

# Reflections on Medical Science Papers Published by 2004 Nobel Prize Laureates in Physiology and Medicine

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*Based on the number of publications and citation, studies the scientific papers published by 2004 Nobel Prize Laureates in Physiology and Medicine. Using International Authoritative Database and Technical Metrology, this paper discusses the quantity and quality of papers published by these top scientists, the regulations for the medical research activities, the progressive processes of the research projects and the cooperation between research scientists on these projects. This study tries to shed a light on facilitating outstanding medical scientists and promoting Nobel Prize-level researchers in China.*

**Key words** Nobel Prize; scientist; medical papers; estimation

Most of current studies on Nobel Prizes in Physiology or Medicine are theoretical in our country. A few of them are of practical applications, and even less studies are involved in the scientific and technical achievements produced by these laureates. This paper, using the international database and metrology, estimated and analyzed the medical papers published by the 2004 Nobel Prize laureates in Physiology and Medicine.

## 1 Reasons for Winning the Prizes and Brief Biography of the Laureates

### 1.1 Reasons for winning the prizes

Richard Axel and Linda B. Buck, American medical scientists, won the 2004 Nobel Prize in Physiology or Medicine for the discovery of human olfactory system. The proclamation, by the Swedish Academy of Sciences awarding the Nobel Prize in Physiology or Medicine to the two scientists, holds<sup>[1]</sup> that the

basic principles for man to recognize and remember about 10,000 kinds of different odors were not understood. This year's Nobel laureates in Physiology or Medicine have solved this problem and in a series of pioneering studies clarified how our olfactory system works. They discovered a large gene family, comprised of some 1,000 different genes (three per-cent of our genes) that give rise to an equivalent number of olfactory receptor types. These receptors are located on the olfactory receptor cells, which occupy a small area in the upper part of the nasal epithelium and detect the inhaled odorant molecules.

### 1.2 Brief biography of the laureates

Richard Axel, born in New York, USA, on July 2, 1946, graduated from Columbia University and received his bachelor degree in 1967. He obtained his M.D. degree at Johns Hopkins University School of Medicine in 1970 and became a professor of Columbia University in 1978 and the academician of Academy of Sciences and Academy of Arts and Sciences in 1983. Now he is a professor of biochemistry, molecule biology and pathology in Columbia University. He won more than ten prizes in American and international communities.

Linda B. Buck, born in Seattle, USA, on January 29, 1947. She graduated from University of Washington and received bachelor degree in 1975, and Ph. D. degree at University of Texas Southwestern Medical Center in 1980. She did postdoctoral research at Columbia University in 1984 and became a professor of Howard Hughes Medical Institute in 2001 and academician of Academy of Sciences in 2003. Now she is a researcher of Fred Hutchinson Cancer Research Center. She won six prizes in American and international scientific communities.

## 2 Choice of Estimation and Origin of Data of Scientific Achievements

### 2.1 Estimation choice of scientific achievements

"Science and technology must be estimated systematically because estimation results influence not only scientific inventors or organizations but society and economy as well."<sup>[2]</sup> Although scientists' achievements consist of the numbers of peer-reviewed papers, conference papers, books, patents and many other indirect achievements, achievements of literature of science and technology are chief estimation of innovation and creation activities in the present scientific and technological achievements. Axel has six patents, a book, but Buck has only two patents, no books. Their published papers or conference papers, grant supports, paper citations and the number of references are not retrieved due to lack of materials. Therefore, this paper, on the basis of the statistical number of papers published by the two scientists and citation analyses, the two subsystems in technical journal paper estimation, estimated and analyzed the scientific results of 2004 Nobel Prize laureates in Physiology or Medicine.

### 2.2 Source of the data

- (1) <http://www.nobelprize.org/>

- (2) Database from Web of Science of SIS
- (3) 2003 database from JCR of SIS
- (4) Medicine database, State Library of Medicine, America
- (5) <http://www.almaz.com/nobel/>
- (6) catalog, loc. gov. Library of Congress
- (7) Derwent Innovation Index

### 2.3 Methods of data analysis

The documents retrieved by using the above database or other ways to the analytical standard are analyzed according to the year of the papers published, the authors and their individual countries, the academic classification of journals, the distribution of journals and their influential level, yearly distribution of the published papers, and their quotations. SCI is adopted in the subject classification of the documents.

