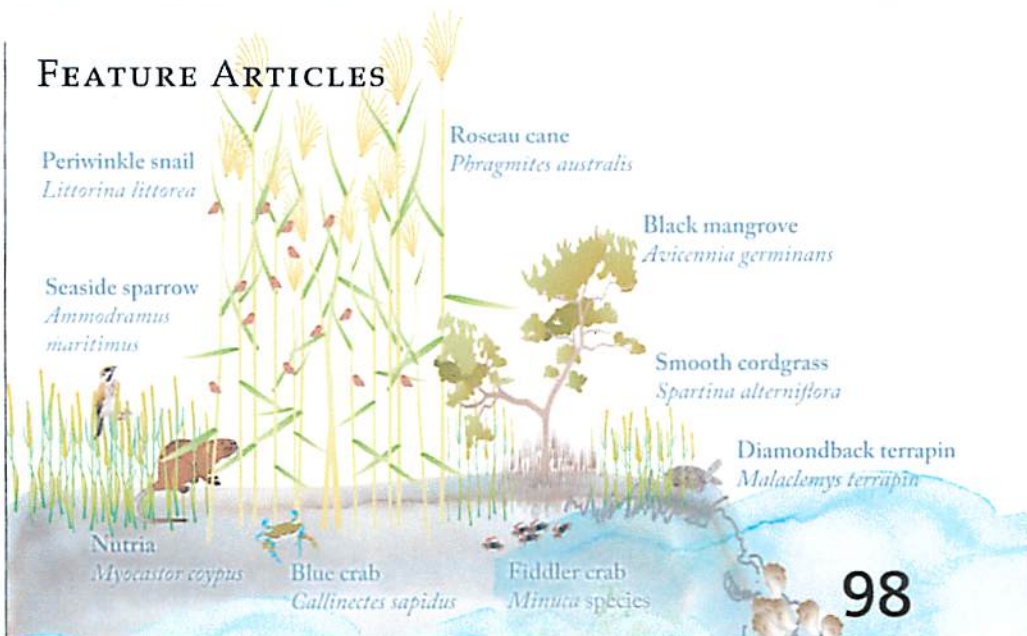
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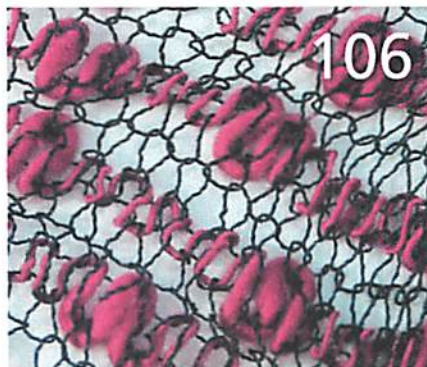
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THE COVER

Louisiana's Highway 1 passes through miles of eroding wetlands in Jefferson Parish. Ridges called *cherniers* mark where the barrier island beach once was. This stretch of road traverses along the barrier island southwest of Barataria Bay, between Grand Isle and Port Fourchon. This island helps protect the bay and has benefitted from the Caminada Headland restoration, which enhanced beaches and dunes near the highway, a critical hurricane evacuation route. In "Renewed Hope for Coastal Marshes in Louisiana" (pages 98–105), Paige Byerly, Bethann Garramon Merkle, and Megan Hepner talk about the restoration of another Louisiana barrier island, Whiskey Island, as an example of the efforts to curb the state's rapid loss of saltmarshes. These marsh ecosystems harbor a diversity of flora and fauna, and also provide protection from storm surges and erosion. Before the Deepwater Horizon oil spill in 2010, many of these plants and animals were not monitored. Today, new data are emerging to provide a fuller picture of marsh ecology. (Photograph taken by Ben Depp in 2014.)

The Root of Misaligned Jaws

The sudden rise in prevalence of crooked teeth is likely related to industrialized diets and environments, rather than genetics.

Sandra Kahn and Paul R. Ehrlich

This is a story about a vast and serious epidemic afflicting the developed world increasingly over the past few centuries, one that has gone virtually unrecognized. The epidemic's roots lie in cultural shifts in important daily actions we seldom think about; we just do them automatically. We don't think about chewing, breathing, growing, or sleeping, or the position of our jaws when we're not eating or talking.

Simple and normal actions, yes. But, we argue, if repeatedly done in certain ways, early in life especially, over time they can undermine your health and alter your appearance in some surprising ways. If you keep your jaws apart and breathe through your mouth rather than through your nose for a few days, bite your tongue once in a while, or have insomnia for a few nights, you are going to be just fine. On the other hand, if from an early age you develop the habits of perpetually breathing through your mouth, eating mostly soft foods that require little chewing, and sleeping restlessly, snoring and squirming through every night, that could lead to distorted development of your jaws, face, and airway and to serious health problems later on. You would be a victim of a growing epidemic that may have far-reaching

health consequences ranging from eczema and depression to increased instances of heart disease and perhaps even Alzheimer's disease.

