THIS WEEK

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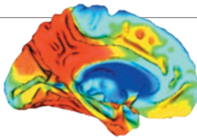

INSIDE VIEW Imaging technique shows ageing protein **p.143**

Food processing

A recreation of how early humans managed to eat a diet of meat hundreds of thousands of years before they had fire to cook it with, shows an ingenious use of tools to cut down on chewing time.

You are what you eat. Not only that, but you are what your ancestors ate, when they ate it, and what they did to it first. One of the many peculiarities that set humans apart from other animals is that eating is more than just stuffing something into our mouths.

True, the human diet is astonishingly eclectic, but this wide range is tempered by elaborate preparation. No other animal, for example, exposes prospective food items to prolonged heating, a habit we call 'cooking'. It's now generally thought that cooking was central to the evolution of modern humans, prompting a massive reduction in tooth size and chewing muscles, alongside a marked increase in available nutrients, more time to spend doing other things besides chewing, and even an expansion of the brain.

There is — as always — a catch. Cooking requires fire, and there is scant evidence for the regular use of fire before around 500,000 years ago. *Homo erectus*, the first hominin to even begin to approach modern humans in stature, brain size and masticatory apparatus, appeared around 1.5 million years earlier than that. *Homo erectus* was a regular carnivore, a habit that has stayed with us and is believed to be necessary to our modern diet (see *Nature* **531,** S12–S13; 2016).

How did *H. erectus* manage to consume meat without cooking it? As Katherine Zink and Daniel Lieberman explore in a paper online in *Nature* (see http://dx.doi.org/10.1038/nature16990), raw meat is tough and practically impossible to break down into swallowable pieces just by chewing it. Side orders of roots and tubers can be crunched, but only if you are prepared to put in the hours. A lot of hours. About 40,000 chews a day, which, at a ruminative rate of 1 chew per second, adds up to 11 hours. That's almost a whole day gone, just chewing. That's no issue for many baseball players or football managers, perhaps, but *H. erectus* had better things to do.

The new study squares the circle by showing that tools equivalent to knives, mortars and pestles entered the kitchen a long time before the oven. Stone tools date back to at least 3.3 million years ago (S. Harmand *et al. Nature* **521,** 310–315; 2015). A freshly struck flake of stone makes short work of slicing raw meat into morsels, and a lump of rock can be used to pound roots and tubers into a paste.

Work with people today has put numbers on these gains. When meat is sliced and roots are pounded, a prehistoric diet of 2,000 kilocalories per day (one-third raw goat and two-thirds raw yams, carrots and beets) can be achieved with 2.5 million fewer chews a year than if the items are unprocessed. That's an entire month spent not chewing — presumably enough to explain the reduction in tooth size and masticatory muscle mass of *H. erectus* compared with earlier, more masticatory species, as well as the increase in brain size allowed by the release of more nutrients. And what does one do with one's mouth when not chewing? One talks a lot, of course. Preferably to other people.

Our ancestors probably also ate fruits and berries, fish and shellfish, nuts, bone marrow, liver and brains, all of which are highly nutritious. But some of those foods need a deal of slicing and pounding to get at. Nuts have hard shells, as do shellfish, by definition; marrow and brains require (there is no delicate way to put this) the smashing of bones and skulls. Many animals are known to use simple tools to acquire food of that sort. But the release of nutrients from muscle by an animal with teeth more suitable for crushing than slicing required the application of some early food technology.

> ***"Raw meat is tough and practically impossible to break down into swallowable pieces just by chewing it."***

Cooking, when it came, enabled yet more efficient nutrient release, and provided other benefits such as the killing of any harmful parasites that raw meat might contain, as well as the gathering of sociable people round a hearth to swap gossip, watch celebrity chefs on TV and share pictures of their cats on the Internet, if only as a way of using up all that time not spent chewing the fat. But cooking did not start this. It merely accelerated a culinary tradition already millions of years old. ■

Who ordered that?

An unexpected data signal that could change everything has particle physicists salivating.

Physicists at the Large Hadron Collider (LHC), the giant particle-physics experiment near Geneva, Switzerland, have searched for many possible subatomic particles and novel phenomena. They have tried to recreate dark matter, reveal extra dimensions of and collapse matter into microscopic black holes.

But the possibility of an electrically neutral particle that is four times heavier than the top quark — the current heaviest — and that could decay into pairs of photons has apparently never crossed anybody's mind. No theorist has ever predicted that such a particle should exist. No experiment has ever been designed to look for one.

So when, on 15 December last year, two separate teams at the LHC independently reported hints of such a particle (see *Nature* http://doi.org/bc4t; 2015), the reaction of many experts was similar to that of US physicist Isidor Isaac Rabi when the muon, a heavier relative of the electron, was discovered in 1936: "Who ordered that?"

If the particle exists, the implications would be enormous. Precisely because it is so unexpected, it could be the most important discovery in particle physics since quarks — the elementary constituents of protons and neutrons — were confirmed to exist in the 1970s. Perhaps it would be the biggest deal since the muon itself.

The evidence so far is scant, however. It amounts to a few too many pairs of γ-ray photons produced with combined energies of 750 gigaelectronvolts when the LHC smashes protons together. The fact that two separate detectors spotted it at almost exactly the same energies gives some hope, but anomalous signals such as this often show up in experiments only to later vanish back into the noisy background.