## 3 Quantity Estimation of Technical Papers

From his first paper included in SCI in 1967 to the year 2004, Axel published 153 papers. 129 of them are SCI papers (5 published in *Science* and 7 in *Nature*). Fig. 1 shows that Axel published 16.13 SCI papers every 5 years. During the three five-year periods from 1981 to 1995 he published more than twenty-one papers on average. Maximally, there were 26 papers published in a five-year period.

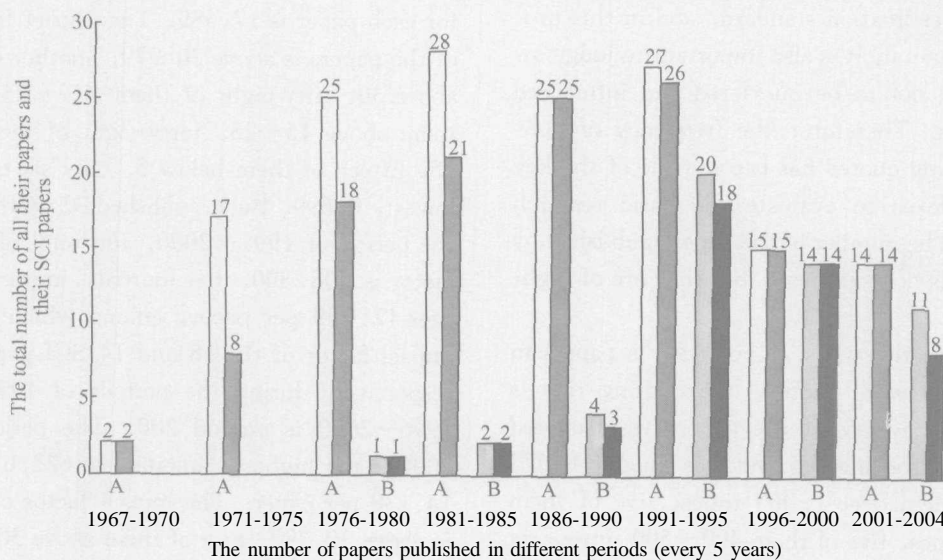


Fig. 1. Variation and collation chart, every five years, of the number of papers published and SCI papers of 2004 Nobel Prize laureates in Medicine (A refers to R. Axel and B refers to L. B. Buck)

Buck has published 52 papers totally since her first paper included in SCI in 1979 to the year 2004. 44 of papers are SCI papers (3 in *Nature*). Buck published 7.33 papers every 5 years. During the two five-year periods from 1991 to 2000 she published more than ten papers on average. She published a maximum of 18 papers in one five-year period. Fig. 1 shows that almost all of their papers published in recent twenty years are included in SCI. This elucidated that both scientists do not merely pay attention to the total number of their published papers, they pay more attention to the international impact factor of the journals their papers are published and opportunities of being quoted by other scientists. The following data of this paper handles this analysis with sufficient grounds.

#### 4 Quality Estimation of Peer-Reviewed Papers

Eliezer Geisler, an American scientist, found that<sup>[3]</sup> the more a scientist's papers are quoted, the higher the relativity and impact factor (i.e. quality) of his work are. Quotation analysis is in fact to be discussed by other scientists on the basis of the practical model. When scientists quote a certain achievement which is of vital importance to their work, they are actually using their papers to show confidence in this achievement. Academic value is taken as the most important estimation standard, and in this process of the estimation, it is also important to judge independently and not to be interfered and influenced by other factors. Therefore, the frequency of published papers being quoted has become one of the key quantitative indexes to evaluate the basic research achievements. The number of the papers published by Axel and Buck is not too many, but they are of higher quality.

According to the statistics, of Axel's papers in SCI, 127 papers were quoted, the quoting rate is 98.45 percent. Seventy of the papers were quoted over 100 times, the highest one was quoted 1,675 times, six of them over 1,000 times, five of them 500—1,000 times, five of them 400—500 times, six of them 300—400 times, seventeen of them 200—300 times, and thirty-one of them 100—200 times. In Buck's SCI papers, 36 of them were quoted, the rate of being quoted was 81.82 percent. Twelve of

the papers were quoted over 100 times, the highest one 1,195 times, one of them over 1,000 times, two of them 400—500 times, one of them 300—400 times, three of them 200—300 times, and five of them 100—200 times. In Axel's 129 SCI papers, the total number of times being quoted was 26,264, averaging 203.6 times per paper. The averaging rate of the papers being quoted is 206.803. In Buck's 44 SCI papers, the total number of times being quoted was 4546, averaging 103.32 times per paper. The averaging rate of the papers being quoted is 126.278.

