

A new ecosystem for evidence synthesis

Synthesizing evidence is an essential part of scientific progress, but it is often done in a slow and uncoordinated manner, sometimes producing misleading conclusions. Here, we propose the idea of an 'open synthesis community' to resolve this pressing issue.

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In the acclaimed BBC documentary *Life of Birds* (1998), David Attenborough narrated male house sparrows displaying a black patch of feathers on their chest or bib as a 'badge of status' to signal their fighting ability. Ten years later, a synthesis of published studies confirmed that the bigger the patch, the higher the social status. However, another ten years later an updated synthesis included unpublished studies, and questioned whether the bib signals their status at all¹.

This sparrow example may seem benign but consider the following example. An early synthesis of clinical trial evidence led governments to spend billions of US dollars stockpiling the anti-flu drug Tamiflu². It took another ten years to access the unpublished data that showed Tamiflu was probably not as effective, or as safe, as was first believed³. There are an increasing number of examples of evidence weakening or disappearing over time, not only in the field of ecology and evolution, but also in other fields³. This phenomenon is called a 'decline effect'. Such a phenomenon suggests that we should reconsider the way we synthesize evidence.

Evidence synthesis, such as a systematic review, aims to integrate all available research articles to summarize research knowledge and test or generate new hypotheses. The process of evidence synthesis is often slow and laborious⁴, and biases are introduced when primary research remains unreported or otherwise inaccessible for synthesis. Usually, a large group of primary researchers (empiricists, hereafter) collect data and they may or may not publish their work. Then, a smaller group of synthesists try to find and compile all relevant studies, often without empiricists being aware. Both parties spend many years' worth of work, independently, before reliable evidence and consensus emerge on a topic.

To change this inefficient process, we propose to overhaul the current ecosystem of how evidence synthesis is created, forging a community between empiricists and synthesists. First, we briefly discuss how current inefficiencies can affect society. Then, we illustrate the benefits of our proposal by discussing our future vision and what actions academic societies, universities and funding agencies can take. Although we preferentially draw examples from the field of ecology and evolution, our future vision is broadly applicable across fields.

Where the status quo may be taking us

It has been nearly impossible to keep up with the deluge of information made available to support not only our academic tasks but also our daily decisions. To manage the day-to-day information overload, we rely on algorithms to decide for us what information we want to see. Google uses our search history to decide what is relevant, Reddit and other forum-like websites use voting mechanisms to draw on the wisdom of the crowd, and Amazon predicts what we will want by looking at what people like us have already selected.

The algorithms we rely on to filter and select the day-to-day information have developed rapidly and are seamlessly integrated into our lives. The methods we use to synthesize research evidence, however, are much more complex, and therefore harder to automate⁵. Rather than simply identifying the most relevant information, evidence syntheses need to find all relevant information, make sense of it, identify potential biases, and summarize it for consumption. To meet the challenge of streamlining evidence synthesis, we clearly need tools to do it as fast as possible, but we also need to make sure we are synthesizing the right evidence at the right time and in the right way to avoid waste and, more importantly, to avoid poor scientific practice.

There has been a recent suggestion that, in biomedical research, many systematic reviews and meta-analyses are redundant, unnecessary or misleading⁶. While this has been studied less outside of medical research, we expect that it is already happening in the field of ecology and evolution⁷. The inability to recognize gaps where evidence is needed and to avoid repeating systematic reviews that have already been written is likely due to a lack of communication between empiricists and synthesists as well as competition and a lack of communication between these groups. Competition and lack of integration are expected to lead to the poor translation of research findings into policy outcomes. As such, we cannot completely blame policy makers for not adopting more evidence-based approaches in their decision-making process because they must often rely on dubious, premature, scattered and outdated sources of evidence.

Our future vision of an open synthesis community

In the future, we envision a new research ecosystem where every empiricist is contributing to evidence synthesis by being part of a community. This community comprises a group of researchers who engage in research synthesis on their study topics with support personnel, such as librarians, statisticians and computer programmers. Where researchers undertaking primary research are part of such a community, synthesis is recognized as the end goal, as researchers design, undertake and report their work (see ref. ⁸).

Consider a graduate student researching the effect of deforestation on insect communities. As part of their research, they carry out experiments to collect data. But in a new research ecosystem the student is also embedded in a synthesis community studying deforestation and related issues.

