To what extent have giant leaps in scientific progress been influenced by shifts within the scientists themselves?

Can one mind change society? Can the genius, the principles and the choices of a single human all converge to great discoveries and giant scientific progress?

In the summer of 1945, a young man was watching through a truck's windshield something no one else dared to look at with the naked eye. It was only he who saw the blinding light and the deadly cloud rising from what was the first atomic bomb in history. However, in the shadow of his beloved wife's recent death, the joy of success was suddenly followed by disturbance. The race he embarked to save his country had a side he did not contemplate much on before, but that eventually grew too prominent to oversee – Hiroshima and Nagasaki, two names that became synonymous to 'destruction' in the young scientist's vocabulary. In the aftermath of the genocide he realised he contributed to, Richard made himself a life-changing promise. This promise, however, was going to change more than one man – it was going to change mankind. He vowed that he would never again use science to provide humanity with tools, but that he would only pursue it for a more selfish reason – for the fun of it.[1,2]

Deciding what is right

Richard Feynman was born in New York City during the Great Depression. His father worked in a company that manufactured uniforms for the military, which made him develop a strong rejection of authority. He considered a human should only be admired for what he "especially did" and not because of his "name and position – his uniform". As Feynman later said, together with curiosity, disrespect was the most important thing his father taught him. It allowed him to place himself and his thinking above social norms and hierarchies, turning him into a nonconformist.[1]

As a successful MIT graduate and remarkable Princeton PhD student, he was recruited to join the Manhattan Project at a secret laboratory in Los Alamos. The fear that Germany would invent first the atomic bomb and win World War 2 to become a ruling power – a defeat the US could not afford – called the brightest physicists of the time at work. Feynman felt this was part of his duty as a citizen, so he accepted the job and helped the team speed up their calculations.[1,2]

America did win the atomic bomb race and, with that, the war. But the fact that he contributed to the deaths of so many deeply disturbed Feynman – the whole race had not been worthwhile. Leaving for Cornell University to become a professor in the Physics department and still shaken by the events of the summer, he developed anxiety about doing anything *important* that could eventually turn into something destructive. However, he recalled he used to enjoy physics, and because he "used to play with it, it was never very important". This decision of only approaching science with ludicrous curiosity and solely for personal entertainment made him even more of a nonconformist in the world of science and shaped his style of enquiry.[1,2]

Nonconformity fuels creativity

Individuals with an independent self-concept are stimulated by standing out and being seen as separate from others. Insensitive to isolation, they place reduced value on belonging to a group, and so renounce all the constraints that prevent them from *thinking* by their own rules in an environment that demands conformity.[3] Exploring unusual or controversial ideas, which pose a high risk of being rejected or not understood by the scientific community, led to some of the most creative solutions and truly, some of the world's greatest discoveries. This was also the case of Albert Einstein, who revolutionised Physics through his theory of general relativity, first proposed to an incredulous public.[4] Another example is Oswald Avery, the first to state that, contrary to the general scientific opinion, the genetic material was represented by DNA and not proteins.[5]

Feynman was a nonconformist as "he did not need the external validation of having everybody respecting him all the time". His manner of disregarding the opinion of exterior entities, which was primarily installed by his father, enabled him to assert his ideas in entourages that were likely to dismiss them. It is this attitude that allowed him, for instance, to become one of the most valued partners of debate of Niels Bohr. As Feynman said, once he was made to talk about physics, he would forget about all social subtleties. That is why he pointed out any flaws in the thinking of Bohr, making him very appreciated, though not liked, by the great physicist.[1,2]

But most important for Feynman was – as he had promised himself – to *play*, guided by what was "interesting, fun and right to do". He took a sabbatical year to study viruses and ants, a decision fueled purely by his refusal to conform his passions. He also took drawing classes to his colleagues' discontentment, who thought he was "wasting his time" and gift for Physics. When the time came to be nominated for a Nobel Prize, he scorned it saying he did not need any honours – "uniforms". "The pleasure of finding the thing out, the kick in the discovery and the observation that other people use it" was the only prize he needed. This playful curiosity coupled with anti-authoritarian values projected over his style of enquiry. His unconventional mode of approaching problems incited his creativity, which meant he could arrive to solutions in an unprecedented manner.[1,2]

Sometimes it is *important* just to *play*

Feynman's unorthodox way of thinking stepped in when Physics was confronting with a great crisis. Classical theories were beginning to fail explaining or predicting all phenomena in the universe as a new field was emerging: Quantum Electro-Dynamics (QED). This area of Physics describes the interaction of light with charged elementary matter particles. By explaining how these interactions work, QED thoroughly explains electromagnetism, one of the fundamental forces of nature and of the universe. As electromagnetism underlies how atoms come together or break apart to form molecules, it explains Chemistry – the science indulging in the behaviour of matter. And, as living organisms are the result of a myriad of complex chemical reactions, electromagnetism is also at the base of all biological processes.[6]

Without a coherent QED theory, nature could not be entirely understood. But, there was a problem – when the mathematics of QED was not becoming inhumanly complex, it appeared to be flawed. Some equations predicted results of infinity for measurements that yielded finite numerical values in the laboratory – a contradiction. It was Feynman who found the underlying cause of this problem, though his source of inspiration was rather unconventional.

As a student tossed a plate up in Cornell's cafeteria, Feynman observed how its blue imprinted crest of the university was wobbling as the plate was spinning down. He "played around" with the equations of motion until they led to the similar problem of the electron's spin in QED equations. Richard realised that the equations resulting in infinity did not mean they were wrong, but that they needed to be approached from a different perspective. For a man who decided to explore Physics *for fun* and who did not care about how his ideas were going to be judged by fellow scientists, this was the perfect task. Feynman's strange method of depicting complex mathematical equations through *diagrams* meant that the complicated calculations required by QED could be side-stepped.[1,2]

Though revolutionary, Feynman's idea was unfamiliar and only understood by few at first. Although some great personalities of Physics raised objections, they all soon began to acknowledge the powerful tool that Feynman had created, and which eventually brought him a Nobel prize. QED was finally a complete theory which made meaningful predictions about the world. The "most numerically precise theory invented" was working, and it was all down to Richard Feynman's childish self, who gave no *importance* to the implications of his work – he just wanted to *play.*[1]

Feynman's work has found applications in numerous fields, that either explain the world around us or affect our daily lives. From elucidating the evolution of galaxies to telecommunications, from fundamental phenomena to daily life, everything is QED at work. Even our smartphones and computers might have been science fiction today if it was not for a young heartbroken scientist who decided *not to ever do anything important,* in the summer of 1945.

Do shifts within scientists affect humanity? Nonconformity, coupled with an individual self-concept and the mind of a genius lead to spikes in creativity. Eminently creative people are daring and do not care about social norms or patters. Creative solutions are sometimes found by exploring realms that are novel, unusual and often get rejected by the more conservative thinkers. The choices that scientists make, the approach they decide to take when tackling a problem are reflected in how they find a solution. A problem solved, a small success for a single man, could be a scientific revolution for mankind.

References

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