The Nobel Prize delay

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The time lag between the publication of a Nobel discovery and the conferment of the prize has been rapidly increasing for all disciplines, especially for Physics. Does this mean that science is running out of groundbreaking discoveries or that, on the contrary, there have been too many breakthroughs?

The 2013 Nobel Prize in Physics was awarded to Higgs and Englert for their prediction of the existence of the Higgs boson. Though the Higgs particle was experimentally discovered at CERN in 2012, the original theoretical works date back to the 1960s. Thus, it took about half a century of intense work to confirm their prediction.

Long time lags between discovery and recognition are not unusual. In fact, it has been significantly increasing over the years (Figure 1). Let $\Delta^{\mathrm{D}\to\mathrm{N}}$ be the time between

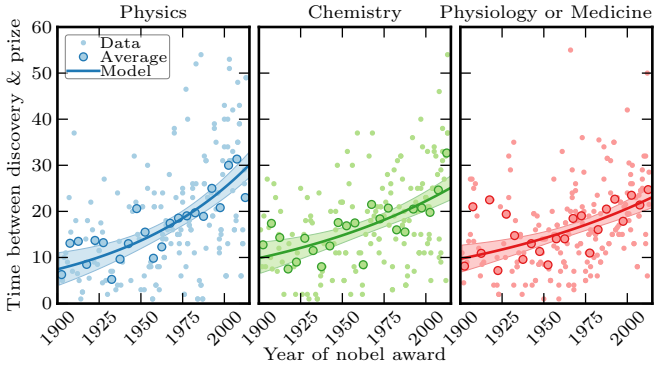

FIG. 1. Time difference (in years) between the discovery and the awarding of the Nobel prize, versus the year when the award is received. Each plot shows the raw data, the 5-year average, and the exponential fit with its confidence interval. The lag is increasing for the three fields, with rates of 0.012±0.002, 0.008±0.002 and 0.008±0.001 for Physics, Chemistry and Physiology or Medicine, respectively.

the discovery and the Nobel award. We model the variation of $\Delta^{\mathrm{D}\to\mathrm{N}}$ with time t by considering an exponential law:

$$\Delta^{\mathrm{D}\to\mathrm{N}}(t) = c_\alpha \exp(\alpha t), \tag{1}$$

where α is the rate of increase in $\Delta^{\mathrm{D}\to\mathrm{N}}$ and c_α is a proportionality constant. Figure 1 shows an increase in $\Delta^{\mathrm{D}\to\mathrm{N}}$ for all fields. The predicted values and indicated 95% confidence intervals are given by the exponential regression model. Using linear regression we get consistent results. The rate of increase in $\Delta^{\mathrm{D}\to\mathrm{N}}$ is highest for Physics, followed by Chemistry and by Physiology or Medicine. On the x-axis of Fig. 1 we report the year when the Nobel Prize is actually awarded. This means that future awards for already published discoveries will have no influence on the ones shown in our plots, they will contribute to the future evolution of the curves.

Figure 2 elaborates the details of the field-specific $\Delta^{\mathrm{D}\to\mathrm{N}}$-dynamics. It shows the percentage of prizes awarded over 20 years of the discovery. The predicted values and indicated 95% confidence intervals are given by logistic polynomial regressions. Here we estimate

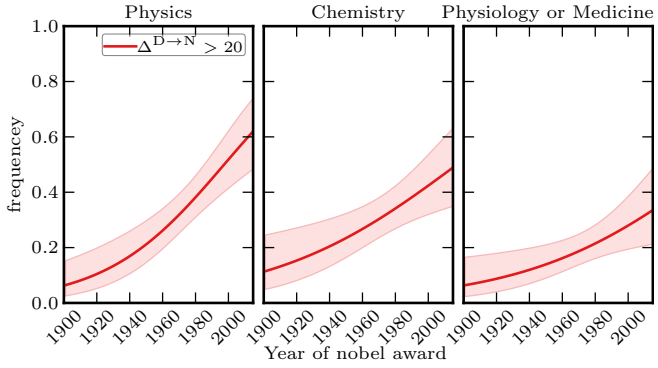

FIG. 2. The frequency of prizes awarded over 20 years of the discovery is increasing for all disciplines. The growth is fastest for Physics and slowest for Physiology or Medicine.

first-degree logistic polynomial regressions for all the fields. The conditional probability of the discovery being awarded within T year is given by

$$\Pr(\Delta^{\mathrm{D}\to\mathrm{N}} < T|t) = \frac{1}{1+\exp[-(\mu+\nu t)]}, \tag{2}$$

where the parameters μ and ν are estimated using the maximum likelihood method. After 1985, about 15% of Physics, 18% of Chemistry and 9% of Physiology or Medicine prizes are awarded within 10 years of their discovery. In contrast, before 1940 about 61% of Physics, 48% of Chemistry and 45% of Physiology or Medicine prizes are awarded within 10 years of the discovery. Correspondingly, after 1985 about 60% of Physics, 52% of Chemistry and 49% of Physiology or Medicine prizes are awarded over 20 years of the discovery. In comparison, before 1940 only about 11% of Physics, 15% of Chemistry and 24% of Physiology or Medicine prizes were awarded over 20 years of the discovery. In all fields the frequency of the prize being awarded over 20 years since discovery

