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Our Skulls Are Out-Evolving Us

A motley crew of scientists argue that our ever-shrinking skulls are wreaking havoc on our well-being

Katherine Reynolds Lewis
Sep 19 · 16 min read ★





Skulls from the Morton collection at the Penn Museum in Philadelphia. Photography by Jonah Rosenberg and Lyndon French

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indsey Hanes burst into tears at the wheel of her black Dodge Caravan. Ugly crying. Heaving sobs. Through raindrops on her car window, she glanced back at the medical building she'd just exited. That therapist had been her last hope to address her son Micah's sleep and breathing problems. Her sweet, cheerful baby had transformed into a withdrawn, ornery, uncooperative five-year-old. As a

registered nurse, Hanes felt convinced that sleep deprivation lay at the root of his problems. He snored, tossed and turned at night, and woke up with bags under his eyes.

At age four, Micah underwent a sleep study and received a diagnosis of apnea — intermittent waking due to a blocked airway. A surgeon removed Micah's tonsils and adenoids and the operation seemed to work: Fluid no longer collected in his ears, previously a recurring problem. But a year later, he still snored — a possible sign of continued airway obstruction. It was back to the ear-nose-throat doctor, who ruled out apnea after a second sleep study.

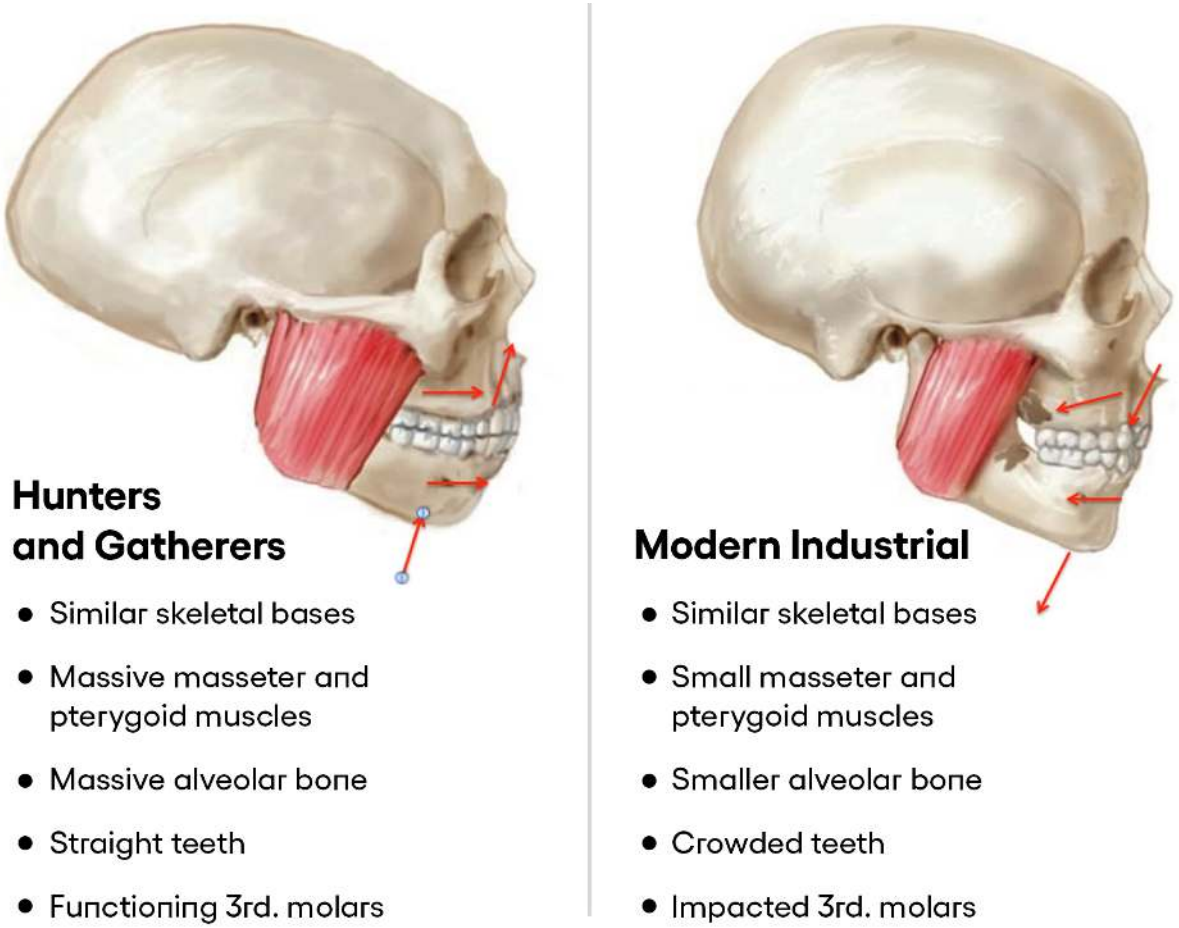
The ENT offered no other ideas. Desperate, Hanes tracked down the only myofunctional therapist in southern Illinois, trained in teaching tongue and lip exercises that might reshape Micah's mouth muscles. Maybe that would facilitate better breathing and sleep.