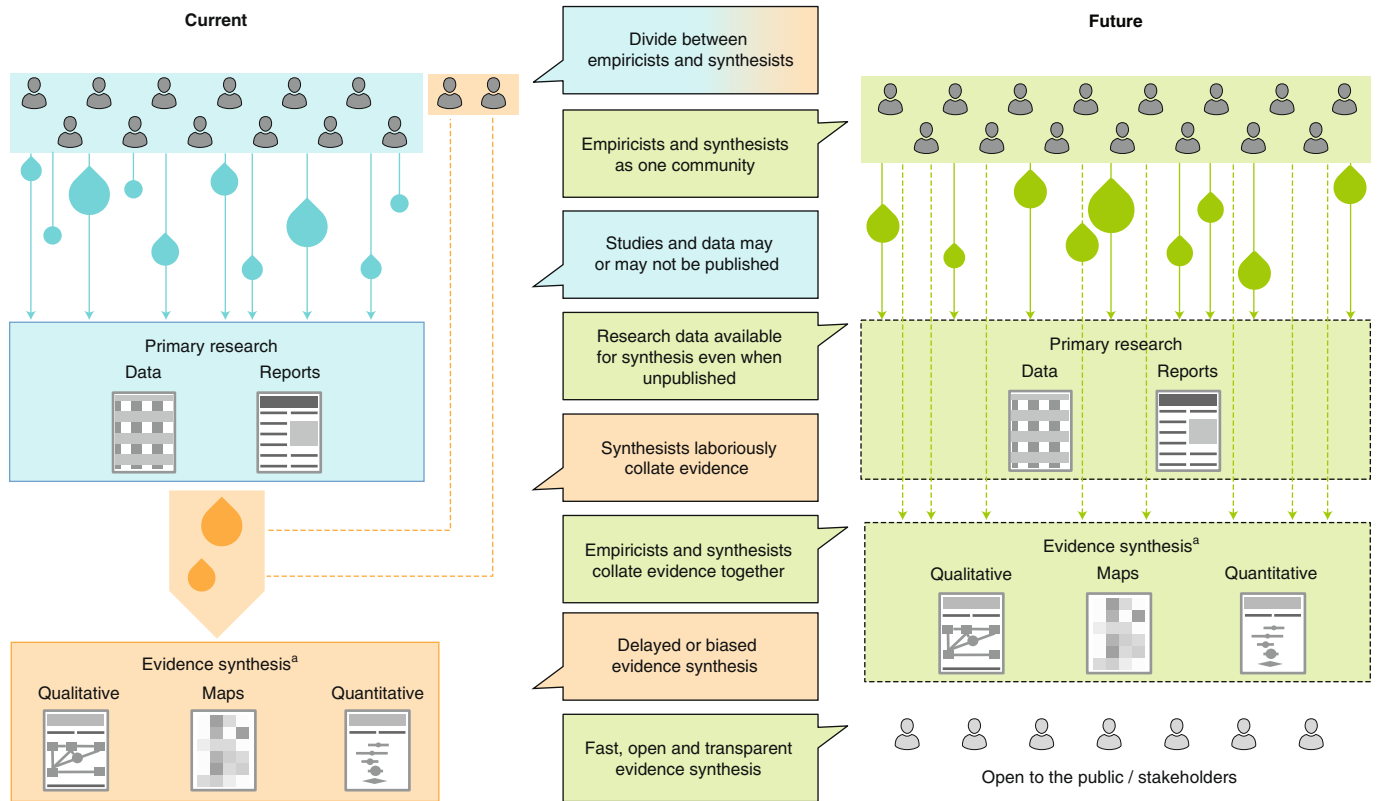


Fig. 1 | Open synthesis community. Bridging the divide between empiricists and synthesists will lead to less research waste, more collaboration, faster research progress and better engagement. Notably, in the current ecosystem, the process of research synthesis and resulting synthesis are mostly inaccessible to the public or stakeholders, whereas the proposed future ecosystem includes opening up both the process and publications. ^aEvidence synthesis includes qualitative systematic reviews, quantitative systematic reviews (including meta-analysis), systematic maps (which catalogue research on broader topics), and other types of reviews.

Mentors from the community guide the student on how their new research fits within the current body of work and help ensure that their primary research is synthesizable⁹. With community guidance, they upload information about their research designs, results and other research materials to a database regardless of the statistical significance of their results. In this way, the student takes responsibility for ensuring their data can be readily discovered and integrated into relevant ongoing research syntheses and their contributions are recognized through authorship or contributorship on the synthesis articles that include their data (Fig. 1)¹⁰. To ensure quality and fairness, standards and checking procedures are in place to maintain the quality and objectivity of data entries to manage conflicts of interests when new primary researchers become involved in the synthesis community.

In this future scenario, evidence syntheses are updated continuously. In biomedical science, some groups have already initiated 'living' systematic reviews, where a synthesis team monitors new

trial results as they are reported to rapidly incorporate new evidence in already published reviews¹¹. Our living synthesis differs from this model because it directly embeds the whole research community into evidence synthesis in an open and transparent way.

