Highly Cited Publications in World War II: A Bibliometric Analysis

Yuh-Shan Ho[1]* and James Hartley[2]

[1]Trend Research Centre, Asia University, Taichung 41354, Taiwan

[2]James Hartley, School of Psychology, Keele University, Staffordshire, ST5 5BG, UK

Tel: 886 4 2332 3456 ext. 1797

Fax: 886 4 2330 5834

E-mail: ysho@asia.edu.tw

Abstract What are the characterisics of scientific papers published in World War Two, and what papers from World War II, if any, are highly cited today? This paper reports that 3,767 publications from World War II have been cited at least 100 times since 1939-1945 to the end of 2015. The data show that the publication rates of scientific papers declined during World Wars I and II only to pick up again rapidly after it. In World War II the USA was the most prolific source of scientific publications, and Harvard University was the most dominant institute. (American??? – delete 'American' if not all American!) Nobel laureates contributed 5% of these highly cited articles.

{Yushan there is a problem with the wording here. Do you want to say 5% of these articles were published by authors who subsequently became Nobel Laureates or were they Laureates already/during the war?}

In addition, there were five ‘Sleeping Beauties’, that is papers that were published during the war but came into prominence at a much later date.

Keywords: High Impact Sleeping Beauties, Nobel Prize, Web of Science, World War II, SCI-EXPANDED.

Introduction

Figures 1 and 2 show that publication rates decline during periods of war. However, little is known little about the effects of war on the remaining publications. In this paper we used the

Figs 1 and 2 here. [Note they have to be added to this text. These are the graphs for WW1 and WW2 that you sent separately to me.]

Science Citation Index to examine some of the properties of highly cited papers initially published during Word War Two (1940 - 45). Such highly cited articles are of particular importance because a high citation count is indicative of high impact or visibility in the research community, and highly cited articles provide interesting and useful insights into which authors, articles, and topics influence research over time (Smith, 2008). Furthermore,

citation rates also reflect the impact of published works on the international community.

In recent years, Ho and his co-workers have used the total number of citations since publication to evaluate highly cited articles (e.g., Chuang et al., 2011; Ho and Hartley, 2016; Wang et al., 2011). The advantage of this indicator is that it is an invariant parameter, in comparison with the index of citations from the Web of Science which has to be updated from time to time (Fu et al., 2012).

In this pape we sought to discover some of the properties of the highly cited papers that were published during World War Two.

Methodology

To collect the bibliographic data we used the Science Citation Index Expanded (SCI-EXPANDED) of Web of Science Core Collection (Thomson Reuters). As noted in the *Journal Citation Reports (JCR)* of 2015, this indexes 8,778 journals across 176 subject categories. In this study we searched for documents published between 1939 and 1945. Initially, we found 203,230 documents (as of June 13th, 2016). We then selected from these those papers that had been cited over 100 times. This yielded 3,767 highly cited publications and we used data derived from these publications for further analyses. In addition, we also used the number of citations per paper in 2015 - the most recent year then available to characterize these highly cited papers (Ho, 2013).

Results and discussion

It is clear from Figures 1 and 2 presented above that similar publication trends were found during and after World War I and World War II respectively, with a decline during the war years and an increase after them (especially World War II). In this study we analyzed those articles that were published in World War II that had had at least 100 citations since publication to the end of 2015.

Document types

We found 3,767 highly cited documents in World War II in seven document types (see Table 1). Ninety-four percent of these documents were articles. The three (?) most highly cited documents were: (Give name/date citations)

Table 1 about here

Language of publication

96% of the 3,523 highly cited articles published in War II were published in English, followed by German (125 articles, X%), French (11, X%), and one each for Dutch, Rumanian, and Russian. Warburg and Christian (1942) published "Insulation and crystalisation of the fermenting process of Enolase" – the only non-English article with the highest number of citations (1,199).

Publication year

Figure 3 shows the number of articles published in World War II and the number of citations per publication year. Of these, a total of 3,523 articles (2.2% of 158,660) were identified as highly cited articles.

Figure 3

Highly cited articles

These 3,523 highly cited articles were published in 261 journals across 90 Web of Science categories in SCI-EXPANDED. Of these 261 journals, 63 (24%) contained only one highly cited article; 26 (10%) contained two; 22 (8.4%) contained three; and 22 (8.4%) contained four. In total 2,209 articles were published in 128 journals that had impact factors in 2015 and 1,314 articles were published in 133 journals which did not.

