Cultural Evolution and the Paradox of Diversity

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Humans are a different kind of animal, dependent on not just genes, but culture. We rely heavily on this socially acquired knowledge. Over generations culture has shaped our genes. Our guts are too short and our jaws are too weak for raw food and yet we don't have instincts for cooking or even fire making, nor could we easily figure these out in isolation. Instead, we are born assuming a world of cooked food and plenty to learn. That body of knowledge, what we call culture, has been evolving for generations through innovation and accumulation. This process of *cultural evolution* gives us a framework for understanding innovation and designing policies that maximize innovation by leveraging levers like diversity.

Diversity is a paradox. We often push for greater diversity, because our tendency is toward squashing difference and selecting others like ourselves. But diversity is a double-edged sword. On the one hand, innovations are often diverse ideas recombined, a process of *intellectual arbitrage*. Discoveries and technologies situated in one discipline, but drawing on a key insight from another. On the other hand, diversity is, by definition, divisive. Without a common understanding, common goals, and common language, the flow of ideas in our social networks are stymied, preventing recombination and reducing innovation. Consider the challenge of collaborations between scientists and humanities scholars or even between scientists in different disciplines. The key to resolving the paradox is finding common ground through strategies such as optimal assimilation, translators and bridges, or dividing into subgroups.

Innovation is often assumed to be driven by genius innovators—the giants upon whose shoulders we stand. What this view ignores are the scientists, engineers, and other inventors of equal stature whose efforts led to dead ends. Instead, innovation is driven by collective processes as ideas flow through our social network, recombining in the minds of innovators and groups. We would see a lot less simultaneous invention and would be a lot less afraid of being scooped or beaten to market if innovation was truly a product of our individual genius alone. But to understand this process, we need to understand a little bit more about cultural evolution.

Cultural evolution is an extension to the mathematical toolkit of evolutionary biology into the realm of socially transmitted information. Any adaptive evolutionary system, whether genes or a genetic algorithm requires three ingredients—things must vary, things must be transmitted without losing too much information, and things must be selectively transmitted where more adaptive things persist better than less adaptive things. Natural selection describes how these ingredients manifest allowing organisms to genetically adapt to environments over generations. Cultural evolution describes how these ingredients manifest allowing societies to culturally adapt faster than genes.

Culture has been accumulating to the point where today, not even the smartest among us could recreate the world we live in. Indeed, many adaptations and societal changes have evolved to deal with better ways to store and manage collective capabilities that exceed the storage capacity of even our smartest brains. We got better at learning and even teaching. Many hunter gatherers mostly let children hang around to learn. Pastoralists and horticulturalists do some deliberate demonstration. Since the Industrial Revolution, we have created an institution and made it compulsory—formal schools. Schooling helps our young efficiently catch up on the last several thousand years of human progress. And despite ongoing pressures for educational innovation, we still spend longer learning, extending our juvenile period and then a cultural adolescence—the period between when you can reproduce and when you actually do—to the point where our challenge is less the ability to birth a big head, and more the ability to give birth at an older age. Most effective of all, we divided up the knowledge and labor—we specialized, creating the paradox of diversity.

Specialization allowed us to exceed the capacities of a single brain. Imagine 10 things are required to survive—food, housing, shelter, clothes, the rules of society, defense, and so on. And imagine we max out at brain size 10 units. It's difficult to birth anything bigger until medical interventions like Cesareans are invented. If we must learn everything to survive, we can achieve 1 unit on each skill; 10 brain units, 10 things, skill level 1. But imagine you only had to learn half those things because there are enough people that even if some die, you know that there's enough other people who know the other half. Now you can dedicate yourself to getting better at those 5 things and reach skill level 2. Now imagine, you only needed to learn 1 thing; our society can now reach skill level 10. Divide it further and the sky is the limit, despite a limited 10 size

brain. Further specialization means further increases in the average skill of the society. In a small town, there may be one general physician, but in New York, a doctor may specialize on a small part of the renal system and get very good at treating that one part. Society is then able to compute almost as a collective brain, but this creates a new challenge. You become smarter at a few things and stupider at everything else, siloing specialists into disciplines and creating a challenge for coordination between different specialists.

Many of the most impactful research papers and patents are the result of *intellectual arbitrage*—leveraging common knowledge in one discipline to solve the problems in another. The solutions to common problems are sometimes stored in separate disciplines, sometimes spread across the heads of many people.

Cultural evolutionary theory predicts 3 key processes that lead to innovation. Incremental innovation is the product of small improvements through partial causal models—Edison's 99% perspiration. We often do understand a small part of our larger discipline better than others do. But large innovations are typically recombined ideas or simply serendipity. Cultural evolution in turn predicts 3 levers of innovation that increase the likelihood of discovery through these processes. Sociality, which describes the size and interconnectedness of a society—larger more interconnected societies have more ideas that can more easily flow through denser social networks to meet and combine. Transmission fidelity—better means of communicating information allow information compression, easier learning, simplified steps, discovery of fundamental principles, and more information stored per head. And finally, diversity, the double-edged sword.

Resolving the tension between diversity and selection is at the core of a successful innovation strategy. And there are many possible solutions. Some dimensions of diversity matter more than others—without a common language, communication is difficult. On the other hand, food preferences create little more than an easily solved coordination challenge for lunch. But between these are many dimensions where optimal assimilation may be desirable. Between these are traits that can be optimized, such as creating psychological safety that makes people feel free to share unorthodox ideas. Other strategies include interdisciplinary translators. In my role at the Database of Religious History—a large science, humanities collaboration—we have benefitted from a few scholars trained in both and bridge the gap. Innovation can also be divided into

independent groups, coordinating within the group, but competing against others trying different strategies, as is the case in competition between firms.

Cultural evolution and the dual inheritance—culture-gene coevolutionary—framework represent the closest we have come to a theory of human behavior. Like other formal unifying frameworks of the past—from natural selection to the periodic table—it helps us make sense of our existing knowledge, but also helps us design new approaches to tackle the challenges of the future.