The idea and the egg

A rambling essay

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It starts with the egg.

It was, in the beginning, an unremarkable brown egg pulled from a carton three months earlier and placed in a tupperware container filled with white vinegar. A kitchen science experiment I had conducted with Joe and Abby – twelve and ten, respectively – in an attempt to cultivate their interest in chemistry. The acetic acid of the vinegar would dissolve the opaque calcium carbonate of the shell over time, said the internet. I wasn't sure if egg shell actually contained calcium carbonate, but six semesters of college chemistry told me that if it did, the experiment would work. Should work, chemically speaking. Though I hoped to successfully cultivate young passions for chemistry, I was far less certain of the outcome.

The tupperware did cultivate one thing, though: dust. I disappeared into the final throes of my senior thesis, and then the Christmas holidays came and went, and months passed in which I never made it back to Joe and Abby's house to inspect the egg. Finally Joe and Abby's father Jenry threatened to throw out the experiment if I didn't come inspect the results, soon.

Which brought me, one day in January shortly after the inauguration of President Trump, to Jenry's kitchen. Normally, Jenry's eyes sparkle with impish amusement behind frameless glasses while we talk politics and social issues. Jenry relishes a good debate and any chance to play the devil's advocate brightens his eye sparkle. But on this particular January day, on my way to inspect the egg, the conversation turned towards the influence of Christianity in public education and politics in a country supposedly founded on a separation of church and state. The sparkle disappeared behind the glasses, and Jenry fumed that there could still be a voice, credited with media attention, that advocated against teaching evolution in schools. The same evangelical voices, he suggested, that now unabashedly supported Trump, denied anthropogenic climate change, and risked shutting down the government to defund Planned Parenthood.

It reminded me, for some reason, of a thermometer. Not any thermometer, but a particular thermometer I'd heard about on the podcast *Freakonomics*, one of many thermometers in a Leipzig hospital, used by the German physician, Carl Wunderlich. A thermometer used in the mid-1800s to take the temperature of some subset of 25,000 patients. A thermometer that was on display at a museum in Philadelphia, and lent out to a curious infectious disease internist from Maryland.

The internist, Philip Mackowiak, often takes the temperature of his patients, because temperature is a useful indicator of how his patients are faring in their battle against the particular infectious disease with which they've been diagnosed by the time they arrive in his office. Mackowiak was, in fact, fascinated by this Wunderlich thermometer, because it and others had been used to establish, with a dataset of 25,000 patients and a million temperature readings in Leipzig, Germany in the mid-1800s, the average human temperature: 98.6°F. Mackowiak and other doctors around the world use this baseline temperature to determine whether a patient is feverish or not. The 1990 edition of

Stedman's Medical Dictionary defined "fever" as a rise in temperature above 98.6°F. The number represents the gold standard of clinical thermometry.

But when Mackowiak compared the Wunderlich thermometer to thermometers in his clinic, he found the Wunderlich thermometer ran 3.6°F warmer. He decided to run a small study in 1992 – 148 patients – in which measured temperatures were recorded several times throughout the day.[1] And they showed that the Wunderlich's numbers were off, at least in this particular clinic during this particular study.[2]

But in the world of big data and statistics, Mackowiak's study, though thought-provoking, was paltry. 148 patients hardly hold water against the Leipzig 25,000. But Mackowiack's assessment that the Wunderlich baseline needed updating echoed out into the biomedical community. And eventually, more studies followed. A few studies in mice, a few studies in people. A study that looked at how average temperature changes with age. A study that took into account other factors that may affect body temperature (season, room temperature, weight, etc). One study had 18,630 individuals. Another analyzed temperature records for 35,488 patients.[345] Most of the studies cited Mackowiak.

And the consensus among the newer, larger studies: healthy human temperature varies between 95°F and 99°F with almost as many factors as can be measured. A single temperature reading in and of itself does little good. What matters is how an individual's temperature changes over the course of an infection, or in recovering from exposure to extreme temperatures. Like your computer's software every month, the baseline, the gold standard, 98.6, well, it needs a conceptual update.