Within the 90 Web of Science categories in SCI-EXPANDED, 31 categories (34%) generated 1–5 highly cited articles published in the World War II, 11 categories (12%) generated 6–10 articles, 17 categories (19%) 11–30 articles, 21 categories (23%) 31–100 articles, and 10 categories (11%) generated more than 100 articles. REVERSE THIS ORDER OF THE TEXT ABOVE TO GO FROM HIGH NUMBERS TO LOW – TO BE CONSISTENT?

Table 2 shows the 12 Web of Science categories with at least 100 highly cited articles.

Table 2 about here

Publication performances: countries, institutions, and authors

To evaluate the publications of countries and institutions, 1,920 articles (54% of the 3,523 highly cited articles) with author information were analyzed, following the procedures advocated by Ho and Kahn (2014). Among the articles with this information, 1,900 (99%) were country independent and only 20 (1.0%) involved international collaborations.

Table 3 lists the all 29 countries (DO WE NEED ALL THE COUNTRIES IN THIS TABLE? How about the top 10?) that published highly cited articles in World War II. Five indicators were used as shown: total articles, independent articles, collaborative articles, first-author articles, and single-author articles. The USA convincingly took first place for all of the indicators shown followed, distantly by the UK and the USSR. The USSR was also ranked 3rd for country independent and single author articles. Surprisingly, 12 of 20 internationally collaborative articles were published by single authors with affiliations from two countries. (E.g., paper n was published by x who was based in places 1 and 2).

Table 3 about here

Altogether, 1,920 highly cited articles [Cut: 'with affiliation information in Web of Science'], among which 1,951 (86% of 1,920) (Something wrong here – 1,951 can't be 86% of 1,920) resulted from inter-institutional collaborations and 269 (14%) were institutional independent articles. Thirty-seven institutions published at least 10 highly cited articles. The Academy of

Sciences of the USSR was the only insitution not located in USA that published (more than?) 10 articles.

(I have cut the text here)

Table 4 lists the top 10 institutions with more than 40 publications. Harvard University dominates the list (11%) followed by Columbia University (8.0%) and the University of Chicago (5.5%). In World War II Harvard University not only provided the most highly cited articles but also the most institutionally independent articles, inter-institutional collaborative articles, first author articles, and single author articles.

Table 4 about here

Publication performance: authors

In total 4,337 authors were involved in 3,523 highly cited articles published during World War II. Of these 3,170 (73%) contributed one article, 675 (16%) contributed two, 243 (5.6%) contributed three, 103 (2.4%) contributed four, and 146 (3.4%) contributed five or more. Ninety-six of the authors (2.2% of 4,337) won a Nobel Prize, including 40 in physiology or medicine, 31 in chemistry, and 25 in physics. In total Nobel laureates published 184 highly cited articles as first authors.

The most prolific author was P.J. Flory (at Harvard??) who published 13 highly cited articles in World War II, including the most first author, corresponding author, and single author publications. Flory won the Nobel Prize in chemistry in 1974 for his achievements in the

physical chemistry of macromolecules - both theoretical and experimental. {However, it is important to note here with these data that a potential bias in the analysis of authorship might occur when different authors have the same name, or the same authors use different names over time (Ho and Hartley 2016).} This sentence needs to go somewhere else? Or just cut? Or maybe a footnote at this point?

The lifespan of the most cited articles in World War II

As shown in Table 5, only 21 articles were cited at least 100 times by 2015, and this number represents 0.60% of the highly cited articles published in World War II. Five of these 21 articles were published in *Journal of Chemical Physics*, two in *Proceedings of the National Academy of Sciences* of the United States of America and in *Physical Review* respectively. Sixteen articles were published by a single author, four by two authors, and one by four authors. The article by Cassie and Baxter (1944) had the highest number of citations (584), and Avrami, of Columbia University, was the only author who published two articles with over 100 citations each (Avrami 1939; Avrami 1941). An article by Nelson from the University of Cincinnati published in 1944 had the highest overall score of 10,845 citations and this still received 142 citations in 2015. Two articles were published by the Nobel laureates (Flory and Rehner, 1943 and Onsager, 1944).

Table 5 about here

Figure 4 provides a picture of the citation lives of the top five articles based on their totals in 2015. Two of these five articles were also ranked among the top five articles cited in 2015 ??. These were the articles by Cassie and Baxter (1944) ranked 1st and by Avrami (1939) ranked 4th. Other highly cited articles (e.g., Bratton and Marshall (1939) and Schmidt and Thannhauser (1945)) have had a low impact in recent years, and it is widely accepted that the impact of a highly cited article might not always be high (Fu et al. 2012).