> Over the last 250 years, our skulls have morphed in dangerous and troubling ways.

Micah behaved wildly in the appointment, jumping all over the chair and hiding behind Hanes. He refused to let the therapist look in his mouth, no matter how she coaxed or tried to engage his interest. By the end of the appointment, Hanes felt sweaty and exhausted, a familiar experience. She apologized profusely to the therapist, who declined to charge the family. Hanes trudged back to her car with Micah, where she dissolved into sobs.

The Hanes family felt they had reached the limits of established medical practice and found no cure to Micah's sleep and breathing problems. So Hanes did what any modern parent would: she turned to Google. There, she discovered a whole community of researchers and medical professionals who point to abundant evidence that Micah's experience is increasingly commonplace. To them, Micah represents a perfect case study of an alarming trend in human development with far-reaching implications: over the last 250 years, our skulls have morphed in dangerous and troubling ways. The problem with Micah, they say, is his face.

Science suggests that crooked teeth, overbites, narrow jaws, and crimped nasal airways are a modern phenomenon. Skeletal remains show that just 300 years ago, humans commonly displayed straight, perfectly aligned teeth, wide jaws, flat palates and the large nasal passages that signal habitual, healthy breathing.



Slides courtesy of Kevin Boyd

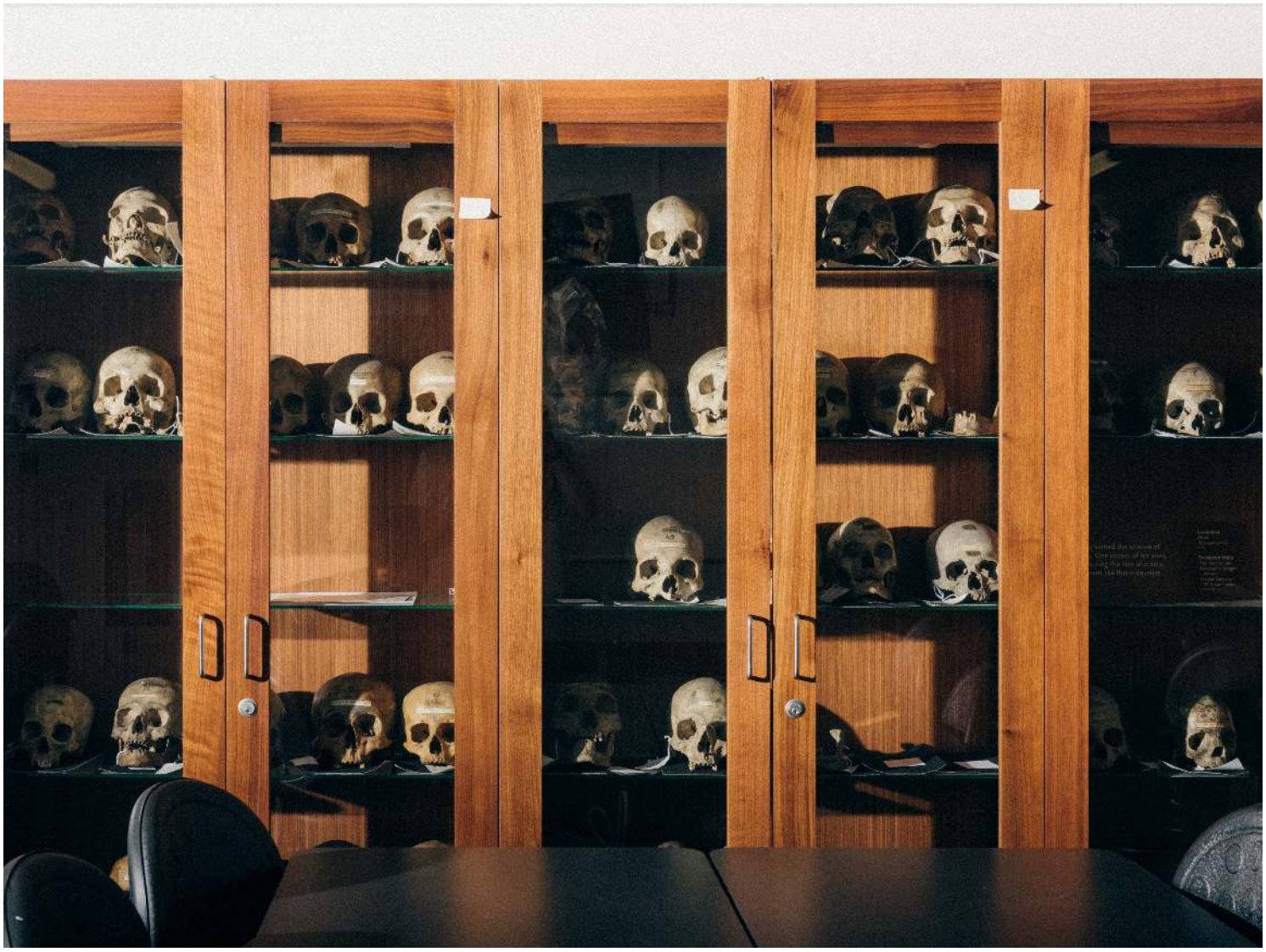
But more recently, our faces have begun to deform. Today, our skulls are marked by high, narrow palates, short lower jaws and, often, insufficient space. When children drop their baby teeth, there's typically inadequate room for the adult teeth, which leads to crowding and misaligned teeth. Worst of all, this anatomy encourages mouth-breathing, which can, in turn, lead to under-the-radar sleep difficulties and a whole array of problems ranging from behavioral challenges, anxiety, and depression to cognitive issues. These conditions often cost thousands of dollars to correct through orthodontics, dentistry, therapy, and even surgery to remove tonsils and adenoids.

