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Seeds of Science

Randomness in Science

Roger's Bacon[1], Sergey Samsonau[2], Dario Krpan[3] (example article)

"Could we improve science by exploring new ways to inject randomness into the research process?"

Humans have a randomness problem. We are bad at generating randomness as individuals (try to out-random a computer in Man vs. Machine) and in the aggregate - ask a group of people to choose a "random" number between 1-20 and the most common number will be 17. We are also bad at detecting randomness, that is we find patterns where there is none, known as patternicity - also see apophenia, pareidolia (no, the burn pattern in your toast that looks like Jesus is not a sign from the Holy Spirit), the clustering illusion, and the hot hand fallacy.

Humans also have an aversion to randomness. It's not hard to see why from an evolutionary perspective – randomness is the antithesis of life's imperative to minimize risk by controlling and predicting the environment. However, there are situations in which the best strategy is to generate and harness randomness. In the modern world, we can use fancy mathematics to work out when a situation can benefit from randomness and use computers to generate it (or at least pseudo generate it). How did our ancestors accomplish these tasks? Joseph Henrich discusses how cultures around the world (unconsciously) evolved divination practices in situations where true randomness is the best strategy in his book *The Secret of Our Success.*

> "When hunting caribou, Naskapi foragers in Labrador, Canada, had to decide where to go. Common sense might lead one to go where one had success before or to where friends or neighbors recently spotted caribou.
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> However, this situation is like the Matching Pennies game. The caribou are mismatchers and the hunters are matchers. That is, hunters want to match the locations of caribou while caribou want to mismatch the hunters, to avoid being shot and eaten. If a hunter shows any bias to return to previous spots, where he or others have seen caribou, then the caribou can benefit (survive better) by avoiding those locations (where they have previously seen humans). Thus, the best hunting strategy requires randomizing.
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> Can cultural evolution compensate for our cognitive inadequacies? Traditionally, Naskapi hunters decided where to go to hunt using divination and believed that the

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> shoulder bones of caribou could point the way to success. To start the ritual, the shoulder blade was heated over hot coals in a way that caused patterns of cracks and burnt spots to form. This patterning was then read as a kind of map, which was held in a pre-specified orientation. The cracking patterns were (probably) essentially random from the point of view of hunting locations, since the outcomes depended on myriad details about the bone, fire, ambient temperature, and heating process. Thus, these divination rituals may have provided a crude randomizing device that helped hunters avoid their own decision-making biases."

As this passage demonstrates, there are some situations where randomness can serve to compensate for our biases and deficiencies in our judgement. Divination practices can serve as a cover for injecting chance into a strategic decision, but it would seem to me that we have no such disguise in the modern world and that any suggestion of using randomness will have to overcome our significant bias against it (i.e. randomness represents a "blind spot" in contemporary culture). Given that science consists of many activities in which we aim to minimize randomness (measuring, manipulating, and predicting), we wonder if it might be especially difficult to overcome randomness aversion when it comes to the organization and practice of science. This begs the question - could we improve science by exploring new ways to inject randomness into the research process?

"Chance favors the prepared mind." – Louis Pasteur

The history of science is filled with serendipitous events ("happy accidents") that lead to breakthroughs, with Alexander Fleming's discovery of penicillin being perhaps the most famous example. This suggests that it might be beneficial to study serendipity and see if there are ways in which we can increase the likelihood of it occurring; social scientist Ohid Yaqub has launched such a research project.

> "Starting in the archive of US sociologist Robert K. Merton, Yaqub gathered hundreds of historical examples. After studying these, he says, he has pinned down some of the mechanisms by which serendipity comes about. These include astute observation, errors and "controlled sloppiness" (which lets unexpected events occur while still allowing their source to be traced). He also identifies how the collaborative action of networks of people can generate serendipitous findings." (from "the serendipity test")

One obvious application of randomness is the use of lotteries for grant funding. Numerous agencies are already experimenting with random allocation of funds (see "Science funders gamble on lotteries"); we won't recapitulate the arguments for funding lotteries and the evidence of their effectiveness as these have already been discussed extensively (see "Mavericks and Lotteries"), but suffice it to say it seems promising and is worth exploring further.

Meta-scientific research suggests that atypical knowledge combinations and unusual collaborations often lead to impactful, innovative work. Shi and Evans (2020) ask, “Do unusual individual scientist backgrounds, atypical collaborations, or unexpected expeditions where scientists and inventors reach across disciplines and address problems framed by a distant audience contribute most to novelty and impact?” The answer appears to be a resounding yes (see Shi and Evans (2020) for details). They also find that the, “improbability of new combinations itself predicts up to 50% of the likelihood that they will gain outsized citations and major awards” (also see Uzzi et al., 2013). Their results reveal, “ regions that have been over-explored, where the likelihood of making a new discovery or invention is vanishingly low,” and suggest, “the possibility of negative crowdsourcing, where researchers can exploit the crowd estimate of prior fruitfulness to identify where not to look for important opportunities.”

Rzhetsky et al. (2015) “Choosing Experiments to Accelerate Discovery” draws similar conclusions: “By analyzing millions of biomedical articles published over 30 years, we find that biomedical scientists pursue conservative research strategies exploring the local neighborhood of central, important molecules. Although such strategies probably serve scientific careers, we show that they slow scientific advance, especially in mature fields, where more risk and less redundant experimentation would accelerate discovery of the network.”

All of this is to suggest that the strategic use of randomness might help us better find these high-impact atypical combinations/collaborations and collectively pursue less conservative and less redundant research strategies. There may be potential for some kind of tool – perhaps a negative crowdsourcing platform as suggested above or a kind of computational meta-science advisor system (whatever that means) – to facilitate more efficient search of knowledge space.

To the degree that poor incentives lead to bad science (see the “natural selection of bad science” (Smaldino and McElreath, 2016), randomness can be used as a tool to subvert these incentives and thereby improve research quality. Penders and Shaw (2020) discuss the nature of civil disobedience in science and highlight various examples of deviant author assignment strategies that involve randomness (e.g. flipping a coin, brownie bake-off, free throw shooting contest, authorial order by height, utilizing random fluctuation in the euro/dollar exchange rate).

Lastly, science might benefit from increased randomness in the lives of scientists. We recommend that scientists adopt divination practices such as the burning of caribou shoulder blades, the reading of entrails, bird augury, or the I Ching. For a full list of possibilities, see the “Methods of Divination” Wikipedia page.

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