Besides being quoted directly, another important index to assess the importance of basic research projects is that papers are published on top international journals. This has become one of the critical practical indexes to evaluate basic research achievements, which refers to the impact factor of the papers published. Fig. 2 shows that the impact factor of 90 of papers published by Axel during the period of 1976—1995 is 1,627.612. The journals' impact factor averages 18.085 per paper, among which the journals' impact factor of the 18, 21, 25, 26 papers published respectively during the periods of 1976—1980, 1981—1985, 1986—1990, 1991—1995 is above 300. The period of 1981—1985 is the highest, amounts to 470.749, averaging 22.417 per paper. Of the 129 SCI papers published by Axel, the total of the impact factor is 2,281.881, The impact factor for each paper is 17.689. The impact factor of seven of the papers is above 30.979, another seven of them above 30, fifty-eight of them above 25—30, one of them above 15—25, forty-eight of them above 5—15, fifteen of them below 5, only six of them is the lowest, 0.699. Buck published 32 SCI papers during the period of 1991—2000, the total of their impact factor is 408.300, the journals' impact factor averages 12.759 per paper, among which the journals' impact factor of the 18 and 14 SCI papers published respectively during the periods of 1991—1995 and 1996—2000 is around 200. The period of 1996—2000 is the highest, amounts to 622.073, averaging 14.138 per paper. The impact factor of three papers is above 30.797, four of them above 30, ten of them 25—30, two of them 15—25, sixteen of them 5—15, nine of them below 5, only three of them is the lowest, 0.699.

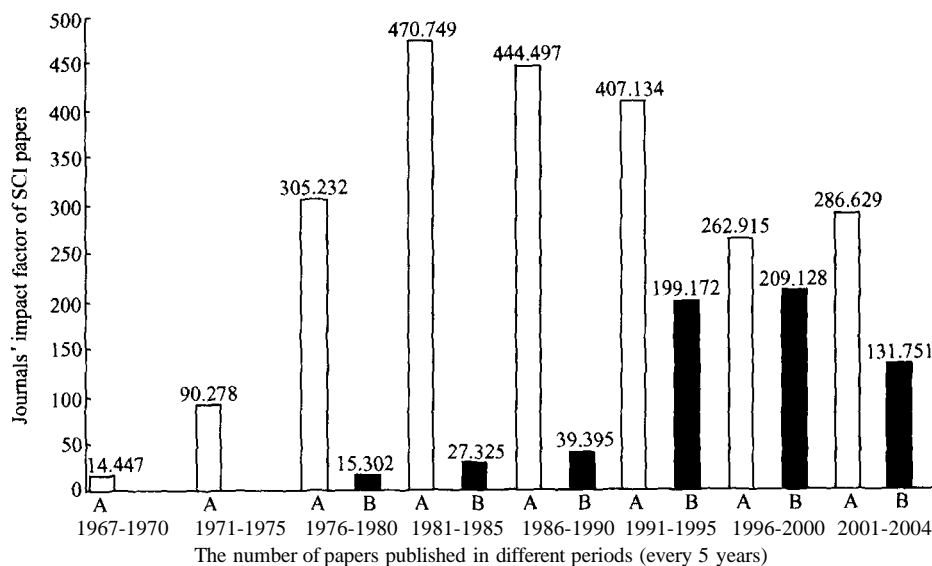


Fig. 2 . Variation and collation chart, every five years, of the number of papers published and SCI papers of 2004 Nobel Prize laureates in Medicine {A refers to R. Axel and B refers to L. B. Buck)

## 5 Analysis and Discussion

### 5.1 The research level of scientists depends on the dialectical relations between the quantity and quality of their papers