A motley crew of scientists and health-care providers are now coalescing to investigate how our faces are changing and the ramifications for our health. It includes a Chicago dentist, a Philadelphia anthropologist, and a Las Vegas feeding specialist, along with sleep researchers at Stanford and Northwestern. These professionals argue that modern life has disrupted the complex biological systems in our faces, heads, and throats, leading to problems as varied as jaw pain, chronic headaches, allergy, asthma, sleep disruption, and all the associated disorders. While many other factors contribute to these issues — from diet and technology exposure to parenting and societal changes — they see the evolutionary cause as crucial to understanding and addressing the problem.

“It’s such a multidimensional problem,” said Diane Bahr, a Las Vegas-based feeding specialist and author of the book *Feed Your Infant and Toddler Right*. “We need a stream of parent and professional education and an appropriate stream of treatment.”

But first, this group of professionals has to convince the medical community — and millions of parents — to face the serious impact of our changing skulls.

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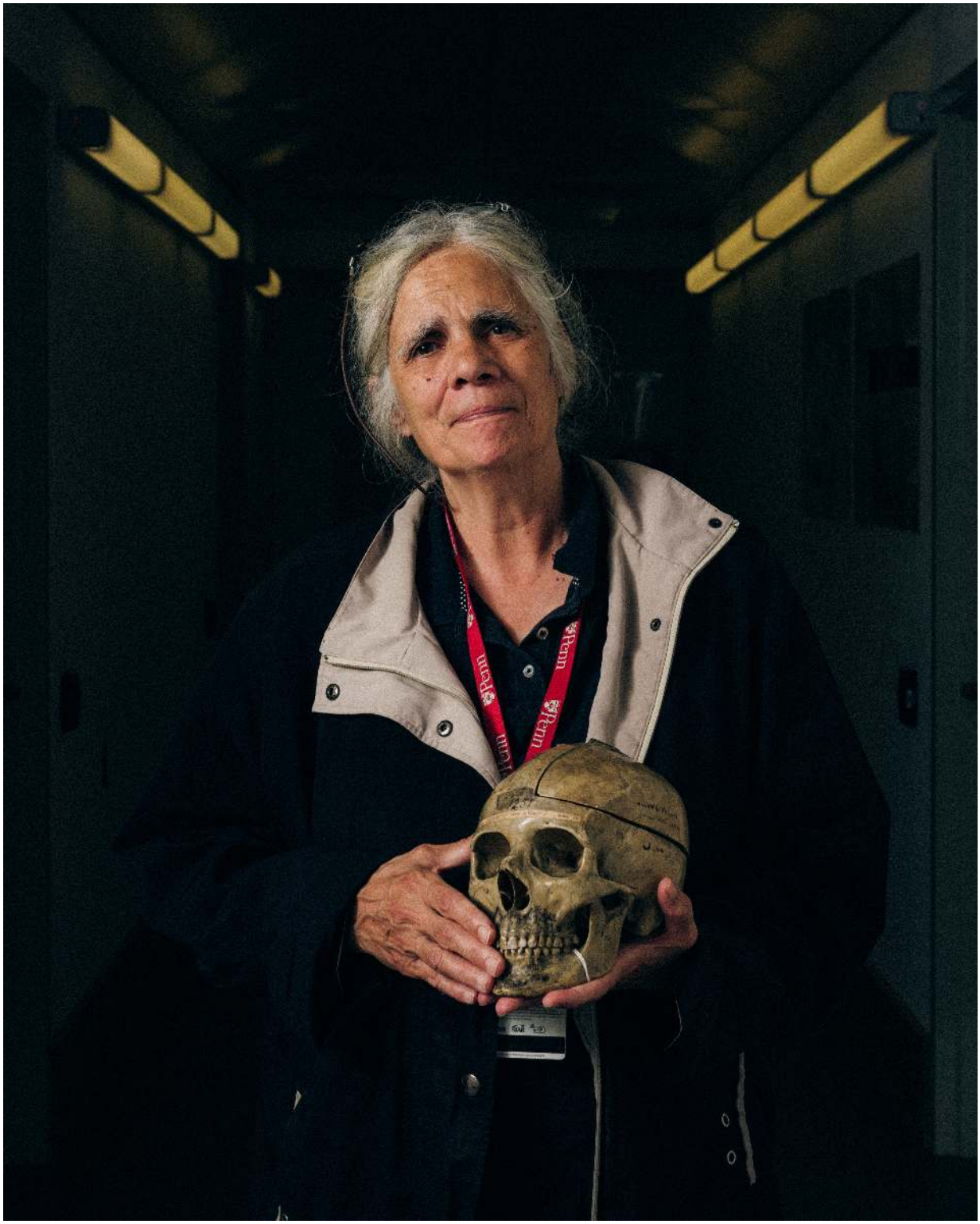