Figure 4 about here

High impact Sleeping Beauties in the World War II

Citation analyses can draw attention to papers that are suddenly discovered - or even "rediscovered" - after several years of dormancy (Garfield 1980). Gregor Mendel's (1866) "Versuche über pflanzenhybriden" is a typical example. This paper did not without notice, but its significance was not appreciated for over 30 years (Garfield 1980). van Raan (2004) discusses three main variables here: (1) the depth of sleep, where an article receives at most one citation on average per year (deep sleep), or between one to two citations per year during a specific period (less deep sleep); (2) the length of sleep - the duration of the above period; and (3) the intensityof the wakeup period: the number of citations per year for four years following the sleeping period.

Table 6 lists six high impact Sleeping Beauties from World War II and Figure 5 shows typical citation curves for three of them. (NOTE: Changes to your text and figures here) The life of

the article by Patterson (1939) shown in Figure 5 is typical of that of a high impact Sleeping Beauty. This article was in deep sleep for 40 years and then in less deep sleep for 20 more. It then spent only one year more to reach 100 annual citations. Similar curves are also shown in Figure 5 for World War II articles by Hyers (1941) and Dice (1945).

Figure 5 and Table 6 about here

Conclusions

In World War II, 3,767 highly cited documents including 3,523 articles were listed in SCI-EXPANDED. English was the dominant language. The *Journal of the American Chemical Society*, the *Journal of Biological Chemistry*, and the *Physical Review* were the three most productive journals. Articles in the basic sciences such as chemistry, biochemistry, molecular biology, medicine, and physics were the main sources for these highly cited articles.

The USA contributed most highly cited articles and was also the most collaborative country, whilst the USSR was highly independent with no internationally collaborative articles. The top 36 research sites in the war were in the USA, and Harvard University ranked top in six of the studied indicators. The Academy of Sciences of the USSR was ranked 37th in the total number of highly cited articles. The most active authors were P.J. Flory and F. Albright.

Ninety-six of World War II authors won a Nobel Prize in physiology, medicine, chemistry,

and physics (?? Is this right?) . Six high impact Sleeping Beauties were published during the War, and five of the top ten highly cited articles are still listed in the top ten articles in 2015. So, we are still indebted to these scientists who worked during World War II, and it is a pleasure here to be able to recall their contributions.

References (I have not checked these – and may have deleted some of them in the text/list by mistake)

"The Nobel Prize in Chemistry 1968". Nobelprize.org. Nobel Media AB 2014. Web. 24 July 2016. <http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1968/>

"The Nobel Prize in Chemistry 1974". Nobelprize.org. Nobel Media AB 2014. Web. 25 July 2016. http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1974/

Yuan - Please check these – are the dates right or has something slipped here!

Note journal titles, vols nos etc need to be in italic for Scientometrics…

Archie, G.E. (1942). The electrical resistivity log as an aid in determining some reservoir characteristics. Transactions of the American Institute of Mining and Metallurgical Engineers, 146, 54-61.

Avramescu, A. (1973). Science citation distribution and obsolescence. Studii şi Cercetări de Documentare, 15(4), 345-356.

Avrami, M. (1939). Kinetics of phase change. I. General theory. Journal of Chemical Physics, 7(12), 1103-1112.

Avrami, M. (1941). Granulation, phase change, and microstructure: Kinetics of phase change. III. Journal of Chemical Physics, 9(2), 177-184.

Baltussen, A., & Kindler, C.H. (2004). Citation classics in anesthetic journals. Anesthesia and Analgesia, 98(2), 443-451.

Biot, M.A. (1941). General theory of three-dimensional consolidation. Journal of Applied Physics, 12(2), 155-164.

Bratton, A.C., & Marshall, E.K. (1939). A new coupling component for sulfanilamide determination. Journal of Biological Chemistry, 128(2), 537-550.

Bray, R.H., & Kurtz, L.T. (1945). Determination of total, organic, and available forms of phosphorus in soils. Soil Science, 59(1), 39-45.

Brunauer, S., Deming, L.S., Deming, W.E., & Teller, R. (1940). On a theory of the van der Waals adsorption of gases. Journal of the American Chemical Society, 62(7), 1723-1732.

Cassie, A.B.D., & Baxter, S. (1944). Wettability of porous surfaces. Transactions of the Faraday Society, 40, 546-550.

Chandrasekhar, S. (1943). Stochastic problems in physics and astronomy. Reviews of Modern Physics, 15(1), 1-89.

Chiu, W.T., & Ho, Y.S. (2007). Bibliometric analysis of tsunami research. Scientometrics, 73(1), 3-17.