People in modern industrialized societies are plagued by small jaws and crowded, ill-aligned teeth, a condition that the dental profession refers to as *malocclusion* (literally, "bad bite"). Malocclusion is often accompanied by mouth breathing. Together, the two are increasingly common. William Profit, author of the most widely used textbook in orthodontics, pointed out the scale of the epidemic in the United States in 1998:

Survey data reveals that about a fifth of the population has significant malocclusion, and irregularity in the incisors (crowding of the front teeth) is severe enough in 15 percent that both social acceptability and function could be affected. Well over half have at least some degree of orthodontic treatment need.

These statistics are the sign of a huge and growing public health problem, one that is persistently misunderstood as a superficial issue of cosmetics or, at most, oral hygiene.

More than Teeth

The focus of almost all orthodontic practitioners today is crooked teeth, the straightening of which is the bread and butter of the orthodontic trade. But it may be that most orthodontists are concerned with the least of the jaw-related problems. Crooked teeth, other than their effect on appearance, are virtually harmless. Crooked teeth are, however, a signal of a more basic problem: poor development of the jaws. And distorted jaws influence more vital functions. For example, more than 10 percent of children may now have jaw-related potentially dangerous interrupted breathing

at night; in one study in an urban area of Brazil with a total population of 23,596, 55 percent of a randomized sample of 370 children aged 3 to 9 years were mouth breathers.

It's important to note that the two of us had no idea a jaw-based "epidemic" was happening until one of us (Kahn) discovered its symptoms in her own children. Like the vast majority of people, even with our long-term scientific interests in public health, we had no awareness of an epidemic that could be of substantial importance. The "jaws" epidemic was concealed behind the commonplace. Its most obvious symptoms are oral and facial: crooked teeth (and the accompanying very common use of braces), receding jaws, a smile that shows lots of gums, mouth breathing, and interrupted breathing during sleep. A bother, but hardly an "epidemic"—at least not until one recognizes that underlying these symptoms are potentially serious diseases, many related to the stress of poor sleep.

Escalating attempts to straighten teeth, to treat one of the epidemic's most prominent symptoms, are one obvious indicator of the scale of the epidemic. Having braces as a child has become so common in the Western world that it can seem a rite of passage. Today an estimated 50 percent to 70 percent of children in the United States will wear braces sometime between the ages of 6 and 18. It is not clear how much of the increase in use of braces in recent years is a response to a great explosion of malocclusion and how much of it is a consequence of less expensive tooth-straightening appliances, better marketing by dentists, and changes in attitudes on appearance in a photo-addicted society. Ironically, the effects of braces may not always be as beneficial as people have been led to think. Braces may actually reduce the size of the airway, leading

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Modern diets tend to favor soft foods over harder ones, with an unexpected result: The reduced need for vigorous chewing can lead to improper development of the jaw. When compared with a human skull dating from the 14th century (right), a modern human skull (left) shows jaws that are poorly aligned, protruding front teeth, and too little space for the third molars, or wisdom teeth.

eventually to problems in breathing, such as sleep apnea.

That such diseases are related to modern civilization is strongly indicated by the near absence of their symptoms in the evolutionary and historical record. Our hunter-gatherer ancestors had spacious jaws, with a continuous smoothly curved arch of teeth in each jaw, including third molars ("wisdom teeth") at the back ends of the arches. Further, the oral-facial epidemic of modern times, although rooted, we believe, in the agricultural revolution, was very slow in starting. Recently, a cemetery of common people of the Amarna culture of ancient Egypt, dating to more than 3,000 years ago, was discovered. The skeletons had the tooth wear characteristic of preindustrial peoples, the investigators noted:

Except for the occasional slight incisor crowding and rotation, observation of the teeth indicated that they were well-aligned with very good to excellent occlusion, in general. Thorough analysis of dental data from the Amarna burials has shown that Egyptian and most ancient teeth have extensive tooth wear on occlusal (chewing)

surfaces of even the youngest individuals. Malocclusion is rare in Amarna but very common in America; tooth wear is extensive in Amarna yet rare in America.

The anthropological evidence strongly indicates that the epidemic of oral-facial problems can be traced not to our genes but to changes in our culture, particularly to ones in how and what we eat and where we live. These have changed greatly from those of the Stone Age, in complex patterns starting around the time people began to settle down and practice agriculture. As anthropologist Clark Larsen observed in 2006, "There has been a dramatic reduction in the size of the face and jaws wherever humans have made the transition from foraging to farming."