The age of the individual crania in the Morton collection ranges from several thousands years old to as recent as 250 years old. Photo by Jonah Rosenberg

Last December, pediatric dentist Kevin Boyd hunched over a tray of plaster casts of children’s teeth in a basement laboratory at the Penn Museum in Philadelphia. He pulled down the glasses perched on his head to peer at the

tiny molds spread across the black-topped tables. He measured the distance from molar to molar, jotted down a figure, and turned to the next tray.

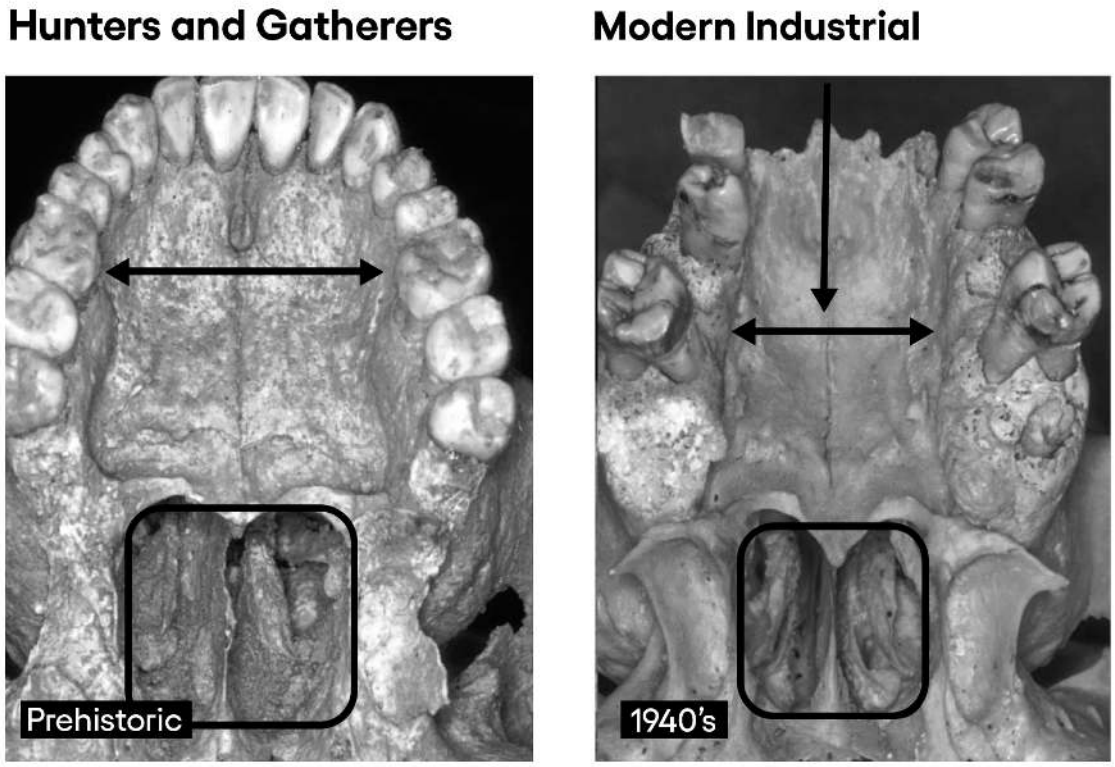
Yellowed skulls in glass cases lined the room. Janet Monge, who is responsible for the physical anthropology section of the museum and its collection of skeletons, perched on a stool nearby.



Janet Monge, the Keeper of Collections, Physical Anthropology Section at the Penn Museum. Photo by Jonah Rosenberg

“What happened?” Boyd asked me and Monge, turning a mold over in his hands. “How could all of a sudden we develop crooked teeth and narrow jaws, and impacted nasal airways? That’s only recently happened, and it coincides with women going into the textile mills in the industrial revolution.”