The number of papers published by top-ranking medical scientists may not be many, but they are all of high quality and quoted frequently. It makes us think on the dialectical relations between the quantity and quality in the estimation of research achievements. This study proposes that the dialectical relations between quantity and quality of the papers published by scientists be based on the quality of papers. The impact factor of papers determines their quality. It can be understood from three aspects; First, quantity is a first priority, no quantity means no quality. In the process of scientific research whatever scientists discover, the only way to make them accepted is to make them known to the world and exchange them with others. "There are indications that technical journals are the most effective one in the many ways of scientific communication"<sup>[4]</sup>. Second, the quality of papers depends on the quantity of their being included in the authoritative index references, such as SCI. In the modern world, achievements of scientific research emerge in an endless stream and change with each passing day. "Even in the recent twenty years since 1989, the number of technical journals has been

steadily on the increase at the rate of 2,000 types every year."<sup>[5]</sup> If papers published are not included in SCI or other authoritative index references, chances of being discussed by other scientists are few. Finally, the quality of papers depends on the number of times being quoted. In the index of scientific metrology, the norm used to estimate papers is quotations and the number of times being quoted in technical papers. "<sup>[6]</sup> According to the statistical results regarding the 2002 peer-reviewed papers in China by the Research Institute of Chinese Science, Technology and Information<sup>[7]</sup>", the number of technical papers published by the Chinese scientists takes the fifth place in the world and the number of papers being included in SCI is in the sixth place. However, of the papers published by Chinese scholars in international journals, the quoting index number is 2.78 per paper, that taking 127<sup>th</sup> place in the 150 countries and areas of the world during the ten years from 1993 to 2003. This indicates that the scientific and original creative abilities of our top-ranking scientists need to be further improved.

### 5.2 The peak age period of the scientific creation of medical scientists tends to be postponed

The prior estimation of the technical papers published by Axel and Buck and the successful experiences of these two medical scientists provide new cases for the study of medical scientists'scientific activities. Zhao Hongzhou created a term<sup>[8]</sup> "the best age

level for scientific creation". He thinks that the best age level for outstanding scientists to make great contributions is between the ages of 25—45. The analysis of seventeen Chinese SCI scientists' quotations proves well the law summarized by Zhao. However, the successful experiences of these two scientists whom we are discussing here do not follow this law. Axel is a precocious scientist. At the age of 21, he published his first SCI paper, obtained his Ph.D. degree at 24, became professor at 32, became academican of National Academy of Sciences at 37, and at the age of 40, he published his SCI papers which were quoted the highest. Buck belongs to the group of "great minds mature slowly." She published her first SCI paper at the age of 32, received her M. D. degree when she was 33, published her SCI papers which were quoted the most at 47, became professor at 54 and became academican of National Academy of Sciences at the age of 56. It is easy to see that, from the number of their SCI papers published, the number of times being quoted and the sum total and percentage of the journals' impact factor of their published papers, the best age level for their scientific creation is between the ages of 30—50 and 35—55 respectively. This indicates that a new problem that whether the best age for medical scientists' scientific creation should be postponed at least 5—10 years than normal, that is between the ages of 30—35. All this may be due to the dramatic increase of the sum of human knowledge and the specific characteristic of medical science that make the medical breakthrough more difficulty. Of course, this assumption still needs to be proved by group study of medical scientists.

### 5.3 Researches to win Nobel Prize need to urge in science.

The research experiences of these two Nobel Prize winners in Physiology or Medicine are important enlightenments for our scientists to heighten their confidence in Nobel Prize in Physiology or Medicine and to adjust their academic attitudes. According to a study in China<sup>[9]</sup>: it requires knowledge accumulation of three generations to train a Nobel Prize laureate, but the cases of Axel and Buck does not support it. In 1984, Axel and Buck started the olfactory research that they had never done before, but they achieved their first breakthrough and published their most important paper in 1991. With no doubt, their experiences give more confidence to our

scientists in different research fields to win the Nobel Prize laureates in the recent future, but it's also a warning for our scientists to keep and adjust their academic attitudes. During the period from 1984 to 1991, Axel and Buck, especially Buck, she had been a post-doctor for four years before 1984, and she became an assistant professor at the age of 44 in 1991. She had published only 6 papers (five of them are included in SCI) before 1991. However, due to their real interest in science and no eagerness for quick success, they concentrated on the research and approach to the formation principle and process of complex olfaction. As Buck said while she referred to the research project: "In the long course of my research, I have been trying and doing countless experiments, but haven't been able to discover anything that comforts me. So when I discovered the new gene in 1991, I could not believe my eyes!"<sup>[10]</sup> Look at the attitudes and phenomenon of those doctors and post-doctors in our country. They are eager to publish as more as possible papers to pursue quick professional promotion to professors in only one or two years after their graduation. There is no doubt that this is one of the reasons why the number of technical papers published in our country takes the fifth place in the world and the quotation rank is only the 127<sup>th</sup>.