Moving Jaws Forward

With proper attention to our children's diet, eating habits, breathing patterns, and what we term "oral posture" (how they hold their jaws when not eating or speaking), we believe that many aspects of the malocclusion epidemic could be ameliorated or avoided entirely. Jaws could return to their hunter-gatherer and Amarna patterns

of growth. The views expressed here are not typical of the dental and orthodontic mainstream, but we feel these somewhat heterodox ideas need to get a hearing. There is some history for the minority view we present, especially in the work of orthodontist John Mew, beginning in the 1970s. Mew successfully treats patients by returning distorted oral-facial growth to its normal course through *orthotropics*, a program that encourages normal jaw growth and development. But the name is easily confused with standard *orthodontics*, from which it has major differences. As a result, one of us (Kahn) renamed *orthotropics*, calling it *forwardontics*. *Forwardontics* is a more descriptive term and it includes all treatments that focus on forward development of teeth and jaws in both children and adults.

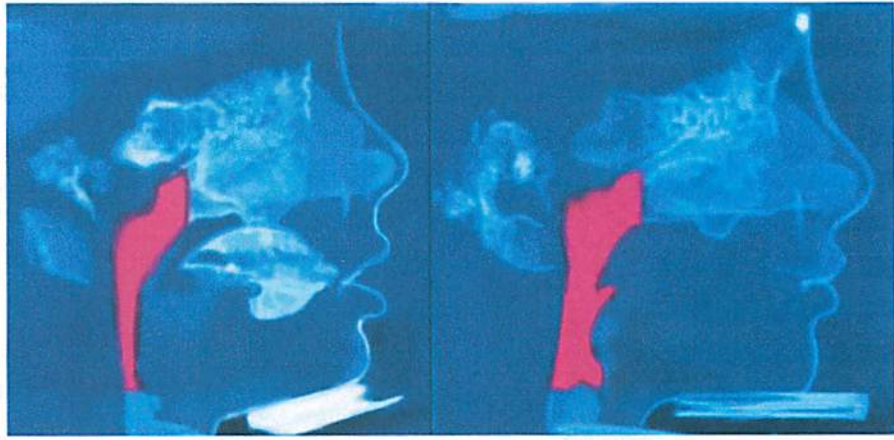
Some of this information has been around for a long time, simple advice that may start to sound like your mother telling you to "eat with your mouth closed," "sit up straight," and "chew your food." Well, Mom was onto something: She didn't realize that what she was asking for was not just about manners and being polite, it was also one dimension of forestalling a trend that has now become a public health problem. The oral-facial epidemic seems to have developed over centuries, but it has accelerated as a result of common practices associated with our highly industrialized Western

civilization, which has taken over the world since World War II.

The human face provides visible signals that could indicate serious underlying health problems. Using fixes such as braces or plastic surgery to solve our health problems and adjust our smiles may in some cases lead to additional problems in the long term.

Changes in Jaw Growth Patterns

The term *jaws* may remind us first and foremost of sharks, but human jaws are really at the center of our story here. Our upper jaw, or *maxilla*, seems as if it is just the base of our skull, but it is actually formed by two bones, one on each side, fused together. Our lower jaw, the *mandible*, is likewise made by the fusion of two bones. If the jaws develop correctly they have ample room for all the teeth, and the teeth fit together well. Both upper and lower jaws can move and change in the process of development. That process has been gradually changing ever since our ancestors began to use tools and cook, ceased their mobile hunting-gathering lives, and settled down to practice agriculture some 10,000 years ago; they



Oral posture—the way we habitually hold our mouth, jaws, and tongue when eating, talking, or at rest—has received little attention from medical practitioners, but it plays an important role in lifelong health. Poor habits of oral posture, such as chewing with one's mouth open or breathing through an open mouth (left) rather than through the nose (right), can chronically restrict the airway in the throat, raising the risk of sleep apnea and a host of related disorders. (Unless otherwise indicated, all images are courtesy of the authors.)

long process, natural selection kept children's development occurring in ways that produce a harmonious whole in a wide variety of natural environments.

Natural selection has led our species to function in a postnatal environment in which the developing person will gain nutrients by eating in a certain manner.

than those with other configurations. In other words, members of industrial societies—us—still must work with DNA plans that evolved for building individuals in a hunter-gatherer environment. We have entered the Space Age with Stone Age genes that evolved to produce jaws adapted to a hunter-gatherer diet. This has had some unfortunate consequences.

In the Stone Age, human DNA evolved into plans for wide upper and lower jaws in which all the teeth fit without crowding and the jaws met without malocclusion. That DNA, interacting with that environment, resulted in ample airways. Since the agricultural revolution and then the industrial revolution, however, that eating-resting environmental pattern has been dramatically altered. Societies have culturally adapted to changes such as the easy availability of softer weaning foods after the invention of agriculture and the comfort and safety of moving indoors once perpetual wandering in search of food was no longer required.

Our jaws are a product of genes and environment, but the environment has changed dramatically over the course of a few millennia, while the genes have not. The result is a decline in what we've called *oral-facial health*, and this is why we've had to look elsewhere than major genetic change to explain the rise of malocclusions and other modern oral-facial problems.

