



Awakening sleeping beauties during the COVID-19 pandemic influences the citation impact of their references

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Abstract

In this research letter, we build upon recent studies about the sleeping beauties awakened by the COVID-19 pandemic. We prove that a peak of citations for sleeping beauties is associated with a sharp increase in the number of citations received by their references. This demonstrates the existence of a cascading activation of citation-based sleeping beauties.

Keywords Sleeping beauties · References · Citation impact · Indirect impact

Sleeping beauties have always been one of the most challenging phenomena in scientometrics (Garfield, 1980; Haghani & Varamini, 2021; van Raan, 2021). Their citation patterns characterized by their spooky delayed awakening have urged multiple scientists to study the reasons behind late citation bursts (Garfield, 1980; Haghani & Varamini, 2021; van Raan, 2021). Such factors include the bibliographic features of sleeping beauties such as keywords (Yang, et al., 2022) as well as altmetric data like social media interactions (Hou & Yang, 2020). Delayed recognition of these research publications can also be due to their opposition to the main knowledge of their field of interest or the limited scientific rank of their authors when the research papers were published (Garfield, 1980). In this context, citation and co-citation data can bring insights into how an uncited paper can be transformed into a trendy one within a short period, particularly through the influence of a novel and trendy paper citing it (so-called *Prince*) (Song et al., 2018). This is enabled thanks to machine learning models (Wang et al., 2021), network analysis (Song et al., 2018), the use of statistical metrics such as the *Sleeping Beauty Index* (Lin et al., 2022), and co-keyword analysis (Zhang et al., 2021).

During the COVID-19 pandemic, a notable number of sleeping beauties have been awakened due to the resurgence of several topics that were not active in the last years and

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that reappeared because of their close semantic links with coronavirus research (Zhang et al., 2021). Several papers have been aroused thanks to being cited by or co-cited with a recent highly cited paper about the outbreak (Haghani & Varamini, 2021; Song et al., 2018). Fifteen publications published between 2003 and 2015 have been identified by Haghani and Varamini (2021)¹ as sleeping beauties awakened by the COVID-19 pandemic (Haghani & Varamini, 2021). As of March 9, 2022,² the number of citations received by these publications ranges from 86 to 3,477 with an average of 1,090. Most of these citations are caused by a large peak of citations³ following the ongoing outbreak beginning in 2020, confirming the status of these research publications as sleeping beauties. For the analyzed papers, Haghani and Varamini (2021) have analyzed bibliographic coupling, co-citation, and citation networks of the COVID-19 literature coupled with keyword analysis for finding the motivations resulting in the COVID-19-induced citation bursts (Haghani & Varamini, 2021).

However, there is an interesting feature of sleeping beauties that has not been evocated by the previous studies and that can contribute to our understanding of the main mechanisms of sleeping beauties. This characteristic is the citation behavior of the references of the sleeping beauties. Concerning the fifteen publications, we found out that 75% of them have their references covered by *Web of Science All Databases* at least by a rate of 86.0% as of March 9, 2022. This encourages the use of this bibliographic database for the study of the effect of the awakening of sleeping beauties on the variations in the number of citations received by their references. When this is applied to the considered works, we witnessed the appearance of a peak of citations from 2020 for the references of every scholarly publication that is constituted of a proportion between 26.8% and 43.8% of all the citations received by these references. The less sharp nature of the peak for reference citations can be explained by the fact that references are older than citing papers and that they could have been cited during the SARS epidemic in 2003 by contrast to the fifteen publications that were considered by Haghani and Varamini (2021). Although the topic similarity between a sleeping beauty and its references and their co-citation by a novel groundbreaking research paper can simultaneously trigger their citedness (Haghani & Varamini, 2021; Song et al., 2018), this correlation can be explained by the fact that the awakening of a sleeping beauty can set off the arousal of other sleeping beauties it cites, making a cascade of citation-based sleeping beauty awakening. This effect applies to most of the references of the sleeping beauties awakened by the ongoing COVID-19 outbreak and is not restricted to a limited number of highly cited references. This is clearly shown in Fig. 1 for Van der Sande et al. (2008) and can be easily verified for the other sleeping beauties identified by Haghani and Varamini (2021).

As a result, sleeping beauties can be princes for catalyzing citation bursts for their sleeping beauty references, particularly in the margin of the COVID-19 pandemic. A sleeping beauty can consequently have a direct citation impact due to the recency of its research topic and an indirect impact caused by its influence on the citation impact of its references. Such a finding will transform all the practices for identifying and studying sleeping

¹ An exhaustive list of the fifteen sleeping beauties awakened by the COVID-19 pandemic is available at Table 3 of Haghani and Varamini (2021).

² We took one year to evaluate the fifteen sleeping beauties using *Web of Science All Databases* to prevent the effect of indexing delays on citation count.

³ The peak includes between 65.1% and 95.4% of the citations received by every publication (Mean: 84.0%).

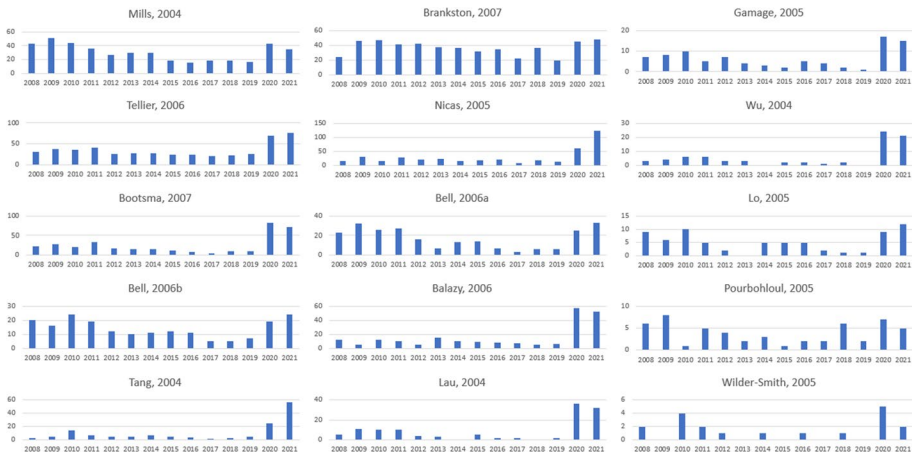


Fig. 1 Yearly number of citations received between 2008 and 2021 by the references of Van der Sande et al. (2008), one of the sleeping beauties awakened by the COVID-19 pandemic and identified by Haghani and Varamini (2021)

beauties as it proves that sleeping beauties are not always awakened by recent research papers (Song et al., 2018). That is why this fact should be validated through the analysis of the references of various sleeping beauties evocating distinct research fields (e.g., Artificial Intelligence and Sociology), having different sleeping times (e.g., five and ten years), and published in different years (e.g., 2001–2010 and 2011–2020). Scientific theories that study entangled phenomena such as graph theory (mathematics), quantum theory (physics), game theory (economics), and chain reactions (chemistry) can be used for further studying the cascading awakening of sleeping beauties and consequently for enhancing research evaluation and prediction.

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Data availability The data extracted from the Web of Science All Databases on March 9, 2022, about the sleeping beauties identified by Haghani and Varamini (2021) can be found at <https://github.com/csisc/SB-COVID>.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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