Chuang, K.Y., & Ho, Y.S. (2015). An evaluation based on highly cited publications in Taiwan. Current Science, 108(5), 933-941.

Chuang, K.Y., Wang, M.H., & Ho, Y.S. (2011). High-impact papers presented in the subject

category of water resources in the Essential Science Indicators database of the Institute for Scientific Information. Scientometrics, 87(3), 551-562.

Cole, K.S., & Cole, R.H. (1941). Dispersion and absorption in dielectrics I. Alternating current characteristics. Journal of Chemical Physics, 9(4), 341-351.

Dice, L.R. (1945). Measures of the amount of ecologic association between species. Ecology, 26(3), 297-302.

Duncan, A.P., & Johnson, A.R. (2007). A “classic papers” approach to teaching undergraduate organometallic chemistry. Journal of Chemical Education, 84(3), 443-446.

Flory, P.J. (1942). Thermodynamics of high polymer solutions. Journal of Chemical Physics, 10(1), 51-61.

Flory, P.J., & Rehner, J. (1943). Statistical mechanics of cross-linked polymer networks II Swelling. Journal of Chemical Physics, 11(11), 521-526.

Fu, H.Z., Wang, M.H., & Ho, Y.S. (2012). The most frequently cited adsorption research articles in the Science Citation Index (Expanded). Journal of Colloid and Interface Science, 379(1), 148-156.

Garfield, E. (1973). Highly cited works in mathematics. Part 1. “Pure” mathematics. Current Contents, 47, 5-9.

Garfield, E. (1980). Journal citation studies. 33. Botany journals. Part 2. Growth of botanical literature and highly-cited items. Current Contents, 32, 5-15.

Garfield, E. (1980). Premature discovery or delayed recognition - Why. Current Contents, 21, 5-10.

Garg, K.C., Kumar, S., & Lal, K. (2006). Scientometric profile of Indian agricultural research as seen through Science Citation Index Expanded. Scientometrics, 68(1), 151-166.

Goodall, A.H. (2006). Should top universities be led by top researchers and are they? A citations analysis. Journal of Documentation, 62(3), 388-411.

Goodall, A.H. (2009). Highly cited leaders and the performance of research universities. Research Policy, 38(7), 1079-1092.

Ho, Y.S. (2012). Top-cited articles in chemical engineering in Science Citation Index Expanded: A bibliometric analysis. Chinese Journal of Chemical Engineering, 20(3), 478-488.

Ho, Y.S. (2013). The top-cited research works in the Science Citation Index Expanded. Scientometrics, 94(3), 1297-1312.

Ho, Y.S., & Hartley, J. (2016). Classic articles published by American scientists (1900-2014): A bibliometric analysis. Current Science, (in press).

Ho, Y.S., & Kahn, M. (2014). A bibliometric study of highly cited reviews in the Science Citation Index Expanded™. Journal of the Association for Information Science and Technology, 65(2), 372-385.

Ho, Y.S., Satoh, H., & Lin, S.Y. (2010). Japanese lung cancer research trends and

performance in Science Citation Index. Internal Medicine, 49(20), 2219-2228.

Horsfall, J.G. (1986). This week's citation classic: Horsfall, J.G. and Barratt, R.W. An improved grading system for measuring plant diseases. (Abstract) Phytopazhology 35:655. 1945. Current Contents, April, 14.

Horsfall, J.G., & Barratt, R.W. (1945). An improved grading system for measuring plant diseases. Phytopathology, 35(8), 655-655.

Hyers, D.H. (1941). On the stability of the linear functional equation. Proceedings of the National Academy of Sciences of the United States of America, 27(4), 222-224.

Ioannidis, J.P.A. (2005). Contradicted and initially stronger effects in highly cited clinical research. JAMA-Journal of the American Medical Association, 294(2), 218-228.

Kramers, H.A. (1940). Brownian motion in a field of force and the diffusion model of chemical reactions. Physica, 7(4), 284-304.

Landau, L. (1941). The theory of superfluidity of helium II. Journal of Physics-USSR, 5(1-6), 71-90.

Lefaivre, K.A., Shadgan, B., & O'Brien, P.J. (2011). 100 most cited articles in orthopaedic surgery. Clinical Orthopaedics and Related Research, 469(5), 1487-1497.

Leydesdorff, L., & Wagner, C. (2009). Is the United States losing ground in science? A global perspective on the world science system. Scientometrics, 78(1), 23-36.

Li, Z., & Ho, Y.S. (2008). Use of citation per publication as an indicator to evaluate

contingent valuation research. Scientometrics, 75(1), 97-110.

