Published in final edited form as:

Epidemiology. 2018 November ; 29(6): 753–755. doi:10.1097/EDE.0000000000000913.

When intuition invites the analytical mind to dance –The essential role of creativity in science

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Good epidemiologic research demands logic, rigor, and objectivity. These cardinal virtues are essential to scientific progress, but they are not sufficient. Intuition and creativity also play a key role. Unfortunately, an emphasis on scientific rigor can translate into a distrust of less structured processes. Intuition may be dismissed as irrelevant, trivial, and even “unscientific.” Nothing could be further from the truth. The history of science is rich with examples of intuition and creativity at the very core of the scientific process.

In 1950, W. I. B. Beveridge published a book titled “*The Art of Scientific Investigation*.”¹ Although he was a professor of animal pathology, Beveridge’s ideas are strikingly relevant to modern epidemiology. He uses a wealth of anecdotes and case studies to show how intuition and creativity have contributed to scientific discovery. From Archimedes, who leapt from his bath with a solution to the measurement of density, to August Kekulé, who solved the structure of benzene while gazing into a flickering fire, creative imagination has played a crucial role in scientific insights.

How can we cultivate these skills in ourselves, and in the young epidemiologists we mentor? We attempted to address this question in a workshop held in Bergen, Norway last spring. We learned a lot in the process. Some participants were sceptical about the relevance of creativity to their work. We heard people say “I’m not the creative type.” The best response

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The authors have no conflicts of interest to disclose.

to this comes from John Cleese, of Monty Python fame: “Creativity is not a talent. IT IS NOT A TALENT. It is a way of operating.”² Just like logic and rigor, creativity can be learned, practiced, and encouraged. Moreover, a “creative way of operating” is not just for grand solutions; even small stubborn problems can yield to intuitive insights.

There is a vast literature promoting creativity and innovation, much of it geared towards technology, commerce, and other endeavors outside the research setting. Some books we have found useful are *Out of Our Minds: Learning to be Creative*, by Sir Kenneth Robinson,³ *The Courage to Create*, by Rollo May,⁴ and *Thinking, Fast and Slow*, by Daniel Kahneman⁵. (Kahneman’s book describes work for which he won the Nobel Prize in economics in 2002). Our specific interest is more narrow: how can creativity and intuition help scientists solve problems? We found YouTube (and TED talks in particular) to be a rich source of material, often presented by scientists themselves. Some examples: “Why science demands a leap into the unknown” by Uri Alon; “The surprising habits of original thinkers” by Adam Grant; and “Where good ideas come from” by Steven Johnson. (A list of videos and other materials used in our workshop is provided in the e-supplement.)

We also discovered how much we all can learn from each other. We asked participants in our workshop about conditions under which they have experienced unexpected insights. After initial hesitation, our colleagues offered a surprising range of responses. For some people, fresh ideas come while showering, or in that half-awake state of early morning, or while putting their feet up on their desk and day-dreaming. For others, routine physical exercise (biking, walking, gardening) can help unleash creative thoughts. Charles Darwin took at least one long walk every day, and called his route his “thinking path.”⁶ There is no single right answer that works for everyone. But what these activities have in common is that they do not involve working harder. Indeed, they all involve getting away from concentration on work. This is a strong theme in the history of scientific discovery.

This is not to suggest that hard work has no place. No strategy for creative insights can be productive without preparation. Problem-solving requires immersion in the problem at hand. But immersion alone is seldom enough and may, in fact, create a block. Freeing the mind after delving deeply can provide unexpected progress. Recognizing that ideas can unexpectedly appear outside of work is the first step towards putting this tool to intentional use.

Another time-honored route to novel ideas is through discussions with colleagues. We all need colleagues we can trust, who will not think ill of our half-formed notions. The interplay of intellects wrestling with a puzzle can release insights that would not occur to any of us alone. A related theme is the benefit that can come from exchanges with experts from other disciplines – or from other cultures. Those who have worked with colleagues in other countries know the fresh perspectives that can result. Not only do we learn about alternative ways of thinking, but we can reflect on our own work in a different light.

Yet another constructive activity is to explore topics outside our area of expertise. We can stumble on valuable insights by browsing far afield, even outside of science. Nadrian

Seeman says the woodcut *Depth* by MC Escher led him to see how a three-dimensional lattice could be constructed from DNA, thus launching the field of DNA nanotechnology.⁷

There are social barriers that can block creative thinking. None of us wants to look foolish (especially in front of our colleagues), and yet such fears can squelch provocative questions and fledgling ideas. Professional hierarchies can also inhibit discussion. The authority of specialists and the dogmas of established thought do not encourage fresh perspectives. Senior researchers can help draw out new ideas among their more junior colleagues by admitting their own ignorance and confusions, welcoming conflicting views, and openly sharing untested ideas.

One universal theme in stories of scientific insights is the importance of holding distractions at bay – especially when deep into a puzzle. This is easier said than done. The trivial and relentless demands of our bureaucratic institutions are hard to withstand. A first step might be to raise the status of creativity as a legitimate part of research. The more we collectively recognize the value of creativity, the more likely we are to find structural ways to protect the space and the time that creativity requires.

The role of intuition in science deserves serious attention. How often do you discuss with your colleagues where your ideas come from? How many epidemiology courses even mention the role of intuition and creativity? Our graduate schools give high priority to mastering methods, but little attention to cultivating the insights that steer those methods towards productive ends. The payoff of combining logical rigor with creativity can be enormous. As Beveridge observes, instruction in the art of scientific investigation not only improves a researcher's chances of solving a problem, but makes the process more richly satisfying. Simply put, creative thinking can be fun.

One caution: just because an idea comes as an intuitive hunch does not mean it is right. Cognitive and other biases may color our thinking. For example, psychologists have shown that intuition is a poor guide to estimating the sample size needed to test a hypothesis.⁵ One reason power calculations have achieved such stature in our field is because our intuition does not do the job. Separating our good ideas from the not so good is precisely the role of rigor and logic. The physicist Luis Alvarez set aside Friday afternoons to “think crazy.”⁸ (“Unless you set the time aside,” he said, “you’ll never find the time to do it. It’s just like exercise.”) But Alvarez didn’t stop there. He also had the immense skill of separating penetrating insights from the merely “crazy” – winning him the Nobel Prize for physics in 1968.

The bottom line is that researchers need to cultivate both creative and critical skills. Daily pressures so easily tie us up in a straitjacket of interruptions and minutiae. To create relaxed settings in which our intuition can emerge requires deliberate effort. While this may not come easily, such effort has a reward. The balance of reason and intuition is the dance that leads to discovery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank Prof. Trond Riise, who helped organize the Bergen workshop, and our colleagues and students who have expanded our understanding of this topic. Sally McKay has generously given permission to reproduce her dance drawing (<http://blog.sallymckay.co.uk/>).

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