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Mozart, Newton and You?

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"Inspiration is needed in geometry, just as much as in poetry." -- Alexander Pushkin

Creativity is essential to particle physics, cosmology, and to mathematics, and to other fields of science, just as it is to its more widely acknowledged beneficiaries -- the arts and humanities. Science epitomizes the extra richness that can enhance creative endeavors that take place in constrained settings. The inspiration and imagination involved are easily overlooked amid the logical rules. However, math and technology were themselves discovered and formulated by people who were thinking creatively about how to synthesize ideas -- and by those who accidentally came upon an interesting result and had the creative alertness to recognize its value.

OUTLYING TALENT

Lately it has become fashionable to question innate creativity and talent and attribute success solely to early exposure and practice. In a *New York Times column*, David Brooks summarized a couple of recent books on the subject this way: "What Mozart had, we now believe, was the same thing Tiger Woods had -- the ability to focus for long periods of time and a father intent on improving his skills." Picasso was another example he used. Picasso was the son of a classical artist and in his privileged environment was already making brilliant paintings as a child. Bill Gates too had exceptional opportunities. In his recent book, Outliers, Malcolm Gladwell tells how Bill Gates's Seattle high school was one of the few to have a computer club, and how Gates subsequently had the opportunity to use the computers at the University of Washington for hours on end. Gladwell goes on to suggest that Gates's opportunities were more important to his success than his drive and talent.

Indeed, focusing and practice at an early stage so that the methods and techniques become hard wired is unquestionably part of many creative backgrounds. So Brooks and Gladwell undoubtedly are correct in some respects. Though skill and talent matter, they won't get you very far without the honing of skills and intensity that comes with dedication and practice. But opportunities at a young age and systematic preparation are not the whole story.

SCALING A HILL OF BEANS

Practice, technical training, and drive are essential to scientific research. But they are not all that is required. Autistics -- not to mention some academics and far too many bureaucrats -- frequently demonstrate high-level technical skills yet lack creativity and imagination. All it takes is a trip to the movies these days to witness the limitations of drive and technical achievements without the support of these other qualities. Scenes in which animated creatures fight other animated creatures in hard-to-follow sequences might be impressive accomplishments in themselves, but they rarely possess the creative energy needed to fully engage many of us -- even with the light and noise, I frequently fall asleep.

For me, the most absorbing films are those that address big questions and real ideas but embody them in small examples that we can appreciate and comprehend. The movie Casablanca might be about patriotism and love and war and loyalty but even though Rick warns Ilsa that "it doesn't take much to see that the problems of three little people don't amount to a hill of beans in this crazy world," those three people are the reason I'm captivated by the movie (plus, of course, Peter Lorre and Claude Rains).

In science, too, the right questions often come from having both the big and the small pictures in mind. Identifying the big questions is rarely sufficient, since it's often the solutions to the smaller ones that lead to progress. A grain of sand can indeed reveal an entire world, as William Blake, and Galileo, understood so early on.

An almost indispensable skill for any creative person is the ability to pose the right questions. Creative people identify promising, exciting, and, most important, accessible routes to progress -- and eventually formulate the questions correctly. The best science frequently combines an awareness of broad and significant problems with focus on an apparently small issue or detail that someone very much wants to solve or understand. Sometimes these little problems or inconsistencies turn out to be the clues to big advances.

The cracks and discrepancies that might seem too small or obscure for some can be the portal to new concepts and ideas for those who look at the problem the right way.

Einstein didn't even initially set out to understand gravity. He was trying to understand the implications of the theory of electromagnetism that had only recently been developed. He focused on aspects that were peculiar or even inconsistent with what everyone thought were the symmetries of space and time and ended up revolutionizing the way we think. Einstein believed it should all make sense, and he had the breadth of vision and persistence to extract how that was possible.

Many of the creative people I know also have the ability to hold a number of questions and ideas in their heads at the same time. Anyone can look things up using Google, but unless you can put facts and ideas together in interesting ways, you aren't likely to find anything new.

A lot of people prefer to work linearly. But this means that once they are stuck or find that the path is uncertain, their pursuit is over. Like many writers and artists, scientists make progress in patches. We might understand some pieces of a puzzle, but temporarily set aside others we don't yet understand, hoping to fill in these gaps later on.

Space adventurers, but artists and scientists, too, try to "boldly go where no one has gone before." But the boldness isn't random or haphazard and it doesn't ignore earlier achievements, even when the new territory involves new ideas or anticipates crazy-seeming experiments that appear to be unrealistic at first. Investigators do their best to be prepared. That's what rules, equations, and instincts about consistency are good for. These are the harnesses that protect us when traversing new domains.

Scientists who were very adventuresome in their ideas could also be very cautious when presenting them. Two of the most influential, Isaac Newton and Charles Darwin, waited quite a while before sharing their great ideas with the outside world. Charles Darwin's research spanned many years, and he published the Origin of Species only after completing extensive observational research. Newton's Principia presented a theory of gravity that was well over a decade in development. He waited to publish until he had completed a satisfactory proof that bodies of arbitrary spatial extent (not just pointlike objects) obey an inverse square law. The proof of this law, which says gravity decreases as the square of the distance from the center of an object, led Newton to develop the mathematics of calculus.

The expression "thinking outside the box" doesn't come from getting outside your work cubicle (as I once thought might be the case), but from the nine-dots problem, which asks how to connect nine dots with four lines without lifting your pen. No solution to the ninedots problem exists if you have to keep your pen inside the confines of the square, but no one told you that was a requirement. Going "outside the box" yields the solution. At this point you might realize you can reformulate the problem in a number of other ways too. If you use thick dots, you can use three lines. If you fold the paper (or use a really thick line, as a young girl apparently suggested to the problem's creator), you can use just one line.

These solutions would only be cheating if they ignored additional constraints. Competition also plays an important role -- in science as well as in most any other creative endeavor. The artist Jeff Koons told me that when he was young, his sister did art -- and he realized that he could do it better. The chef David Chang expressed a similar thought a little more bluntly. His reaction after going to a new restaurant is, "That's delicious. Why didn't I think of that?"

Research is an organic process. We don't necessarily always know where we are headed, but experiments and theory serve as valuable guides. Preparation and skill, concentration and perseverance, asking the right questions, and cautiously trusting our imaginations will all help us in our search for understanding. So will open minds, conversations with others, wanting to do better than our predecessors or peers, and believing there are answers. No matter what the motivation, and independently of the particular skills that might come into play, scientists will continue to investigate inward and outward -- and look forward to learning about the other ingenious mechanisms the universe has in store.