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Complexity Drives the Rate of Innovation

By Chuck Dinerstein — January 10, 2019

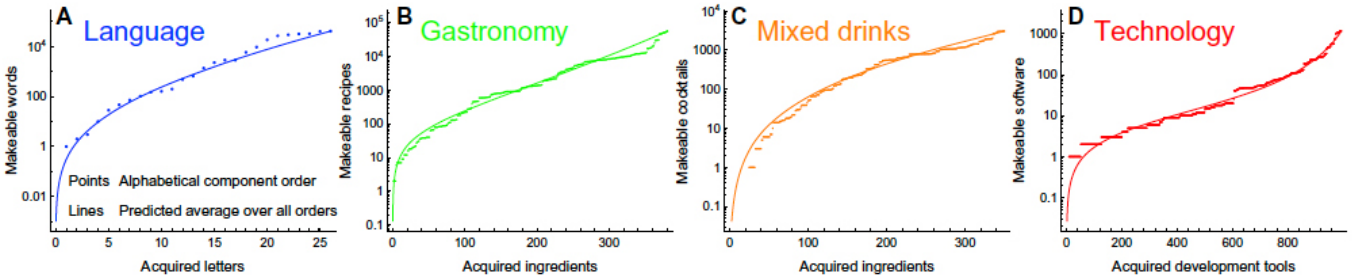
Courtesy of Jadvani Sharad [1]

What drives innovation? After all, innovation is how we feed more with less and enhance and extend our lives. Is improvement something we can control by who and how we organize research and implementation? Or is there some intrinsic rate to how fast we can improve? As the authors of a new *Science Advances* paper suggest, is it the nature of health care discovery or how it is nurtured?

The researchers looked at four different domains: our language, recipes, mixed drinks, and technology looking at how the acquisition of “new components” led to the growth in “makeable” products. For their study letters, ingredients, beverages, and software development tools were components and words, recipes, drinks and new software the resulting makeable products. In extending their work to healthcare, think of our outcomes, who we can save, treat, whose lives we extend and improve. Healthcare’s components are medications and surgery and devices — like pacemakers, or the new wave of smartphones reporting your blood sugar or abnormal heart rhythm.

It makes intuitive sense that the more components you have available, the more products you can create. Having the letters A to D allows you to create 10 words, add the letter E to the mix and the number of word products you can build rises to 28. Similarly, the component ether opened up a number of new surgical products that went deeper into the body for more extended periods. The addition of antibiotics again increased the number of products we could offer, including safer surgery and treating some real problematic diseases like cholera.

Beginning with no products and adding one component after another, researchers calculated how many products could be made.



They found that the graphs for these four disparate domains were very similar, varying more in rate than shape. And as you might expect, the order in which products were added also made a difference. To extend our health analogy, getting antibiotics before ether would have just increased “medical” products, just as getting ether first resulted in more surgical procedures. Having more components, like ether and antibiotics allows us to create both more and more complex products. Amputation was supplanted by bypass surgery to save a limb; pain medication to soothe shingles was supplemented by a preventative vaccine.

A recipe’s complexity is part technique and part ingredients. Escoffier and his sauces, the basis of fine French cooking, is a good example. Complexity is related to how many components you have and use. Gin and tonic has two elements a “complexity” of 2; a Gin Gin Mule involves gin, mint, simple syrup, lime juice and ginger beer. The five different components create a different complexity or taste.

In the health care analogy consider the treatment of breast cancer. We have at least three main components: surgery, chemotherapy, and radiotherapy. We use all, and if we factor in the individual chemotherapeutic agents separately, we have far more complex treatments today than 100 years ago, when the only possible cure was a radical mastectomy.

The researchers found that the rate of innovation — creating new products — is driven primarily by the types of complexity present. Having lots of components is necessary, but how those components are utilized and assembled is what determines the speed of innovation. It is a mathematical way of talking about the low-hanging fruit of solutions.

In my healthcare analogy, Semmelweiss’s hand washing was a pretty simple idea (still often honored more in name than deed) and was the low-hanging fruit of its day. Antibiotics are a more complex solution and required a number of other components beyond soap and water.

Research to better understanding our physiology helps identify new components, expanding our repertoire of makeable products. We have lots of new “target” molecules and risk factors to manipulate. But the speed at which we create new healthcare outcomes is a result of how many simple, moderate and complex solutions exist. In many ways, the simple treatments have all been found. Innovation slows dramatically when the remaining products are all increasingly complex.

Much of what we consider innovation today is what the researcher's term “frugal innovation,” or reducing components to make a product more accessible. The ability of the Apple Watch to detect arrhythmias is a form of frugal innovation; the same for telemedicine. In both instances, we have eliminated the component of traveling to a physician and extended their reach.

The best examples of increasing complexity are the profound differences in the newly-developed

pharmaceuticals. Most of our current medicines are simple compounds. Innovations in drug discovery have been frugal – reducing labor costs by automating identifying and testing of compounds. The more significant innovation are biologics that are far more complex in their focus, development, and production, in that it takes more time and money to bring them to market.

To be honest, if you thought drug prices were high now, brace up. A 1994 paper [1] on rheumatoid arthritis put the annual cost to the patient in today's dollars at $8,900. The current estimates put the price of using biologics to more-effectively treat that same condition at about $30,000 annually. [2]

We should not be surprised that it takes longer to develop the next "blockbuster" drug or to create other "significant" improvements in care. Most of the simple solutions given our current knowledge have been already utilized. Advancing care will take longer and cost more, and that is in part the result of how innovation advances, not because of evil Big Pharma or Big Device.

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[1] The Costs of Rheumatoid Arthritis Pharmacoeconomics DOI: 10.2165/00019053-199406060-00005

[2] RA Treatment Costs: What are the Costs of RA Medications and Surgery? [2]

Source: How much can we influence the rate of innovation Science Advances DOI: 10.1126/sciadv.aat6107

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