Shut Your Mouth

As far as we can discover, the changes in jaws with new diets and urbaniza-

Using fixes such as braces or plastic surgery to solve our health problems and adjust our smiles may in some cases lead to additional problems in the long term.

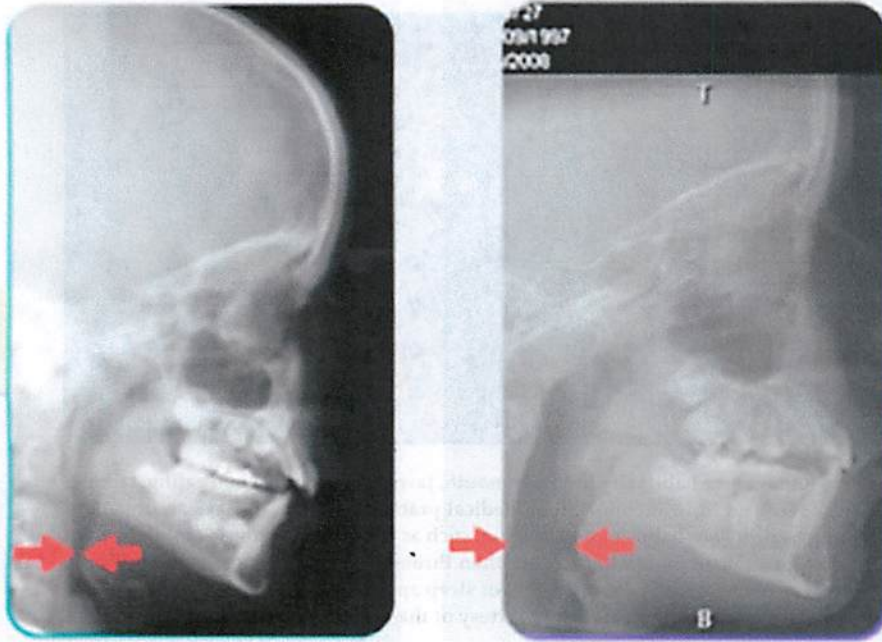
then marched on to create the civilization we know today. The superficial result, as we have seen, is malocclusion.

The evidence shows that some common notions about malocclusion are wrong. A predominant story is that malocclusion is caused by bad mixes of genes. But in fact badly fitting teeth are not usually caused by bad genetics or by parents having contrasting genetic endowments for facial structure—say, inheriting dad's giant teeth and mom's dainty jaws.

With extremely rare exceptions, everyone is born with the DNA that allows normal development of teeth, jaws, and tongue. After all, for thousands of generations individuals with a working combination had more offspring than those who couldn't eat so well—natural selection in action. Through that very

The individual will learn to crawl, toddle, and walk, providing the environment that will interact with the DNA to produce strong leg muscles. The person will also, in the right environment, counter the force of gravity tending to drag down the lower jaw. That "right" environment, we argue, is created by tough foods, much hard chewing, and, when not speaking or eating, holding the mouth closed with teeth in light contact and the tongue resting on the roof of the mouth (palate). That's the environment in which the jaws should spend most of their time, especially at night, when growth takes place.

Genetic endowments take many generations to evolve in response to novel environments, and they only do so when individuals with certain DNA configurations reproduce more



In contrast to conventional orthodontic practice, with its focus on repositioning the teeth along the jawline, orthotropic practice aims at realigning the jaws themselves. As seen in this pair of x-ray images before (left) and after (right) treatment, orthotropics brings the lower jaw forward, leaving the teeth intact. The red arrows indicate the significantly different width of the airway in the two images.

tion were first noticed and recorded in the 1830s. For two decades before the American Civil War, a Philadelphia attorney named George Catlin, a talented artist, made a series of trips to the American West that would make him famous as a painter and ethnographer of Native Americans. He saw a group of Native Americans passing through Philadelphia, became fascinated by them, and decided to document their ways of life. He ended up claiming to have visited 150 tribes with more than 2 million members throughout the Western Hemisphere. Catlin's portraits of Native Americans, made before their cultures were altered by contact with European cultures, form an invaluable archive, now housed in the Smithsonian American Art Museum.

In his travels among those who had been relatively isolated from the culture of the European settlers, Catlin was struck by the difference in facial structure and bearing of the Native Americans compared with the people of European background he had grown up with. Among the Mandan tribe living in what is now North Dakota, he examined several hundred bleached skulls.

I was forcibly struck with . . . the almost unexceptional completeness and soundness (and total absence

of malformation) of their beautiful sets of teeth, of all ages, which are scrupulously kept together, by the lower jaws being attached to the other bones of the head.