We often think of evolution as something that happened in the distant past, transforming Cro-Magnon people into our modern selves. The “evolution of humankind” timelines in natural history museums typically span hundreds of thousands of years and end with the earliest evidence of written language, a few thousand years B.C. But the truth is that our bodies are still evolving — our brains are shrinking, our elbows are narrowing. And our faces are still changing too, leading to dramatic changes in our teeth, noses, and jaws.



Slides courtesy of Kevin Boyd

Skeletal records show that for hundreds of thousands of years, people had beautiful skulls: straight teeth, wide jaws, forward faces, large airways. Robert Corruccini, an emeritus anthropology professor at Southern Illinois University, found perfectly straight

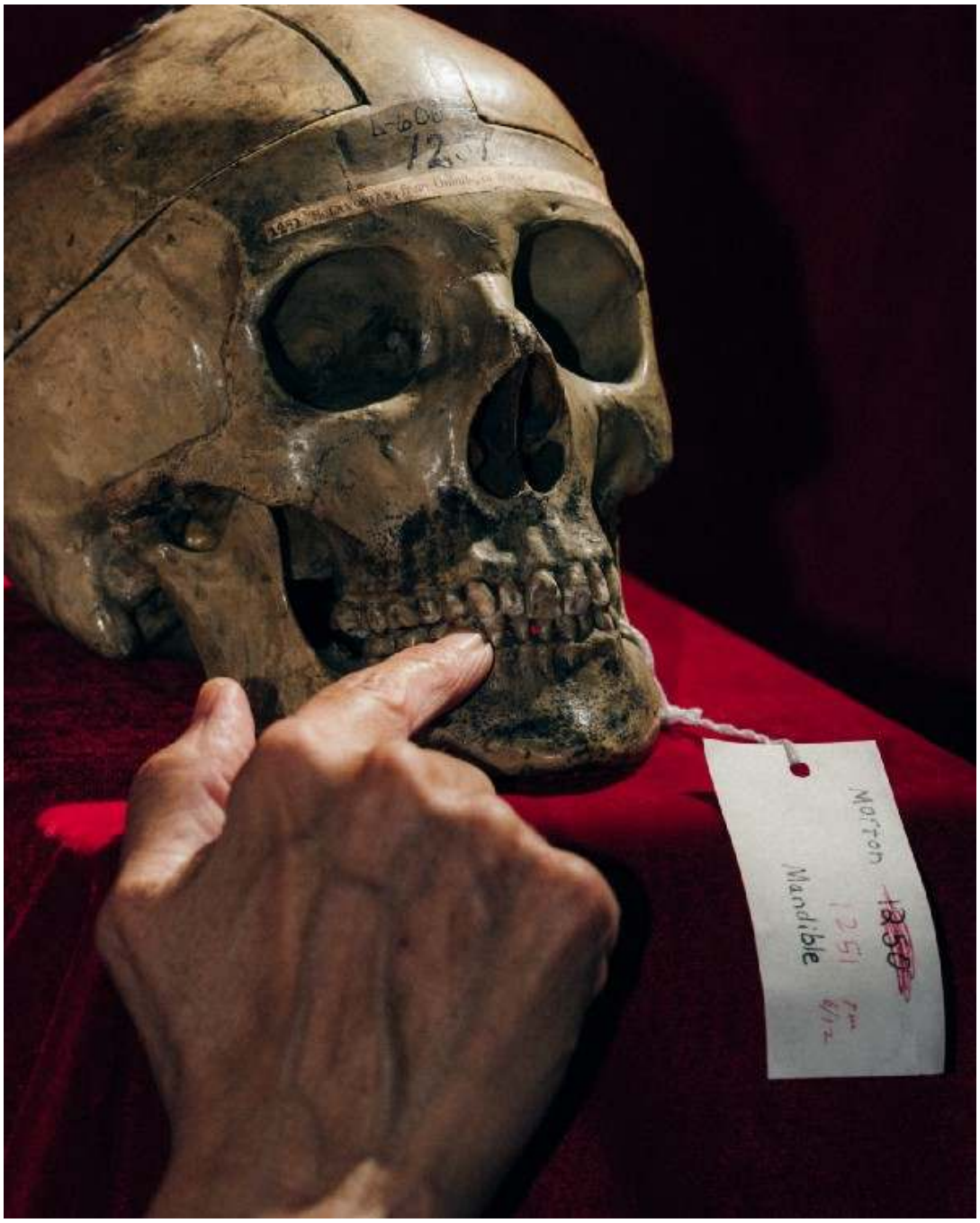
teeth and wide jaws in children's skulls from pre-Roman times among Etruscan remains in southern Italy.

Then, about 250 years ago, our faces began to change. Boyd argues that industrialization interrupted the ancestral patterns of weaning and feeding, with babies nursing on demand for years while also trying solid foods under adults' watchful eyes. Boyd says that the widespread adoption of bottle feeding, pacifiers and soft processed food deprived toddlers of practice chewing and distorted the shapes of their mouths. ("In modern society you have Gerber's baby food," Corruccini told me. "Etruscan kids had to chew once they were getting off breast milk. Babies have remarkably powerful chewing capabilities.") Just like diabetes and heart disease, malocclusion — the misalignment of jaws and teeth — followed industrialization around the globe. Meanwhile, people in societies that never industrialized enjoyed well-aligned teeth and jaws.