Lu, G.D. (1939). Studies on the metabolism of pyruvic acid in normal and vitamin B_1-deficient states. I. A rapid, specific and sensitive method for the estimation of blood pyruvate. Biochemical Journal, 33(2), 249-254.

Mann, H.B. (1945). Nonparametric tests against trend. Econometrica, 13(3), 245-259.

Marker, R.E., Tsukamoto, T., & Turner, D.L. (1940). Sterols. C. Diosgenin. Journal of the American Chemical Society, 62(7), 2525-2532.

Maslow, A.H. (1943). A theory of human motivation. Psychological Review, 50(4), 370-396.

McGeown, J.G. (2006). Passing on the legacy: Teaching capillary filtration and developing presentation skills using classic papers. Advances in Physiology Education, 30(3), 108-112.

Mendel, G. (1866). Versuche über Plflanzenhybriden. Verhandlungen des naturforschenden Vereines in Brünn, 4, 1-47.

Murnaghan, F.D. (1944). The compressibility of media under extreme pressures. Proceedings of the National Academy of Sciences of the United States of America, 30(9), 244-247.

Nelson, N. (1944). A photometric adaptation of the Somogyi method for the determination of glucose. Journal of Biological Chemistry, 153(2), 375-380.

Onsager, L. (1944). Crystal statistics. I. A two-dimensional model with an order-disorder transition. Physical Review, 65(3-4), 117-149.

Patterson, A.L. (1939). **The Scherrer formula for X-ray particle size determination**.

Physical Review, 56(10), 978-982.

Picknett, T., & Davis, K. (1999). The 100 most-cited articles from JMB. Journal of Molecular Biology, 293(2), 173-176.

Raff, H. (2005). Using classic papers to teach physiology. Advances in Physiology Education, 29(3), 138.

Schmidt, G., & Thannhauser, S.J. (1945). A method for the determination of desoxyribonucleic acid, ribonucleic acid, and phosphoproteins in animal tissues. Journal of Biological Chemistry, 161(1), 83-89.

Schneider, W.C. (1945). Phosphorus compounds in animal tissues. I. Extraction and estimation of desoxypentose nucleic acid and of pentose nucleic acid. Journal of Biological Chemistry, 161(1), 293-303.

Smith, D.R. (2008). Citation indexing and highly cited articles in the Australian Veterinary Journal. Australian Veterinary Journal, 86(9), 337-339.

Straub, F.B. (1940). Crystalline lactic dehydrogenase from heart muscle. Biochemical Journal, 34(4), 483-486.

van Raan, A.F.J. (2004). Sleeping Beauties in science. Scientometrics, 59(3), 467-472.

Wang, M.H., Fu, H.Z., & Ho, Y.S. (2011). Comparison of universities' scientific performance using bibliometric indicators. Malaysian Journal of Library & Information Science, 16(2), 1-19.

Warburg, O., & Christian, W. (1942). Insulation and crystalisation of the fermenting process of Enolase. Biochemische Zeitschrift, 310(6), 384-421.

Wilcoxon, F. (1945). Individual comparisons by ranking methods. Biometrics Bulletin, 1(6), 80-83.

Wohlin, C. (2005). Most cited journal articles in software engineering. Information and Software Technology, 47(15), 955.

Wright, S. (1943). Isolation by distance. Genetics, 28(2), 114-138.

Table 1. Document type distributions

Document type	Total number (%)	CPP
Article	3,523 (94)	257
Review	168 (4.5)	238
Letter	64 (1.7)	225
Editorial material	5 (0.13)	193
Note	4 (0.11)	173
Meeting abstract	2 (0.053)	420
Discussion	1 (0.027)	191

TP: total number of highly cited publications

CPP: TC_{2015}/TP - THIS NEEDS EXPLAINING

S- in the physical chemistry of macromoleculesL - don't know where this bit has come from!

Table 2. Top 12 Web of Science categories (TP ≥ 100)

Web of Science category	TP	%	No. Journal
multidisciplinary chemistry	391	11	163
biochemistry and molecular biology	388	11	289
Physiology	275	7.8	83
general and internal medicine	255	7.2	151
multidisciplinary physics	235	6.7	79
research and experimental medicine	230	6.5	124
multidisciplinary sciences	193	5.5	63
Neurosciences	179	5.1	256
physical chemistry	143	4.1	144
Pathology	126	3.6	78
Immunology	100	2.8	150
Mathematics	100	2.8	312