He noticed that the Native Americans slept outside, and they kept their lips closed nearly all the time. Their women breastfed, and as soon as her baby was

Badly fitting teeth are not caused by parents' contrasting genetic endowments for facial structure—say, inheriting dad's giant teeth and mom's dainty jaws.

off the nipple after feeding, the mother would close the infant's lips with her fingers. This was not something the mothers of European background did.

Catlin, originally a mouth breather, observed that the Indians never breathed through their mouths and were extremely healthy. As a result he changed his own pattern of respiration and taught himself to breathe through his nose.

He wanted to convince others of the health advantages of the indigenous

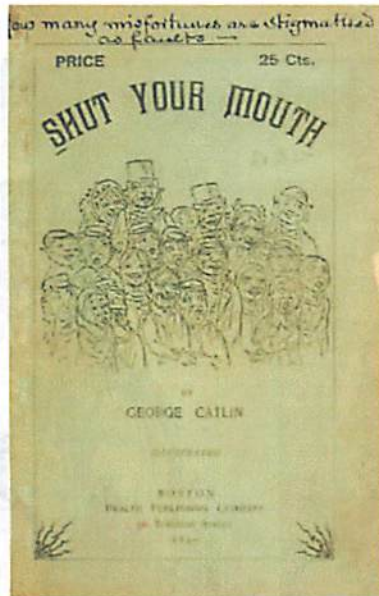
ways. To this end he wrote a short book, *The Breath of Life* (1861)—with subsequent editions appearing in the 1870s as *Shut Your Mouth and Save Your Life*—which condemned mouth breathing and assigned an array of ills to it, including “derangement” of the teeth, that seems remarkably prescient of the jaw derangement that is epidemic today and creates a vast business for orthodontists.

A Modern Shift

Catlin at first may appear rather kooky in some of his views, or at least eccentric. He was writing more than 150 years ago and believed malaria was related to mouth breathing and “poisonous particles in the air,” a belief he shared with members of the medical profession of his day. He was also kooky for his day in his admiration and empathy for Native Americans, whom he saw as examples of the “natural men” living in harmony with nature, idealized in the Enlightenment. He also saw them, rightly, as being abused. He was, above all, a brilliant observer, way ahead of his time in recognizing many threats posed by mouth breathing. And later research would show that he was on to something, even if not always for the right reasons.

Anthropologists have reported that the size of the human mouth has long been shrinking. Because human beings have been using stone tools for at least 3.3 million years, that may represent the

time during which the shrinkage has occurred. Stone tools permitted a greater shift to carnivory because the ability to cut meat into small pieces reduced the amount of chewing required to extract nourishment. Less chewing reduced the need for large, powerful jaws. The same can be said for being able to use stone tools as pestles for grinding food into small, more easily digested fragments. Cooking also reduced the chewing time needed to acquire the nourishment re-



Artist George Catlin traveled throughout the American West in the 1830s and studied the appearance and the folkways of Native Americans with great attention. His book *Shut Your Mouth and Save Your Life* (center, originally published in 1861 as *The Breath of Life*) included sketches in which he characterized the contrast between the healthy, closed-mouth sleeping posture of Native Americans (left) and the fretful, open-mouth snoring of Europeans (right).

quired to support energy-demanding big brains, but tools preceded cooking by as much as a million and a half years.

Stanford evolutionist Richard Klein, a top expert on our species' fossil record, has told us that he personally had never seen an early human skull with malocclusion. This pattern has been confirmed by Harvard evolutionary biologist Daniel Lieberman in his book *The Human Body*:

The museum I work in has thousands of ancient skulls from all over the world. Most of the skulls from the past few hundred years are a dentist's nightmare: They are filled with cavities and infections, the teeth are crowded into the jaw, and about one-quarter of them have impacted teeth. The skulls of preindustrial farmers are also riddled with cavities and painful-looking abscesses, but less than 5 percent of them have impacted wisdom teeth. In contrast, most of the hunter-gatherers had nearly perfect dental health. Apparently, orthodontists and dentists were rarely necessary in the Stone Age.

Nevertheless, dental crowding has been documented in one sample of remains from France dating to a couple of thousand years ago. And it was recently reported in a

single early anatomically modern human from Qafzeh cave in Israel, dated to about 100,000 years ago.

These examples show that malocclusion could occur even in our distant ancestors, which is hardly surprising, considering the varied environments to which they were exposed. Perhaps the early French population had an unusually soft diet; that factor is suggested by the relative lack of wear on



This 1849 portrait by British artist William Fisk shows George Catlin as a striking-looking man, simply dressed. Although he said he was a mouth-breather early in life, the firm jawline evident in this painting indicates that his oral posture had improved.

the teeth. Malocclusion can also occur in modern traditional societies and has been documented in one highly inbred Amazonian population, showing that proper oral-facial development can sometimes be disrupted at a population level by genetic factors. Likewise, the Qafzeh individual's crooked teeth could have been related to his or her genes if there had been a high level of inbreeding in that population.

