Bringing Science Down to Earth

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As scientists, we tend to tell our story through breakthroughs — paradigm shifts that shake the foundations of knowledge and remake everyone's understanding of how the world works. It's a tale of high-flying, singular brilliance, of Einsteins and Darwins, of pure genius.

Such a narrative of exceptionalism isn't entirely wrong, but it's wrong enough to help skew the way society thinks about science and to sow doubt about its findings. It puts us and our work too far out of the reach of too many people, and earns us epithets like "elitist" and "arrogant."

The truth about science is much more prosaic. Detailed case studies on the history of chemistry and physics show that the role of genius in advancing those fields — and even the role of rationality — is overstated. Rather than a hyper-intellectual, alien activity practiced by a remote priesthood, science is hit and miss, the ever-changing product of less-than-brilliant people, just like every other human activity.

Have you ever heard of John Nicholson, Anton Van den Broek, Richard Abegg, Charles Bury, John Main Smith, Edmund Stoner and Charles Janet? Don't worry, chances are many experts in the field of atomic structure — on which all of the above-named scientists worked — haven't heard of them either. After all, the feature linking these men is that, broadly speaking, they didn't always know what they were doing. In some cases, much of what they published turned out to be incorrect.

And yet each of them proposed one or two key ideas in their lifetimes that were picked up by others, modified and tested, and eventually led to major breakthroughs.

In the 1910s, the English mathematical physicist John Nicholson published a number of articles in which he proposed that several proto-elements (his term) existed in outer space and were the basis of our familiar terrestrial elements. Their presence in a number of celestial bodies, he claimed, enabled him for the first time to do successful calculations on the light reaching us from the Orion nebula and the solar corona.

At first his findings seemed to hold up, but it soon became clear that the calculations were incorrect or the result of numerological speculations. Nevertheless in the course of his work Nicholson also proposed that the angular momentum of electrons circulating around a nucleus should be "quantized," meaning that it could only occur with specific definite values. This notion would set Danish physicist (and, ultimately, Nobel Prize winner) Niels Bohr off on his theory of the structure of the hydrogen atom. From that, quantum mechanics and all the technological applications based on it — including lasers and semiconductors — would follow.

Something similar happened with each of the other unknown scientists on my list. Their haphazard, often pedestrian work still provided keys to, for example, how the elements in the periodic table should be ordered (Van den Broek) and the "octet rule" that explains much of chemical bonding (Abegg).

When the whole of the history of atomic theory is understood, it's clear that the missing links turned up by these "regular people" scientists, and the details and even the dead ends they accumulated, are every bit as important as the insights of a star such as Bohr.

This view of science casts a dim light on priority disputes — the intense battles over who was or should be considered first to a discovery — which happens even among otherwise perfectly modest scientists. It helps explain why multiple researchers arrive at the same conclusion so often: Science is a cumulative, incremental, collective effort. Fierce competition among individuals is inevitable, and it may serve to develop better science in the short run, but overall, even heroic individual achievements are simply not as important as the ever-evolving whole.

In these doubting days, almost everyone at least accepts the utility of some science. Very few people so doubt the findings of aeronautics, for example, that they won't board an airplane. But a significant portion of the general public still finds science baffling. What is incomprehensible is regarded as questionable; what is puzzling can be dismissed. It doesn't help that science represents our deepest and most reliable knowledge of the world and yet is also provisional — what we know is constantly being adjusted, tested.

In this too, however, science isn't unusual. Like life itself, it progresses by trial and error. It depends on humans simply trying things out, even if its practitioners don't always want to admit it.

Science is what we know to the best of our human abilities. Such as: Vaccinations don't cause autism; GMO corn is as safe as every other crop that has been genetically modified by other means for thousands of years; and Earth is warming past dangerous levels. The process that resulted in these findings isn't incomprehensible, remote or elitist. Even the rarefied field of atomic theory is built on human error and serendipity, on non-geniuses randomly groping around.

The better science communicates this notion, along with its fundamental ordinariness, the better its chances of being heard, understood and valued.

Eric Scerri's latest book is: *A Tale of Seven Scientists and a New Philosophy of Science*.
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