Other factors may have played a part too. Environmental pollutants and recirculated indoor air increased the strain on our bodies and worsened pregnant women's health in regions that industrialized first. That can impact skull shape of babies in utero by affecting birth weight, jaw length, and size of sucking pads in the cheeks. Skeletal records of animals show similar differences in skull shape between animals raised in the wild and those raised in captivity — suggesting that humans' modern diet and environment play an outsized role in our evolving faces.

One of the first to recognize the shrinking skull was Charles Darwin, who described "civilised" humans as having shorter jaws than the "savages" who lived in non-industrialized societies, in *The Descent of Man*. "This shortening may, I presume, be attributed to civilised men habitually feeding on soft, cooked food, and thus using their jaws less," he wrote. "I am informed by Mr. Brace (the U.S. philanthropist Charles Loring Brace) that it is becoming quite a common practice in the United States to remove some of the molar teeth of children, as the jaw does not grow large enough for the perfect development of the normal number."

In the 1920s and '30s, a dentist named Weston Price traveled around the world, taking photographs of the teeth of indigenous people in Africa, Europe, North and South America, and Australia. His photos confirmed Darwin's suspicions — he documented well-aligned teeth, high palates and forward jaws of non-industrialized populations. Price and Darwin may have been motivated by abhorrent beliefs — eugenics-informed ideas about "civilized" (Caucasian) races being an improvement on "savage" races (African and indigenous peoples) — but their research can still prove useful to modern researchers tracing the evolution of human skeletons.



Perfect occlusion of the teeth was the norm up to about 250 years ago. Photo by Jonah Rosenberg

Early 20th century orthodontists recognized that short jaws and high, narrow palates posed a threat to breathing, Boyd said, plopping his black Patagonia backpack on the lab table. He pulled out a stack of papers from 1917 and 1922, including the precursor to the *New England Journal of Medicine*. The journals advise dentists to correct any irregular teeth or facial structures before the child turns six, with the authors stressing the importance of nasal breathing and wide dental arches. Other papers at the time recommend interventions as early as 30 months of age and include pictures of palate expanders from the 19th century.

Yet some time around the 1940s, this understanding of how our shrinking jaws endangered breathing seemed to disappear. Boyd and like-minded researchers hope to extract the knowledge embedded in the museum's skulls and bones and use it to better document how our skulls have evolved. They've already taken a collection of cone-beam computed tomography images — 3D CT scans — of children's skulls from ancient and modern times, some from the nearby practice of orthodontist Marianna Evans. They hope to collect many more, visualizing airway volume and structural blockages.

"I have a CBCT of a five-year-old caucasian who died 250 years ago, and a five year old who's in my office referred from a pulmonary physician because the kid has sleep apnea. And I can show how that jaw compares to one who died 300 years ago, and how much smaller it is," Boyd explained to me, as we packed up to leave the museum for the day. Monge watched intently to be sure he replaced the dental molds in the correct trays.

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Dr. Kevin Boyd at his pediatric dental practice in Chicago. Photo by Lyndon French

The implications of shrinking modern skulls are more than aesthetic. Our smaller faces do the most harm in one area crucial to physical and mental health: our ability to get a good night's sleep.

In proper development, the tongue moves along the roof of the mouth to push nutrients toward the esophagus, gently expanding the palate and exercising the lower jaw, lengthening and widening it over time. When a child's jaw is too short and palate too narrow, their tongue cannot rest against the roof of the mouth and instead rests against the lower teeth. This causes them to routinely breathe through the mouth, an unhealthy habit. Then, as they lie flat to sleep, the tongue may fall back to block the throat, causing apnea. This can worsen into a vicious cycle through overuse of bottles, pacifiers or sippy cups, misshaping the teeth and mouth. Malocclusion and its resultant sleep problems form part of the cluster known as diseases of civilization, including obesity, stress, and depression. These are all conditions largely caused by our modern lifestyle and environment.

Albert Einstein College of Medicine professor Karen Bonuck has documented the damage that sleep problems can cause without early intervention. Her 2012 paper for *Pediatrics* found that babies and toddlers who mouth-breathed, snored, and experienced apnea were more likely to demonstrate behavior problems at ages four and seven, including hyperactivity, poor conduct, peer problems, and emotional difficulties, based on analysis of more than 11,000 children in a longitudinal study in Avon, a U.K. county. Boyd and his colleagues seized on that paper, and continue to cite it as evidence of the urgent need to identify and solve breathing problems in young children.