But overwhelming evidence indicates that as foods became softer and more refined, malocclusion increased and jaws shrank. Archaeological evidence shows that crooked teeth were extremely rare among hunter-gatherers and that dental crowding was less common among early agriculturalists and people of the medieval period than in industrial populations. For example, a comparison of 146 medieval skulls from abandoned Norwegian graveyards with modern skulls indicated "a significant increase in both the prevalence and the severity of malocclusions during the last 400 to 700 years in Oslo, Norway," according to a study by Jon Petter Evensen and Bjørn Øgaard published in 2007 in the *American Journal of Orthodontics and Dentofacial Orthopedics*. The skulls of people scored as being in "great" or "obvious" need of orthodontic treatment made up 36 percent of the medieval sample and 65 percent of the modern sample.

On the jaw size issue, Swedish orthodontist Lennart Lysell made extremely careful measurements of skeletal remains from a medieval



In his paintings of Native Americans, George Catlin often highlighted their proud bearing and fine posture. Some portraits, such as “Chee-ah-ka-tchee, Wife of Not-to-way” (left) and “Tunk-aht-oh-ye, Thunderer, a Boy, and Wun-pan-to-mee,



White Weasel, a Girl” (right) show the correct oral posture in children as well as adults that Catlin observed in indigenous populations and described in his book *Shut Your Mouth and Save Your Life*.

graveyard uncovered in excavations connected with the construction of an airfield in 1951. He worked with the skulls of some 97 adults representing the individuals with the most teeth preserved out of roughly 250 skeletons from the 11th to the 13th centuries. Lysell also considered whether the sample of me-

His basic results were confirmed in a study by dentist Christopher Lavelle published in 1972 in the *American Journal of Physical Anthropology*. Lavelle’s study compared 210 lower jaws from skulls of the Romano-British period (43–410 CE), the Anglo-Saxon period (410–1066 CE), and the 19th century. The size of British

The Age of Braces

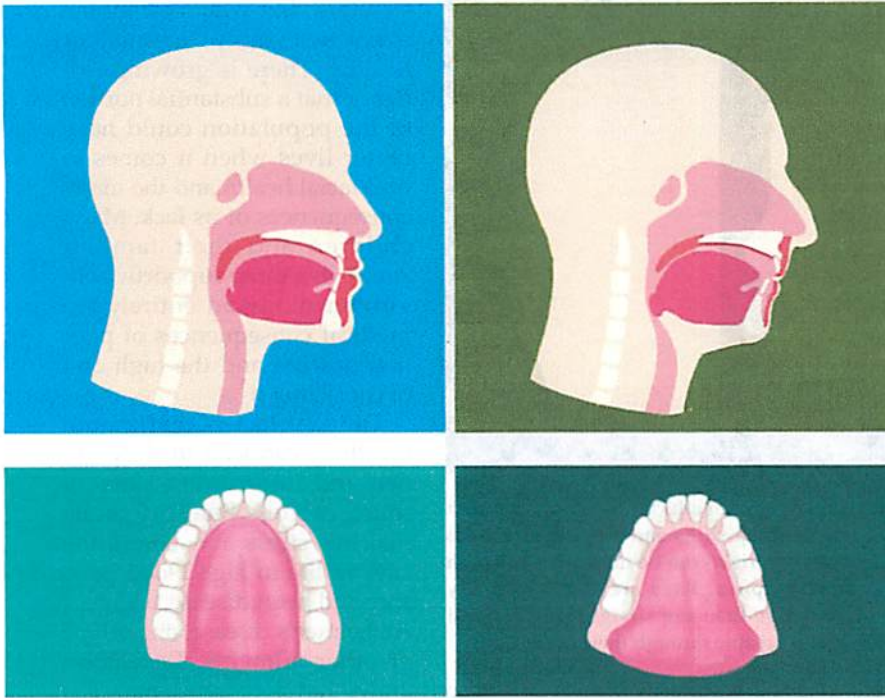
Much more information on diets and jaws is needed to accurately map out the initial course of what has become a pandemic of overcrowded jaws. Yet evidence shows that people switching from traditional to industrialized diets can manifest oral-facial changes in a single generation. Thus it seems likely that the progressive shrinking of jaws suddenly accelerated with industrialization. More information on the pattern of diet-softening over the past thousand years would certainly be desirable to help pin down diet’s contribution to jaw development. Sadly, most of the literature on dietary change focuses on the nutritional content of foods and its influences on diseases such as diabetes and obesity, and not on toughness-softness and jaw development. Be that as it may, the speed of the transition to the age of braces indicates that cultural rather than genetic changes have been primarily responsible for increasing malocclusion.