But for me, as a kid, 98.6°F was gospel, the Biblical truth. It was the number I needed to climb above if I wanted to stay home sick from school. It was the number that determined whether a visit to the doctor was warranted. Mackowiak published his study in 1992, a year before I was born. But my mom never read it, and neither had I until several weeks ago, and I wonder about Ms. Hill, my school nurse. I suspect it hasn't yet crossed her desk; being a school nurse leaves little time for such things.

It's this sticking power that fascinates me. Updated ideas about human temperature exist, and have for decades. But those three digits, strung together into a single number, have wedged themselves into the recesses of my mind, passed down from my pediatrician, school nurse, and mother. Before I'd ever heard of Wunderlich, or Mackowiack, or clinical thermometry, I knew that number. Those three digits persist with an almost viral tenacity in my brain as *the* threshold for a healthy temperature. Perhaps that's why, when Richard Dawkins conjures memes as self-replicating units of culture in his book *The Selfish Gene*, that number, 98.6, immediately jumped to mind.

Memes, Dawkins speculates, exist not in the primordial biochemical soup of early earth in which the first replicating molecules existed, nor in genomic compilations of DNA in which genes exist today, but rather in the soup of human culture: in brains, books, radio, television, computers, art museums. And the memes, as self-reproducing units similar in

nature to genes, compete with each other in each generation. “The human brain, and the body that it controls, cannot do more than one or a few things at once,” writes Dawkins. “If a meme is to dominate the attention of a human brain, it must do so at the expense of ‘rival’ memes.”[6] The image conjured, though merely hypothetical, is arresting: Self-replicating units of cultural transmission, vying for space and time in the human brain.

Of course, the ideas themselves have no agency to vie, but viewed through this lens, it’s no wonder that ideas such as the baseline human temperature update slowly. In the grand scheme of ideas, it’s relatively insignificant, and 98.6 is effective enough and, moreover, simple. Easy to remember, therefore easily established and sustained in a brain.

Similar tales, it seems, litter the history of medicine: old ideas, embedded into the framework of the field, prove difficult to dislodge. The story of William Harvey and the human heart can be read as case and point. For over a millennium, medicine in Europe followed practices laid down in the *Corpus* of Hippocrates in the fourth century (BC) and updated in the second century (AD) by the physician Galen, with a grasp on anatomy gained by animal dissections. Galen observed two chambers in the mammalian heart, and noted different colored blood in each chamber. He concluded that two types of blood existed in the body, and that the organs sucked one kind of blood when they needed food, and the other blood, mixed with air in the heart, was pumped along by the arteries.

But the hypothesis went untested for centuries and Galen’s theory remained uncontested fact. This was largely because human dissection was taboo until the early 1300’s, writes Susan Bauer in her book *The Story of Western Science.* The practice didn’t gain widespread traction until 1482,when Pope Sixtus IV declared “there was no theological reason to avoid human dissection as long as the remains were given Christian burial afterward.”[7] Thereafter, Italian universities in particular became known for their use of human dissections in the teaching of human anatomy in medical education, but many of Galen’s old theories persisted. It wasn’t until 1628 that William Harvey proposed a mechanism by which the heart pumped blood the lungs, back to the heart, and then out into the body, a thesis developed through dissection and experimentation that contradicted the Galenic theory. Harvey’s idea supplanted Galen’s: Four chambers, a system of arteries and veins, and the heartbeat as pumping action. But it took 100 years of human dissections to arrive there. Old ideas, when deep-seated, are hard to replace.

But perhaps that’s the pessimistic lesson to draw from this parable. A more optimistic reading suggests that ideas – European understanding of the function of the human heart, for example – change through time, eventually. Descending through generations of practitioners, cultures, and languages, ideas do not remain static but rather accumulate modifications suited to the eras in which they exist.

And by 1628, the culture no longer resembled that of Hippocrates or Galen. Beyond the changing norms around human dissection, Francis Bacon had published *The Great Instauration*: Part II in 1620, laying down the basic tenets of what we know today as the scientific method: hypothesize, experiment to validate or refute the hypothesis, update the hypothesis, and repeat. The old Greek method of developing theories out of general

principles to apply to specific instances – changes in temperature, or the function of the heart, say – fell out of fashion. The Baconian method gained prominence, because it promised much with its demand for theories developed out of evidence instead of thin air. Eight short years later, 1400 years of Hippocratic tradition was felled by the medical experimentalist Harvey. The human heart does not mix two types of blood; it pumps one type, to every nook and cranny of the body.