### 5.4 Original creative results require close cooperation among top-ranking thinkers

To achieve original creative results, apart from having sufficient investment in scientific research and best laboratories, top-ranking teachers, best students or co-operators, cooperation among teachers, students and scientific workers are indispensable.

There are a lot of successful examples in the history of Nobel Prize showing close coordination and cooperation<sup>[11]</sup>. The cooperation between Axel and Buck added more to the history of science. According to Axel, his code of success is carefulness, patience and cooperation<sup>[12]</sup>. This code played a very important role in their eleven years' cooperation (1980—1991). In 1983, Axel was already an academican of National Academy of Sciences, a famous scientist and was at his peak in scientific creation. However, Buck, only one year younger than him, was in a difficult situation during this period of time. But one did not look down upon the other nor was self-conceited, and the other was not a blind worshipper or jealous. Buck put forward three bold and correct hypotheses

and ingeniously made surprising breakthroughs while Axel, during this period of time, affirmed her achievements and gave her advice. They learned from each other through the communication of what Peter Medawar called "the art of soluble."<sup>[13]</sup> In addition to its large investment in basic research, the reason why American won Nobel Prize so many times is because they pay special attention to the educational ideas and ways of training students' independent thinking, and the national and international cooperation among top-ranking scientists. There are two problems currently influencing postgraduates' independent thinking that warrant our careful consideration about our present education of postgraduates: one is that tutors use their graduates as employees. What graduates are working on during their study at college was only a part of their tutors' projects. They do not independently investigate their own projects. The other problem is that graduates suppose to learn from their research activities, however, with the expansion of graduates' enrollment, there are more and more tutors having more scientific projects. How can we expect high quality of graduates trained in this way? Some of studies<sup>[14]</sup> proposed that to increase the practical training undergraduates and post-doctors is one of the ways to enhance our scientific achievements in a short time.

## References

[1] [http://www.hpe.en/manager/view, asp? id = 7625 & type = index.](http://www.hpe.en/manager/view.asp?id=7625&type=index)

- [2] [USA] Eliezer Geisler. Estimation System of Science and Technology. Beijing: Science Technology and Literature Press, 2004, 369.
- [3] [USA] Eliezer Geisler. Estimation System of Science and Technology. Beijing: Science Technology and Literature Press, 2004, 155.
- [4] Jiang Guohua. Origin of Science, Shijiazhuang: Hebei Education Publishing House, 2001, 146.
- [5] Jiang Guohua. Origin of Science, Shijiazhuang: Hebei Education Publishing House, 2001, 141.
- [6] Jiang Guohua. Origin of Science, Shijiazhuang: Hebei Education Publishing House, 2001, 145.
- [7] Institute of Science, Technology and Information. 2002 Statistics and Analysis of China Scientific and Technical Papers, 2003, 8—10.
- [8] Zhao Hongzhou. An introduction to Science Ability. Science Press, 1984, 199—200.
- [9] Chen Qirong, Yuan Chuang, Chen Jifang. Reason and Mood—Nobel Prizes for the Century. Shanghai: Fudan University Press, 2002, 308.
- [10] [http://x26.2000y.net/mb/l/Read News.asp? NewsID = 230901.](http://x26.2000y.net/mb/l/ReadNews.asp?NewsID=230901)
- [11] Duan Zhiguang, Lu Zuxun. An Approach to the Creative Motive Power of Nobel Prize Laureates in Medicine. Medicine and Philosophy, 2005, 26(1): 16—19.
- [12] Zhou Daping. Why Universities Cannot Win Nobel Prizes. Liaowang News Weekly, 2004, 46: 54—56.
- [13] Pu Muming. Major Science and Minor Science. Xinhua Digest, 2005, 2: 119—121.
- [14] Lan Tian. A Model to Increase Scientific Achievements in China. Science Times, 2004, 11—25.