

Breakthrough scientific discoveries no longer dominated by the very young: study

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Scientists under the age of 40 used to make the majority of significant breakthroughs in chemistry, physics and medicine – but that is no longer the case, new research suggests.

A study of Nobel Laureates from 1901 to 2008 in these three fields examined the age at which [scientists](#) did their prize-winning work.

Results showed that before 1905, about two-thirds of winners in all three fields did their prize-winning work before age 40, and about 20 percent did it before age 30.

But by 2000, great achievements before age 30 nearly never occurred in any of the three fields. In [physics](#), great achievements by age 40 only occurred in 19 percent of cases by the year 2000, and in chemistry, it nearly never occurred.

"The image of the brilliant young scientist who makes critical breakthroughs in science is increasingly outdated, at least in these three disciplines," said Bruce Weinberg, co-author of the study and professor of economics at Ohio State University.

"Today, the average age at which physicists do their Nobel Prize winning work is 48. Very little breakthrough work is done by physicists under 30."

Weinberg conducted the study with Benjamin Jones of Northwestern

University. Their results appear in the online early edition of the *Proceedings of the National Academy of Sciences*.

The researchers believe the reasons for the age shift have to do with both the type of breakthroughs honored – theoretical or experimental – and how long it takes scientists to receive their training and begin their career.

Earlier work on creativity in the sciences has emphasized differences in the ages when creativity peaks across various scientific disciplines, assuming that those differences were stable over time, Weinberg said.

But this new work suggests that the differences in the age of creativity peaks between fields like chemistry and physics are actually quite small compared to the differences in creativity peaks between time periods within each discipline.

For the study, the researchers analyzed the complete set of 525 Nobel Prizes given between 1901 and 2008 in the three fields – 182 in physics, 153 in chemistry and 190 in medicine. Through extensive historical and biographical analysis, they determined the ages at which each Nobel Prize winner produced their prize-winning work.

In general, there was an aging pattern over the 20th century as to when scientists made their breakthrough discoveries, although there were differences between the three fields.

The most interesting case is physics, Weinberg said. In physics, there was an especially notable increase in the early 20th century in the frequency of young scientists producing prize-winning work. The proportion of physicists who did their prize-winning work by age 30 peaked in 1923 at 31 percent. Those that did their best work by age 40 peaked in 1934 at 78 percent. The proportion of physicists under age 30

or 40 producing Nobel Prize-winning work then declined throughout the rest of the century.

The shift in physics stands out from chemistry, where young achievement declined more consistently through the 20th century, and [medicine](#), which shows a decline in achievement before age 30, but otherwise no substantial trends.

The trend toward youthful achievement in early 20th century physics occurred during the same time as the development of quantum mechanics, Weinberg noted. That may help explain why young scientists were more successful then.

"Young physicists at the time were part of a revolution in theoretical knowledge. The development of quantum mechanics meant that older theories and knowledge was less relevant to what they were doing," Weinberg said.

"It may be that young scientists did better, in part, because they never learned the older ways of thinking and could think in new ways."

The researchers found that the probability that a great contribution in physics was theoretical peaked in 1933, supporting the idea that the rise of younger Nobel Prize winners was associated with more theoretical contributions.

Another reason that younger scientists may have made more significant contributions early in the 20th century is that they finished their training earlier in life.

The majority of Nobel Laureates received their doctoral degrees by age 25 in the early 20th century, the researchers found. However, all three fields showed substantial declines in this tendency, with nearly no

physics or chemistry laureates receiving their degrees that early in life by the end of the century.

In another analysis, the researchers examined the [age](#) of studies referenced in important scientific papers in the three fields through the 20th century. They found that in the early part of the 1900s -- the time when [quantum mechanics](#) made its mark -- there was a strong tendency for physics to reference mostly recent work.

"The question is, how much old knowledge of the field do you need to know to make important scientific contributions in your field?"

Weinberg said.

"The fact that physicists in the early 20th century were citing mostly recent work suggests that older scientists didn't have any advantage -- their more complete knowledge of older work wasn't necessary to make important contributions to the field. That could be one reason why younger scientists made such a mark."

But now, physicists are more likely to cite older studies in their papers, he said. That means older scientists may have an advantage because of their depth of knowledge.

Weinberg said the results of this study could be considered good news for science today, because the research workforce is aging considerably.

"If you take the view that science is a young person's game, then this aging trend is alarming. But if scientists can be productive as they get older, as this study suggests, there may be less of a problem," Weinberg said.

Provided by The Ohio State University

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