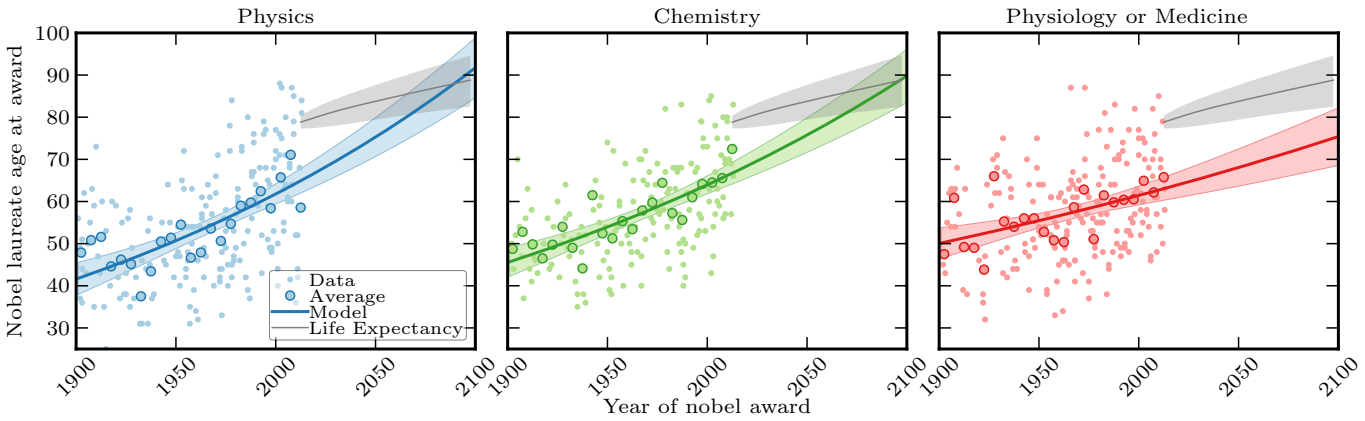

FIG. 3. Change in the age of the scientist at which the Nobel prize is awarded. For all fields there is an increasing trend. For Physics and Chemistry the rate of increase is similar (0.0040 ± 0.0005 and 0.0034 ± 0.0004), while for Physiology or Medicine the increase is much smaller (0.0020 ± 0.0005). The progression of the average life expectancy in the United States is also shown in grey.

is increasing. The rate of increase in the frequency of getting the award 20 plus years since the discovery is fastest for Physics and slowest for Physiology or Medicine.

As a result of the increasing time to recognize a Nobel discovery, the age at which laureates receive the award is also increasing. We consider how the age at which scientists are awarded the Nobel prize a^{N} is changing with time. An exponential increase is represented by

$$a^{\mathrm{N}}(t) = c_\gamma \exp(\gamma t), \tag{3}$$

where γ is the rate of increase of the age and c_γ is a proportionality constant.

Figure 3 shows that a^{N} is increasing for the three fields. We also used the regression model to project the age of the laureates at the time of the award until the end of the century. The predicted values and indicated 95% confidence intervals are given by the exponential regression model. The figure also shows the projected life expectancies (of men and women combined together) across the 21st century. Here we used the data of the United States as a proxy of the life expectancy (as US citizens hasve been awarded the majority of Nobel prizes). The expectancy is based on WPP2012 estimates using the medium scenario and the 95% prediction interval is also shown [1]. We found that by the end of this century for the fields of Physics and Chemistry, the Nobel laureates' age at discovery would become higher than the life expectancy. Therefore, if this trend is maintained, by the end of this century it might become technically impossible to confer the Nobel prize, as it is not possible to award it posthumously.

What is the reason of the increasing delay between discovery and recognition? A plausible explanation could be that the frequency of groundbreaking discoveries is decreasing. Interestingly, since no more than two discoveries can be awarded with the Nobel prize in the same year, it could even be that there are too many important discoveries, and that, in order not to lose worthy winners, one is forced to dig deeper and deeper in the past. Also, in many cases it takes much longer now than before to verify a groundbreaking result (e.g., 48 years in the case of the Higgs boson). All the above generally applies to any discipline. Yet the delay is increasing much faster for Physics than for Medicine. This seems to confirm the common feeling of an increasing time needed to achieve new discoveries in basic natural sciences, a somewhat worrisome trend.

DATA

We collected data on dates of birth, the year of Nobel prizes and year(s) of publication(s) of prize winning work. As a primary data source we used the Nobel Foundation's website, `nobelprize.org`. In the cases where the information was not sufficient to accurately identify year(s) of prize winning publication we consulted all the publications of the Nobel Laureates using `google.scholar.com`. We then determined the year of the most relevant publication related to the topic of the Nobel prize award. We also consulted the biographies of the laureates and other resources, such as `nobel.caltech.edu/`, `journals.aps.org/prl/50years/milestones`.

[1] United Nations, *World Population Prospects: The 2012 Revision* (Department of Economic and Social Affairs, Population Division, New York, 2013).