TP: total number of highly cited articles in the World War II

Table 3. Characteristics of the contributing countries in the World War II

Country	TP	TP R (%)	IP R (%)	CP R (%)	FP R (%)	SP R (%)
USA	1794	1 (93)	1 (93)	1 (90)	1 (93)	1 (90)
UK	30	2 (1.6)	2 (1.3)	2 (25)	2 (1.4)	2 (2.6)
Sweden	18	3 (0.94)	3 (0.79)	3 (15)	3 (0.89)	4 (1.4)
Canada	16	4 (0.83)	3 (0.79)	7 (5.0)	4 (0.83)	5 (1.2)
USSR	15	5 (0.78)	3 (0.79)	N/A	5 (0.78)	3 (1.6)
Holland	10	6 (0.52)	6 (0.42)	4 (10)	6 (0.52)	6 (0.54)
Denmark	6	7 (0.31)	7 (0.26)	7 (5.0)	7 (0.26)	6 (0.54)
Germany	6	7 (0.31)	7 (0.26)	7 (5.0)	7 (0.26)	9 (0.41)
China	4	9 (0.21)	13 (0.11)	4 (10)	11 (0.16)	9 (0.41)
Hungary	4	9 (0.21)	11 (0.16)	7 (5.0)	11 (0.16)	6 (0.54)
Ireland	4	9 (0.21)	9 (0.21)	N/A	9 (0.21)	16 (0.14)
Palestine	4	9 (0.21)	9 (0.21)	N/A	9 (0.21)	9 (0.41)
France	3	13 (0.16)	13 (0.11)	7 (5.0)	15 (0.10)	9 (0.41)
Norway	3	13 (0.16)	11 (0.16)	N/A	11 (0.16)	13 (0.27)
Switzerland	3	13 (0.16)	19 (0.053)	4 (10)	11 (0.16)	13 (0.27)
Australia	2	16 (0.10)	13 (0.11)	N/A	15 (0.10)	16 (0.14)
Belgium	2	16 (0.10)	13 (0.11)	N/A	15 (0.10)	13 (0.27)

Brazil	2	16 (0.10)	19 (0.053)	7 (5.0)	20 (0.052)	N/A
Egypt	2	16 (0.10)	13 (0.11)	N/A	15 (0.10)	N/A
Japan	2	16 (0.10)	19 (0.053)	7 (5.0)	20 (0.052)	16 (0.14)
Turkey	2	16 (0.10)	13 (0.11)	N/A	15 (0.10)	N/A
Argentina	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	16 (0.14)
Argentine	1	22 (0.052)	N/A	7 (5.0)	20 (0.052)	16 (0.14)
Austria	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	16 (0.14)
Finland	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	16 (0.14)
India	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	16 (0.14)
New Zealand	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	N/A
Uganda	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	N/A
Venezuella	1	22 (0.052)	19 (0.053)	N/A	20 (0.052)	N/A

TP: total number of highly cited articles;

IP: single country highly cited articles;

CP: internationally collaborative highly cited articles;

FP: first author highly cited articles;

SP: single author highly cited articles;

R: rank; %: percentage in each of TP, IP, CP, FP, and SP;

N/A: not available.

Table 4. Characteristics of the ten most productive institutions

Institute	TP	TP R (%)	IP R (%)	CP R (%)	FP R (%)	SP R (%)
Harvard University, USA	213	1 (11)	1 (9.2)	1 (23)	1 (9.6)	1 (11)
Columbia University, USA	153	2 (8.0)	2 (6.8)	2 (15)	2 (7.6)	2 (6.0)
University of Chicago, USA	106	3 (5.5)	3 (5.8)	6 (3.7)	3 (5.4)	2 (6.0)
University of Calif, USA	73	4 (3.8)	4 (3.8)	6 (3.7)	4 (3.5)	7 (2.2)
Yale University, USA	69	5 (3.6)	5 (3.6)	10 (3.3)	5 (3.3)	4 (4.4)
Cornell University, USA	59	6 (3.1)	6 (2.8)	5 (4.8)	6 (2.7)	5 (3.1)
Johns Hopkins University, USA	49	7 (2.6)	7 (2.4)	6 (3.7)	8 (2.3)	11 (1.6)
University of Pennsylvania, USA	48	8 (2.5)	9 (2.3)	6 (3.7)	7 (2.4)	6 (2.3)
University Wisconsin, USA	42	9 (2.2)	7 (2.4)	31 (1.1)	9 (2.1)	15 (1.4)
Caltech, USA	40	10 (2.1)	10 (1.9)	11 (3.0)	10 (1.9)	9 (1.9)

TP: total number of highly cited articles;

IP: single institute highly cited articles;

CP: inter-institutional collaborative highly cited articles;

FP: first author highly cited articles;

SP: single author highly cited articles;

R: rank;

%: percentage in each of TP, IP, CP, FP, and SP.