One bottom line in this array of evidence is, as anthropologist Peter Lucas and his colleagues have concluded, that changes in the toughness of diet in mam-

Evidence shows that people switching from traditional to industrialized diets can manifest oral-facial changes in a single generation.

dieval Swedish skulls was representative of the general population then and compared his skull measurements with those previously published of modern Danish and Swedish samples of skulls. His results, like those of some other Swedish investigators, suggested that there had been a detectable reduction in jaw width since the medieval period.

jaws was also declining as the modern age came into being (and the coarseness of the diet was reduced). Well-preserved skulls from four or five centuries ago show almost no malocclusion. In addition, there is much evidence supporting the anthropologists’ conclusion that jaws and faces do not grow to the same size and shape now that they once did.

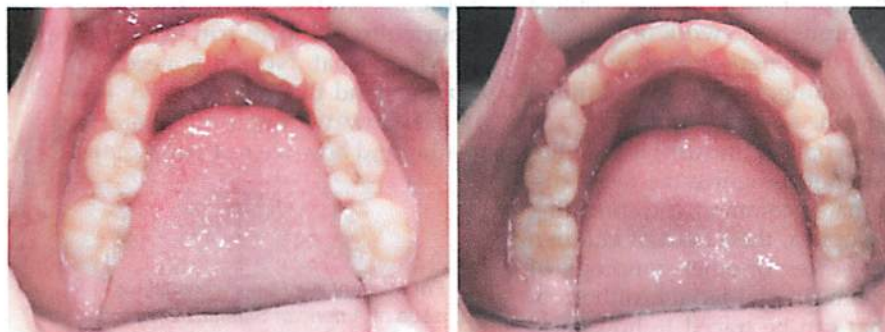


In Western orthodontic practice, when the jaw appears likely to become too crowded with incoming teeth, a common solution is to extract some of the teeth. However, this intervention can lead to several other problems, including the risk of sleep apnea brought on by allowing the tongue to drape back into the throat (right). By contrast, orthotropic expansion—that is, correct oral posture that brings the lower jaw forward—creates more space for the tongue (left).

mals can result in small jaws and malocclusion: “Dental crowding in modern humans is considered the combined result of tool use to comminute [pulverize] foods and cooking to modify their mechanical properties, such as toughness.”

Mouth breathing, especially from increasing allergies and stuffy noses (often from circulating colds in child-care centers) in children, appears to complete the story. These cultural changes, especially the trend toward eating softer foods, appear to have led in turn to progressively more alteration of jaw development and in some cases too little

room for the last molars (wisdom teeth) to erupt (emerge from the gum), a phenomenon known as *impaction* of wisdom teeth. Impaction of these teeth too often results in their routine and often unnecessary extraction in the United States. In addition some 11,000 patients annually suffer permanent numbness of the lip, tongue, and cheek tracing to injury to nerves during the surgery. In a 2007 article in the *American Journal of Public Health*, dentist and public health expert Jay W. Friedman estimated that roughly two-thirds of the extractions are unnecessary.



Dental health professionals nowadays, when confronted with a patient whose jaw appears to be too small to hold a full set of teeth, usually respond by recommending that some of the teeth be extracted to create more room. The patient whose mouth is pictured here before (left) and after (right) orthotropic treatment has achieved straighter teeth and a roomier jaw with more room for the tongue, without removing any teeth.

Refocusing on Prevention

The predominant causes of malocclusion, in our view, appear to be an open mouth too much of the time in childhood and failure to maintain proper oral posture for extended periods, especially when asleep. These habits, along with habitual mouth breathing, possibly less breastfeeding and new patterns of weaning, modern diets and eating implements that impede development of proper muscle tone from chewing hard, and living mostly indoors, are major factors in causing distorted facial development. These problems are part of health issues worldwide in which the predominant focus is not on prevention but on management, so much so that in the United States and much of the rest of the world it would be more honest to call the “health care” system a “health repair” system. It’s the difference between fostering wellness and the more typical policy by default of managing disease as an afterthought, which, in the United States and elsewhere, creates a gigantic economic burden. That huge cost could be greatly reduced by giving primacy to prevention.

A need among so many for braces is not an inevitable part of growing up. There are actions you can take on your children’s behalf to avoid that need. Finding professionals who will help you avoid the need for braces or give you reliable information on the range of choices and the likely consequences of each is difficult, however. If you have poked your nose into the internet or your local health community, it is almost certain that you will find little or no access to forwardontic, orthotropic, or oral-postural therapists.