Still, people at CERN, the European particle-physics lab that hosts the LHC, have scarcely talked about anything else since. And theoretical physicists around the world have gone into overdrive: more than 200 papers have been posted online with theories that could explain the particle. One possibility is that it could be a heavier cousin of the Higgs boson; another, even more tantalizing one, is that it is a type of graviton, the particle hypothesized to carry the force of gravity. If so, it could point to the existence of extra dimensions of space beyond the familiar three.

Some have discounted the outburst of preprint articles as merely an attempt by authors to rake up citations. One physicist has even done a quantitative comparison of this spike in activity with other fads that have come and gone in the past (see M. Backović Preprint at http://arxiv.org/abs/1603.01204; 2016), charting theorists' initially exploding, then fading, interest. But describing theorists' interest as 'ambulance chasing' is a bit unfair. To paraphrase Albert Einstein, if people knew what they should be looking for, it wouldn't be called research.

And particle physicists' excitement is understandable, if tempered by caution. For decades, their field has been finding evidence for the standard model of particle physics, a collection of theories that was put together in the 1970s and has been more successful than anyone expected. The current generation of young physicists was not even born when particle accelerators produced their last genuinely surprising results. Meanwhile, searches for physics beyond the standard model have so far come up empty — at accelerators such as the LHC but also in many tabletop experiments and at detectors built underground or sent into space to look for dark matter. The most notable exception to the standard model's standard fare has been the discovery, beginning in 1998, that the elementary particles called neutrinos spontaneously oscillate between their three known types, or flavours — something that the original version of the standard model had not predicted. That breakthrough earned two physicists a well-deserved Nobel Prize last year.

"The LHC is now providing the opportunity of a lifetime to break entirely new ground."

The LHC is now providing the opportunity of a lifetime to break entirely new ground. In 2015, it restarted after a long shutdown that brought the energies of its collisions to a record 13 teraelectronvolts, from 8 TeV. This has put much more massive particles in reach — if any exist — but it will be the last substantial jump in collider energies in a generation. More-powerful machines, if they ever see the light of the day, will take decades to plan, develop and build.

The good news is that whether the new particle exists or the data bump is a statistical anomaly is not a question that will leave us hanging for long. The LHC experiments had time to observe only relatively few collisions in their first 13 TeV run last year, before the experiment shut down for its winter recess.

At a meeting in the Italian Alps that starts on 12 March, LHC researchers might present fresh analyses of those data that could provide more clues. And the machine will begin to collect vastly more data in April. If the bump seen last year was an anomaly, it should go away by the summer. If not, stay tuned for some interesting announcements at the next round of conferences. ■

Gene intelligence

The risks and rewards of genome editing resonate beyond the clinic.

Last month, one of the top intelligence officials in the United States warned that genome-editing technology is now a potential weapon of mass destruction. Techniques such as the emerging CRISPR–Cas9 system, US director of national intelligence James Clapper warned in an annual threat-assessment report to the US Senate, should be listed as dangers alongside nuclear tests in North Korea or clandestine chemical weapons in Syria (see go.nature.com/jxuyev).

The headline message might scream 'overreaction' — and indeed most serious science commentators seem to have assumed as much and ignored Clapper's hyperbole — but the terms he used to describe the technology seem uncontroversial. The US spooks describe the "broad distribution, low cost, and accelerated pace of development" of gene editing, and say that its "deliberate or unintentional" use could have "far-reaching economic and national security implications".

"Research in genome editing," the threat assessment continues, "increases the risk of the creation of potentially harmful biological agents or products." And Clapper, naturally, points the finger at science in nations "with different regulatory or ethical standards than those of Western countries". But for a glimpse of just how far-reaching the "deliberate or unintentional" use of gene editing could be, he need only look over his shoulder.

Last year, scientists in California reported that they had used gene editing (together with another new biotechnology called gene drive) to introduce a mutation that disabled both normal copies of a pigmentation gene on a fruit-fly chromosome. The change made the insects turn pale yellow — as did their offspring, their offspring's offspring and so on. The change was so powerful that, had any of the California flies escaped, it has been estimated that somewhere between one in five and one in two of all the fruit flies in the world would be yellow today. The flies did not escape — but then, weapons of mass destruction are a political problem because they exist, not because they are deployed.

CRISPR EVERYWHERE
A *Nature* special issue
nature.com/crispr

Clapper was anxious about the implications of gene editing because of its dual-use possibilities. But a binary outcome is inadequate for describing the spectrum of ways in which the CRISPR–Cas9 system is changing science and could benefit scientists and the public. In a special issue this week, we examine some of these (see page 155).

Much of the early attention has focused on the prospect of human-embryo modification. The issues that such 'germline' changes could raise for current and future generations have, rightly, been intensely debated. But the uses of CRISPR–Cas9 with early promise are those in laboratories, not clinics — and in human somatic (non-reproductive) cells, bacteria, viruses, animals and plants, not in human germ cells. A pair of News Features starting on page 156 explores these scenarios.

Genome editing is a science for which the alarm about how it could go wrong has largely lagged behind the hype over what good it could achieve — at least before Clapper had his say. And much of the hype has come from those in the know. The speed at which the biological community has adopted gene editing, and the range of applications that it is being used for, speak volumes about its potential. The possibilities — human–animal chimaeras for organ transplants, climate-change-proof crops, eradication of disease vectors — seem endless.

Among the many unknowns that swirl around the future of gene editing is the reaction of the wider public. To their credit, some scientists and organizations are making attempts to foster openness and discussion, on the topic of gene drives, for instance. It is crucial that these deliberations continue, and that such environmental issues are kept scientifically and ethically distinct from concerns relating to clinical applications. ■