Table 5. Top 21 cited articles in 2015

Rank (C_{2015})	Rank (TC_{2015})	Article information
1 (584)	5 (4,890)	Cassie, A.B.D. and Baxter, S. (1944). Wettability of porous surfaces. Transactions of the Faraday Society, 40, 546-550.
2 (420)	40 (2,018)	Patterson, A.L. (1939). The Scherrer formula for X-ray particle size determination. Physical Review, 56 (10), 978-982.
3 (352)	8 (4,303)	Wilcoxon, F. (1945). Individual comparisons by ranking methods. Biometrics Bulletin, 1 (6), 80-83.
4 (337)	2 (6,917)	Avrami, M. (1939). Kinetics of phase change. I. General theory. Journal of Chemical Physics, 7 (12), 1103-1112.
5 (330)	44 (1,807)	Mann, H.B. (1945). Nonparametric tests against trend. Econometrica, 13 (3), 245-259.
6 (327)	16 (3,193)	Dice, L.R. (1945). Measures of the amount of ecologic association between species. Ecology, 26 (3), 297-302.
7 (294)	4 (5,927)	Cole, K.S. and Cole, R.H. (1941). Dispersion and absorption in dielectrics I. Alternating current characteristics. Journal of Chemical Physics, 9 (4), 341-351.
8 (254)	24 (2,537)	Maslow, A.H. (1943). A theory of human motivation. Psychological Review, 50 (4), 370-396.

9 (238)	13 (3,413)	Murnaghan, F.D. (1944), The compressibility of media under extreme pressures. Proceedings of the National Academy of Sciences of the United States of America, 30 (9), 244-247.
10 (221)	15 (3,197)	Biot, M.A. (1941). General theory of three-dimensional consolidation. Journal of Applied Physics, 12 (2), 155-164.
11 (212)	9 (4,161)	Avrami, M. (1941). Granulation, phase change, and microstructure: Kinetics of phase change. III. Journal of Chemical Physics, 9 (2), 177-184.
12 (191)	3 (5,938)	Kramers, H.A. (1940). Brownian motion in a field of force and the diffusion model of chemical reactions. Physica, 7 (4), 284-304.
13 (188)	37 (2,098)	Archie, G.E. (1942). The electrical resistivity log as an aid in determining some reservoir characteristics. Transactions of the American Institute of Mining and Metallurgical Engineers, 146, 54-61.
14 (172)	22 (2,803)	Wright, S. (1943). Isolation by distance. Genetics, 28 (2), 114-138.
15 (168)	26 (2,513)	Brunauer, S., Deming, L.S., Deming, W.E. and Teller, R. (1940). On a theory of the van der Waals adsorption of gases. Journal of the American Chemical Society, 62 (7), 1723-1732.

16 (142)	1 (10,845)	Nelson, N. (1944). A photometric adaptation of the Somogyi method for the determination of glucose. Journal of Biological Chemistry, 153 (2), 375-380.
17 (134)	73 (1,294)	Hyers, D.H. (1941). On the stability of the linear functional equation. Proceedings of the National Academy of Sciences of the United States of America, 27 (4), 222-224.
17 (134)	34 (2,203)	Bray, R.H. and Kurtz, L.T. (1945). Determination of total, organic, and available forms of phosphorus in soils. Soil Science, 59 (1), 39-45.
19 (131)	41 (2,008)	Flory, P.J. and Rehner, J. (1943). Statistical mechanics of cross-linked polymer networks II Swelling. Journal of Chemical Physics, 11 (11), 521-526.
20 (112)	11 (3,617)	Onsager, L. (1944). Crystal statistics. I. A two-dimensional model with an order-disorder transition. Physical Review, 65 (3-4), 117-149.
21 (100)	30 (2,435)	Flory, P.J. (1942). Thermodynamics of high polymer solutions. Journal of Chemical Physics, 10 (1), 51-61.

C_{2015}: the total number of citations in 2015 from Web of Science Core Collection;

TC_{2015}: the total number of citations from its date of publication to the end of 2015.