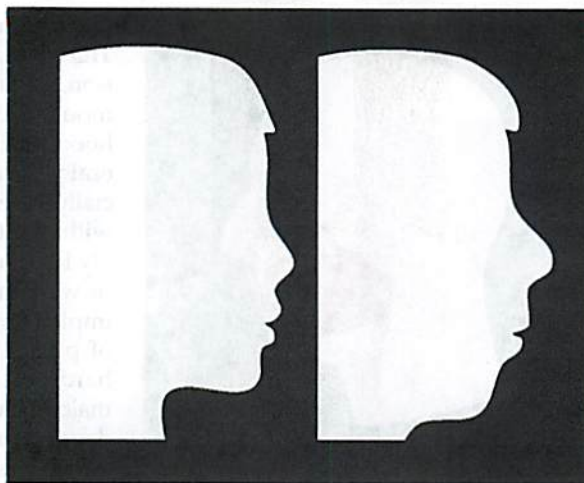
Some of the options that orthodontists provide now include choices such as “if you want your teeth to be straight, we need to pull some of them, and if you want to keep all of them, the alignment may be poor.” Surgical options to enlarge jaws so that more teeth will fit in neat rows are also offered, but they naturally are less popular because of pain and expense. However, orthodontists rarely present the option of stimulating jaw growth of young children and sustaining that growth in balance throughout the developmental period. Because this is technically possible, it should be presented as an option, despite the greater time, expense, and patient commitment needed.

Growing evidence suggests that breathing through the nose with

mouth closed, with teeth in light contact and the tongue resting on the roof of the mouth, is the key to preventing, or at least ameliorating, the ills we've discussed. As children leave infancy, they need regular training to lead a healthy life, which means a lot of focus on posture. Obviously, a child cannot constantly be thinking about having his or her mouth in the proper posture, so muscle memory must be established to activate the muscles in the jaw even while the child is distracted or sleeping. These periods of rest are where the "posture" part comes in.

One of us (Kahn) uses an oral posture exercise program (GOPex) in her practice. It is a set of simple exercises developed by dentist Simon Wong, a pioneer in finding solutions to oral-facial problems. GOPex is designed to develop correct oral posture and to achieve balanced growth of faces, throat, and teeth.

The exercises are partly based on the maxims of good old-fashioned table



Oral posture can have a long-term effects on children's health and appearance. The receding chins and sloping foreheads caused by mouth breathing (*right*) can be indicative of health problems, such as sleep apnea. They are also commonly judged to be less attractive than the straight profiles and strong jaws of those who breathe through their noses (*left*).

required, and the results in improvement of health and facial appearance are often dramatic.

Forwardontics develops good oral posture to counter the forces of gravity that tend to pull the upper jaw down, just as developing overall good posture allows us to oppose the forces

standard. But what is common is not necessarily "normal" or healthy. There is growing evidence that a substantial portion of the population could have better lives when it comes to oral-facial health and the many consequences of its lack. Many children and their families could, in a more supportive environment, avoid entirely the medical consequences of poor oral posture and the high cost of correcting it.

The key fact is that mouth breathing can lead to sleep apnea and interrupted sleep, a source of stress. Studies indicate that this stress may contribute later in life to high blood pressure and heart disease, allergies, Alzheimer's disease, and a host of other ailments. Recent re-

search shows that sleep apnea may also compromise the blood-brain barrier. That barrier generally keeps harmful bacteria, infections, and toxic chemicals that can lead to serious illnesses from entering the brain. We must note, however, that these findings should not be overinterpreted—much more research is required to establish the existence of any causal relations.

One obvious need in moving in this direction is for more information to be gathered on the actual scale of the malocclusion problem. We are convinced it is very serious, but that can be considered an informed guess based on fragmentary evidence. Some serious government polling could supply important ammunition to those advocating a change in the norms of how we eat and often breathe.

A number of people already understand various aspects of the "food problem," starting with the basics of agriculture and nutrition, including what to eat. Now it is necessary to understand the importance of how we eat, how we breathe, where we breathe, and how we rest our mouths.

The exercises are partly based on good old-fashioned table manners, which turn out be remarkably good advice for promoting oral-facial health.

manners—sit up straight, keep your mouth closed, don't chew with your mouth open, don't swallow your food half chewed, and the like—which turn out to be remarkably good advice for promoting oral-facial health. The exercise routine also promotes slowing down when eating or speaking; emphasizing pauses is central to learning the correct resting position. By learning to adopt the ideal rest position in between bursts of mouth activity (chewing or speaking), the brain learns the default position through repetition, and the proper rest posture will come to be held unconsciously through much of the day. Exercises can be tedious (for both parent and child), but typically no surgery or extractions are

of gravity bending us over. In ideal oral development, the lower jaw supports the upper jaw against the pull of gravity through the work of muscles, including the tongue, toned by appropriate weaning, chewing, breathing, and so forth.

Most people in industrial societies today do not recognize the facial distortion that is common, the spreading of sleep apnea, the extent of children wearing braces, or other symptoms of an epidemic in oral-facial health problems that can be traced to how most people eat and hold their mouths at rest, and other contributing features of humanity's new industrial environment. People tend to accept the world in which they grew up as the

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www.amsci.org/magazine/issues/2019/march-april