Though Thomas Kuhn does not mention Francis Bacon specifically in his essay *The Structure of Scientific Revolutions*, I can't help but wonder whether the widespread adoption of Bacon's new method did not lay the foundation for much of the scientific activity which Kuhn treats in his discussions on paradigms and scientific revolutions. With the exception of Aristotle's pendulums, and Ptolemaic and Copernican astronomies, all of the revolutions Kuhn discusses take place after Bacon published *The Great Instauration*. Kuhn defines a paradigm as an achievement that attracts an enduring group of adherents away from competing modes of scientific activity but remains open-ended enough to active problems for the redefined group of practitioners to resolve. Bacon, one might argue, laid the foundation for modern scientific-activity-defining paradigms with the development of a new method for conducting scientific activity. It succeeded so well it is now known, ubiquitously, as the scientific method. The vast influence Bacon's method exerts in science tempts me to call his method a meta-paradigm.

It's only slightly less clunky a word than meme-complex, which Dawkins uses in the *Selfish Gene* to describe a collection of memes that develop a mutualistic relationship. To expand on meme-complexes, Dawkins first delves into an exploration that the idea of God may be a particularly effective self-replicating meme. "The survival value of the god meme in the meme pool results from its great psychological appeal," Dawkins writes. 'It provides a superficially plausible answer to deep and troubling questions about existence. It suggests that injustices in this world may be rectified in the next. The 'everlasting arms' hold out a cushion against our own inadequacies which, like a doctor's placebo, is none the less effective for being imaginary."[8]

Reinforced through art, tradition, texts, social norms, the meme of God comes wrapped in a whole bundle, which Dawkins calls a meme-complex. Memes within the meme-complex can shift and swap out, like Legos: in some brains and books, the God-meme associates with the Christian Bible, in others, the God-meme associates with the Qur'an, and in others, the Talmud. Over time, as different memes are incorporated into or excised out of the meme-complex in each successive generation, and modifications accumulate. Over time, the modifications begin to look like environmental adaptations, responses to selection pressures within their idea ecosystems: meme-complexes, if they exist, evolve.

I find the parallels between Dawkins' meme-complexes and Kuhn's paradigms striking. Though Kuhn admits in a 1969 postscript to using the word paradigm in several different senses, he settles on two unique senses. First, a paradigm "stands for the entire constellation of beliefs, values, techniques...shared by the members of a given community," and second, a paradigm refers to the puzzles and solutions established and accepted by the community in the pursuit of normal science.

I find Kuhn's first definition especially evocative of Dawkins' meme-complexes, and vice-versa, because I can easily imagine each belief, value, and technique used in a scientific community as a discrete meme. During periods of what Kuhn calls normal science (periods without dramatic upheavals in a field), the memes exist in an evolutionarily stable set called a paradigm. But during a scientific revolution, a new theory emerges with explanatory power to rival that of the old paradigm, the stable state is disrupted, and the scientific community in which the revolution occurs must choose between two or more paradigms. Because the standards by which facts are established and considered relevant exist within a paradigm, the competition between two paradigms starts to look something akin to a political revolution. There is no agreed upon standard to objectively make a decision between the two paradigms, no shared logic or even probabilistic basis for deciding which paradigm the community should occupy. It becomes, according to Kuhn, a question of community values: "As in political revolution, so in paradigm choice – there's no standard higher than the ascent of the relevant community."[9]

Kuhn shrewdly observed that this process begins to look like a strain of survival of the fittest. The paradigm best adapted to the priorities and values of the scientific community – the idea ecosystem in which it exists – survives to get passed on to the next generation of scientific practitioners. Though I can't imagine Dawkins being one to take issue with this, Kuhn acknowledges that to some, the most disconcerting part of this logic is the lack of teleology. In this view, scientific paradigms do not necessarily come closer and closer, generation after generation to some Platonic truth. Paradigms, like biological organisms, simply accumulate adaptations to their particular environment. Specialized disciplines proliferate from a common paradigm ancestor, and the idea ecosystem diversifies.