Stacked boxes of brochures line the walls of Bonuck's Einstein office suite in New York's Bronx borough. A slight woman with librarian glasses, Bonuck takes one colorful flip chart off her desk to show me the materials used for teaching parents about children's sleep needs. Her collaborators at the Sweet Dreamzzz nonprofit and two other

universities are working with more than 20 Head Start centers to educate parents, helping them identify possible sleep issues in their children. It's part of her quest to unearth hidden childhood sleep problems and turn around behavioral and cognitive issues before they root deeply.



Our smaller faces do the most harm in one area crucial to physical and mental health: our ability to get a good night's sleep. Photos by Lyndon French

Bonuck rattles off a series of research findings on the far-reaching impact of inadequate sleep, zipping from topic to topic like a pinball. This study found that restricting children's sleep by 30 minutes a night for less than a week lowered their neuropsychological functioning by the equivalent of two years. One meta-analysis, summing up findings from 21 studies, discovered that young children with sleep disordered breathing on average earned grades 12% lower than their peers. Combined with a paper that found kids, on average, have been losing a minute of sleep per year for the last century, this doesn't bode well for the human race.

"When children don't sleep, they're cranky, moody, their expressive language is all impaired. Not only their verbal word-learning. The communication skills are at risk," Bonuck said. Roughly half of children two to five years old experience sleep problems, defined as difficulty falling or staying asleep; inadequate sleep duration; trouble breathing or interrupted sleep. Yet almost no early intervention screenings address sleep or nighttime breathing. To be sure, sleep comes under pressure from many other factors,

including the growth of social media, smartphones, and intense academics earlier in childhood.

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Across the Einstein campus from Bonuck are a team of clinicians trained in children’s mouth and tongue anatomy: speech language pathologists. Bonuck worked with Rose F. Kennedy Children’s Evaluation and Rehabilitation Center speech therapists to better understand the connection between breathing, sleep, and language acquisition. Parents know sleep is important, but they rarely realize how proper sleep relies on a wide dental arch, tongue on the roof of the mouth, and long lower jaw.

When parents bring their children for screening, a simple questionnaire can identify a risk factor for sleep problems, such as mouth-breathing. Solutions range from nasal steroids, speech or myofunctional therapy, and allergy treatment, all the way to adenotonsillectomy, and the early orthodontia that Boyd practices.





A child getting 3D x-rays at Dr. Boyd's office. To Boyd, any time you see crowding or potential problems on the horizon, it's a signal to expand the mouth now. Photo by Lyndon French

"They focus better, less hyper, fewer tantrums, get along with others… Kids do literally grow when they're sleeping. They'll be healthier. By the way, this ties into obesity," Bonuck said, citing a 2011 Institute of Medicine report on preventing childhood obesity and her own 2015 paper that found children's sleep-disordered breathing and behavioral sleep problems before age seven are both risk factors for obesity at 15.

When children mouth-breathe or snore, the air passing through their throat dries out tissues and raises the risk for infection and inflammation, which would further compress the airway. They miss the many benefits of nasal breathing and disuse causes the nasal airway to shrink, exacerbating the problem.

"They have a chronic sinus infection and congestion. They can't smell," explained Joy Moeller, a myofunctional therapist in Los Angeles. "They lose their appetite or become picky eaters, preferring pasta because it's easier to chew. It may lead to obesity, sleep disorders, or crooked teeth."

That's the dysfunctional cycle that sent Lindsey Hanes searching for answers and into tears in the parking lot of the myofunctional therapist in southern Illinois. Micah eventually found his way to Boyd, who started expanding his palate to increase his airway volume. A myofunctional therapist in Boyd's office worked on exercises to train the boy's tongue to stay at the top of his mouth to facilitate nasal breathing. Micah wore an appliance at night to pull his lower jaw forward and boost his airway capacity to normal levels.

Within a month, Micah's sleeping improved and his behavior transformed. Previously, he cried at doctor's appointments, balked at going to school, acted cranky, and hid behind

his mom around guests. Now, he smiles freely and runs up to his grandparents for hugs.

“He’s his old self again,” Hanes said. “I thought we were losing him. What would we do if we waited until he was 10 for orthodontia? He would’ve had depression or anxiety.”





Changing our sleeping and breathing habits can transform our physical and mental health. It all begins in our jaw, mouth and throat anatomy, which shape the path of each breath. Photos by Lyndon French

Thinking back, she recalled speculating that he might even have autism, as he had become withdrawn and averse to eye contact. “If I had listened to my ENT, where would my son be right now? He would be labeled as a difficult kid, put in special ed. If he needs it, fine, but not if they could fix it,” she said. “This is insane, all these kids suffering. They just need sleep.”

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There is no easy way to turn back the evolution of our skulls. It’s unrealistic to advise parents to eschew processed food, breastfeed longer, move to open-air cabins in the country, or perhaps put children on the Paleo diet to prevent these changes taking hold in the skulls of the next generation. We are stuck with our

smaller modern faces, but there are steps we can take to address the conditions that come with them.