Table 6. Six high impact sleeping beauties in the World War II ($C_{2015} \geq 100$)

C_{2015}	TC_{2015}	L_D	L_{LD}	L_H	Article title	References
420	2,018	69	70	1	The Scherrer formula for X-ray particle size determination	Patterson (1939)
134	1,294	57	62	8	On the stability of the linear functional equation	Hyers (1941)
327	3,193	31	44	16	Measures of the amount of ecologic association between species	Dice (1945)
238	3,413	26	33	28	The compressibility of media under extreme pressures	Murnaghan (1944)
221	3,197	25	32	33	General theory of three-dimensional consolidation	Biot (1941)
212	4,161	16	21	37	Granulation, phase change, and microstructure - Kinetics of phase change. III	Avrami (1941)

TC_{2015}: the total citations since publication to the end of the last year (2015);

C_{2015}: the total citations in recent year (the last year 2015) only;

L_D: length of the deep sleep (year);

L_{LD}: length of the less deep sleep (year);

L_H: years to reach 100 annual citations after the less deep sleep (year).

Figures 1 and 2 to go in here – publications in World War 1 and Publications in World War II

You sent me these separately

Figure 3. Number of articles published in the World War II and citations per publication by years

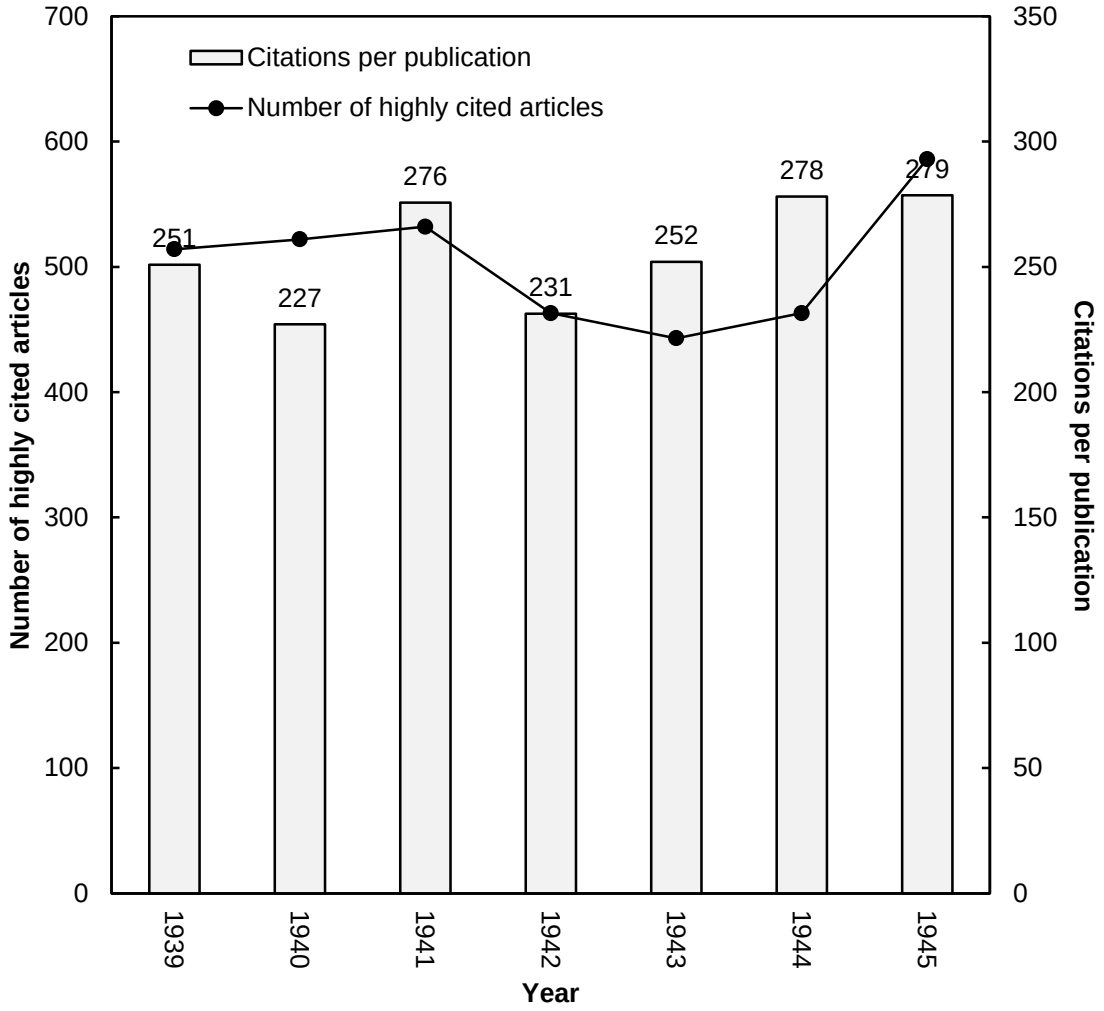

Figure 4. The high impact Sleeping Beauty lifes of Patterson (1939), Hyers (1941), and Dice (1945)