The Structure of Scientific Revolutions ends with this provocative vision. Though Kuhn does draw a parallel between scientific revolutions and political revolutions, paradigm shifts and art movements, he does not elaborate much beyond scientific paradigms. I find these hints tantalizing, and thinking back to that day last January and my conversation with Jenry, I cannot help but extend the metaphor beyond labs and scientific communities into the broader currents of society. If scientific paradigms compete for acceptance by the relevant community, would not competition exist between competing world-views as well? I could extend the metaphor out into modes of government or economic models, but what interests me most – and has since three girls told my seventh grade science teacher that learning Darwin's theory of evolution was against their religion – is just that: religion.

The ideological competition that springs to my mind – perhaps ingrained in me since seventh grade – is that between creationists and evolutionists in the sphere of public education. The debate has raged across the United States in the last century and into this one, from the Scopes Monkey Trial in 1925, in which John Scopes was tried, convicted, and fined by the state of Tennessee for teaching evolution (the whole trial was largely an elaborate hoax to pitch the legality of teaching evolution on a national stage) up to today, when according to the polling organization Gallup, 38% of Americans still believe that

God created humans in their present form, and 38% believe that evolution has been guided by a divine hand.[10] But according to that same Gallup poll, the percentage of Americans who believe that humans evolved, unassisted by God, is at an all-time high (19%) since Gallup began asking the question in 1982 (when the percentage of respondents who answered yes to the question of materialistic evolution was at 9%).

But to paint a picture of creationism pitted against evolution is to render a largely false hyper-caricature of a dichotomy that does not, in the ecosystem of ideas, necessarily exist. Gallup's triad of possible responses already breaks down the dichotomy, and a critical look at creationism reveals an entire population of competing ideologies, from flat-earth, young-earth creationism to theistic evolution. And Kuhn's discussion of paradigms serves as a humbling reminder that, though consensus drives science forward, scientists forge consensus into paradigms from competing theories; it is not given freely.

This image, an ecosystem of evolving ideas, holds some hope for me. Though it may, on the surface appear as disconcerting as Darwin's theory of evolution because it excises any sort of absolute morality from the equation, I find the awareness it engenders simultaneously empowering and humbling. Rather than stand in the kitchen with Jenry and despair about the current political situation and muse about the collapse of reason and the disintegration of the nation, I find I am able to step back, momentarily and reflect on the dynamic nature of the evolution of ideas. My horizon expands: certainly, the current administration and political environment do not align with whatever swarm of memes has infested my brain. But there will be, perhaps a time when I find the political environment more favorable. And in those moments, it will still be valuable to hold the changing nature of ideas in my mind: the pendulum will swing, if not in the opposite direction, in a different direction again.

There is also an element of uncertainty here, glossed over until now. Though the idea of memes and meme-complexes is compelling, fundamental questions about the validity of the theory remain. The field of memetics, spawned from (and now criticized by) Dawkins, has been accused of pseudoscience, and the *Journal of Memetics* only published from 1997 to 2005. A prominent question remains open-ended: what exactly is the medium in which a meme exists? What would the unit of self-replication be? So perhaps the whole idea crumbles upon deep scrutiny.

But ideas, a good friend once told me, are like levers you can press to see the world in a different way. My hope, then, is simply to provide and press several levers while roaming through the realm of ideas, associating freely between disparate threads, contrary to my training as a scientist and an academic. This is an essay, neither a contribution to a scientific journal nor an academic paper, and the associations are those that have appeared in my mind, influenced by the rivers of thought and ideology in which I've spent my life immersed. My hope is not to prove anything, nor necessarily persuade, but simply to provoke.

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I did look at the egg, eventually. I wandered over to the window sill, where the dusty tupperware sat, and peered into the vinegar solution clouded with calcium carbonate. The yolk glowed through the translucent interior membrane of the shell, which had dissolved away. No chick would hatch from that yolk, but something more ethereal, harder to pin down, might, in Joe and Abby. Perhaps, an interest in inquiry, or a skepticism about their own Biblical truths, the 98.6's that have invaded their minds. Perhaps, the idea of a science experiment would wedge itself into their consciousness and eventually spawn two young scientists.

I hope it will.

Or maybe that's just the Baconian method talking through me as it casts around for hosts in the next generation.

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