Across the state from Hanes at Northwestern University's medical school, sleep medicine doctor Stephen Sheldon explained new techniques — or recovered techniques — that encourage the jaw to grow wider and more forward in order to align the teeth and enlarge the airway, and often enlist myofunctional therapy to create healthy tongue and mouth habits. Traditionally, orthodontists are most concerned with straightening teeth, rather than moving the mandible forward as a primary goal.

"We really don't know yet which is better and we really need to pursue that question and answer it in a scientific method," Sheldon said. "We have lots of anecdotes, but depending upon anecdotes is not science."

Last winter, I joined Boyd at his Chicago office in order to see the theory in practice. Boyd strode from the back examination area to a consultation room — a nook off the hallway — to show parents the images of their child's mouth and describe his plan to expand the palate and straighten the teeth. "We're rediscovering something that's always been known, that used to be mainstream," he told the skeptical dad. "Nose-breathers are always healthier than mouth-breathers."





Dr. Boyd and like-minded researchers hope to extract the knowledge embedded in the museum's skulls and bones and use it to better document how human skulls have evolved. Jonah Rosenberg

Some orthodontists wait for braces. To Boyd, any time you see crowding or potential problems on the horizon, it's a signal to expand the mouth now. Why delay? The sooner you intervene, the sooner the airway expands and kids start to develop good habits for nasal breathing and tongue position. He's worked with children as young as two years old, and special needs kids whom some dentists find difficult to treat. Some of his colleagues use removable devices similar to those described in Boyd's stack of early 20th century research papers.

The problem is getting worse, not better. "More babies are born with anatomy that makes nursing and breastfeeding difficult, raising the risk of developing dysfunctional

feeding habits," said feeding specialist Bahr. "More time on their backs than their tummies, processed foods, bottle feeding, and pacifiers contribute to the misshapen jaw, impairing breathing and sleep. Once their sleep suffers, a range of other problems begin to develop."

A huge population of children might be candidates for earlier, alternative orthodontia, such as the Advanced Lightwire Functionals appliance that some osteopaths deploy. Around one-quarter of school age children snore, meaning the upper airway is narrow and vibrating — an abnormal situation. "Even snoring can result in outcomes that are negative, neuro-cognitive deficits," Sheldon said. "Every pediatrician is supposed to screen for snoring. Not every pediatrician does because they have so much to do in 15 minutes at a health maintenance visit."

Even if the screening were adequate, there are only 294 board-certified pediatric sleep specialists, and just over two dozen pediatric sleep centers in the United States. The typical path for children with sleep apnea, or sleep disordered breathing like snoring, is removal of tonsils and adenoids, which often press on the upper airway, narrowing it. But for children like Micah Hanes, whose symptoms don't resolve with adenotonsillectomy, alternative orthodontia may be the only choice.

Sheldon and some colleagues are writing a protocol for a prospective study of alternative orthodontia in young children. They need many institutions to be involved in order to capture data on enough children. Nighttime sleep studies cost a lot of money, raising the challenge. Sheldon is waiting for the publication of his retrospective study, describing results in 18 children. While the wheels of science slowly grind, parents scramble for guidance, acting as researchers, detectives, and advocates for their children.

> We have to adapt, and adapt quickly, to our changing physiology — or risk the consequences.

"Often parents don't even realize their child is having a sleep problem, because they don't think snoring is a big deal," he said. "They don't realize how significant snoring can be to affect the child's life. They're waking frequently at night, can't fall asleep."

At my own children's dental office, I found a 20-page parent education pamphlet from the American Dental Association that stresses the importance of teeth cleaning, a healthy diet, regular checkups, preventing injuries, and limits on sucking. Only one page addresses bite problems or teeth alignment, saying that orthodontic treatment usually begins between eight and 14 years of age. There's no mention of sleep problems that

could connect to a mouth and jaw issue, such as snoring, mouth-breathing, restless sleep, frequent nighttime wakings, effortful breathing, or difficulty waking children in the morning.

“There’s a relationship between sleep apnea and the health of many of our body structures,” said Margaret Rogers, chief staff officer for science and research for the American Speech-Language-Hearing Association, the professional association for SLPs. “It’s everybody’s responsibility. Pediatricians need to be screening. Preschool and classroom teachers, if there’s a kid in your class that’s falling asleep, ask why. It’s not that these kids are lazy, or not attending, or bad kids; they may be kids who are chronically deprived of sleep.”

Humans draw 28,000 breaths each day. We sleep for about one-third of our life. Changing our sleeping and breathing habits can transform our physical and mental health. It all begins in our jaw, mouth, and throat anatomy, which shape the path of each breath.

Jerry Rose, a dental anthropologist and professor emeritus at the University of Arkansas, warned that a whole generation could be impacted if we don’t change course. “In evolution, there are winners and losers,” Rose said. We have to adapt, and adapt quickly, to our changing physiology — or risk the consequences.

“There are groups of people who simply went the wrong way,” Rose said. “And then they’re gone.”