Evidence synthesis communities will be supported with tools to facilitate the work of the community, including data visualization, and the digestion and interpretation of synthesis outcomes¹². Scientists and the public alike will be able to access and assess the most current evidence within any topic. A web-based synthesis platform will provide a way to connect researchers and interested public members, improving stakeholder engagement^{12–14}.

Benefits of open synthesis communities

A key advantage of this vision is the capacity to minimize research waste caused by unpublished data and redundancy¹⁵. When all researchers are part of synthesis projects, both disappointing and exciting results will be published. Redundancy and duplications in evidence synthesis will be

reduced because the community will be aware of ongoing and planned synthesis work, and can work together through a fluid model of contributorship¹⁰. This model incentivizes both empiricists and synthesists. Primary research data are less likely to be wasted because primary researchers will be more aware of the need to make their data FAIR (findable, accessible, interoperable and reusable)¹⁶, ensuring their research is synthesizable and impactful.

A second key advantage is that open synthesis communities will be able to monitor gaps and biases in primary research and synthesis tasks. This will support improved prioritization of future projects, including needed replications, reducing research waste. By breaking down the divide between synthesists and empiricists, open synthesis communities can bring empiricists further along the journey from data collection, through synthesis, to the communication of their research to stakeholders. Rather than being 'research parasites'¹⁷, synthesists instead support empiricists through evidence synthesis processes and both groups respect

and learn from each other through better communication and involvement in each others' processes. Taken together, we will start to see, in advance, how individual studies are likely to fit into the larger scientific jigsaw puzzle, and be able to better measure impact on science and society.

As this proposed community is open to all researchers, it will increase diversity and reduce inequality in the current scientific community. For example, women in science are less likely to be included in certain scientific networks, or receive similar recognition for their work¹⁸. By removing this kind of implicit gatekeeping that has existed in science, all members of the community will be included in this open synthesis community, as they start their own research, acting as a prevention for the leaky pipeline¹⁹. Further, the open synthesis community welcomes all scientists from any laboratories regardless of resources and locations, realizing that diversity promotes better science²⁰.

How do we get there?

We can create and maintain evidence synthesis communities through improvements in education, communication, practice and methodology, changing the status quo. Our journey to an open synthesis community will require better infrastructure and technology to promote openness and interconnectedness between various stakeholders to facilitate synthesis.

We believe scientific societies or academic institutions can provide such infrastructure by starting to organize synthesis topics and groups. They understand the needs of their scientific community assuming that they listen to their community needs. For example, an academic society can form a special committee, identifying urgent topics or topics of greatest interest to the community and then, help in forming special interest groups to start initiatives. Or academic societies, with their journals (for example, the British Ecological Society and the Society for the Study of Evolution), could arrange special issues, associated with special interest groups.

Also, existing organizations overseeing evidence synthesis, such as the Collaboration for Environmental Evidence, Cochrane, and Campbell Collaboration, can take initiatives towards these goals. Funding agencies could kick-start this type of synthesis activity by forming a national centre or a centre of excellence like the National Center for Ecological Analysis and Synthesis (NCEAS) and National Evolutionary Synthesis Center (NESCent). Both centres have been influential, but their

model is to form exclusive expert groups rather than inclusive synthesis communities as envisioned here. These agencies could also create new funding pools that promote relevant workshops to initiate an open synthesis community.

We consider our Evidence Synthesis Hackathon events a great starting point for forming such a community. Our hackathon, which is a form of workshop, includes a diverse group of interdisciplinary scientists (medical, social, environmental and computer scientists, biologists, librarians and statisticians) from all around the world. At our events, we discuss and code together to advance technology to make evidence synthesis easier, less costly and time-consuming, and more transparent and reproducible. While this community was first formed less than three years ago, we have already produced free-to-use synthesis tools to this end (<https://www.eshackathon.org/>). Though it is still relatively small, it is an initiative that is well-aligned with a much larger movement addressing the reproducibility crisis¹³.

Towards an evidence revolution

Glenn Begley was among the first people to warn the scientific community of its reproducibility crisis²¹, which he optimistically refers to as an 'innovation opportunity'. Since then, researchers have taken up this opportunity and have demonstrated that they are willing to engage with open science practices, even though it may mean more work. For example, in the field of ecology and evolution, public data archiving has become mandatory²², and it is now possible to conduct a meta-analysis using archived datasets rather than summary statistics²³. Now psychologists are following suit²⁴. Simine Vazire calls such a positive change the 'credibility revolution'²⁵. Combining this revolution with unprecedented growth in primary research, it seems just the right time to revolutionize the way we do evidence synthesis. □

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Competing interests

The authors declare no competing interests.