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Editorial

How to surf today's information tsunami: On the craft of effective reading

SUMMARY

In this editorial, we provide concise suggestions to help individuals decide *what* scientific papers to read and *how* to read them. We do so because – like others – we are frequently asked by people with interest in science as to how to effectively surf today's information tsunami. This is particularly important in, but not confined to, universities and other research institutions where reading scientific papers is a fundamental task that forms the basis for all other academic activities such as writing papers or grant applications, providing reviews for a journal, preparing for postdoctoral positions, qualifying for collaborations or making oral or poster presentations. Included in our Advices 1–8 are concise suggestions which range from the appropriate motivation for reading articles in books, journals or on the internet to the very craft of systematically reviewing and, indeed, constantly challenging what one reads. We close this editorial with reading Advice 9 "You should always identify the roots of thinking and research" and 10 "The Golden Rule: set aside reading time" which should be necessary conditions for everyone who works in science. Importantly, while maintaining focus on material immediately pertinent to one's primary research area, one should read about developments in other fields as well because this may be the key to original, and sometimes revolutionary, research.

In this follow-up contribution to recent correspondence ("On the craft of effective lectures" [1] and "Complementary thoughts on the future of internet science: can digital libraries avoid scientific tunnel-vision and lead to innovation?" [2]) we provide suggestions to help individuals decide *what* scientific papers to read and *how* to read them. We do this in response to frequent questions by people with interest in science who want to know, and get some advice, as to how to effectively surf today's information tsunami. This is particularly important in, but not confined to, universities and other research institutions where reading scientific papers is a fundamental task that forms the basis for all other academic activities such as writing papers or grant applications, providing reviews for a journal, preparing for postdoctoral positions, qualifying for collaborations or making oral or poster presentations.

Advice 1: Before you start

Ask yourself the following questions: "Why am I reading a scientific paper? What do I hope to achieve?" The answer should be to check your present work and to be stimulated for and prepare your work in the future. You do not have time for "vanity reading".

Advice 2: To read or not to read ...

The title of scientific papers is most important since it determines whether or not you will have a closer look, usually at the abstract or summary of a paper (see Advice 3). A further guide may be the list of authors. While you need to be aware of Advice 4, it is often useful to follow publications from colleagues in your field.

Advice 3: ... Depends critically on the abstract

Assess the abstract or summary of a paper for its relevance to your work, its potential scientific value, and whether or not it persuades you. The abstract must demonstrate that the work is scientifically sound. An abstract must not be abstract, but must be explicit and grounded in real facts and real observations. The readability and above all, the scientific quality of the abstract or summary may guide you to decide whether to read the entire paper or not. Abstracts that are difficult to read and understand often signal that the whole paper will not be any better and not worth the effort of reading.

Advice 4: Judge words rather than journals or authors

Judge work on its own merits and not on the basis of where it is published or by whom [3]. Many examples exist of landmark papers published in "low-impact" journals such as Poultry Science ([4]; this classic in immunology was rejected by Science and has since been cited 584 times) and conversely, of highly-acclaimed work in core journals such as Science or Nature which had to be retracted for reasons of fraud [5], misconduct or error. Many journals now hold back information about authors and their institutional affiliations from reviewers to allow them to form a more objective assessment of the scientific quality of a piece of work.

Advice 5: Organize how and be critical of what you read

Rather than reading the whole paper in one piece, organize your reading. If the title catches your eye and mind, look at the abstract or summary. Pause here, obey Advice 3. Provided that you decide to continue your reading of this paper, you may want to go straight from the Introduction to the Results and to how these are interpreted and put into the context of prior work in the Discussion.

Be critical of all results and conclusions. If you decide that the results might be relevant to you, check if they are valid based on the experimental details given in the Materials and Methods section.

Advice 6: Peer review continues with your reading

Even though the editors and reviewers of a journal will have tried hard to assess the work they present, pre-publication peer review is not infallible. In fact, the real peer review occurs only after publication. Challenge what you read and ask the authors for more information if their data does not seem to add up [6].

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You and the other readers determine if a given paper stands the tests of time. A scientific paper is "an open invitation to inspect ones results and to consider ones preliminary interpretation" [7].

Advice 7: Look for answers to these questions

What research question(s) does the paper address? What do the authors conclude? What evidence supports their conclusions and what is the quality of this evidence? Do the authors consider alternative explanations for their findings? Are the paper's conclusions relevant?

In most good papers you will note that the authors believed in an a priori hypothesis enough to go ahead and test but that they were also capable to doubt the a priori enough to notice errors and faults as a basis to modify their a posteriori reasoning.

Advice 8: If a paper is difficult to read, be critical of yourself but also of those who wrote the piece

If you find it difficult to follow the context, let alone details of a paper, there are two possible explanations. You may be out of your depth and may need to fill gaps in your knowledge before proceeding. However, the explanation may also be that the paper is badly written. If clarity does not ensue in a reasonable amount of time, you are often better off cutting your losses and giving up.

Advice 9: You should always identify the roots of thinking and research

Always use your reading to understand the root or origin of ideas, hypotheses and research. This implies that you need to use all tools for identification of published material that is relevant for your reading, including PubMed, Google Scholar and the ISI Web of Science. But years ago it was already anticipated in Newsweek that eventually you may not have exhaustively researched a topic unless you have also "googled" the theme. To have the basis for better searches for information, Larry Page started out in the mid 1990s with no less ambition than to download the entire World Wide Web onto his desktop. Intriguingly, in a near(er) future, Google's ongoing digitizing of millions of books from libraries around the globe will allow to search scientific literature – old and new – easily and make them amenable to your qualified reading [2]. Note that lack of appropriate reading is one explanation for the somewhat distressing fact that a considerable number of research papers seem to stop with the reference catchment which the popular Medline database provides, i.e., references to journal articles from 1950 to the present, with limited older material. This can lead to astonishing results. How else could one explain that Japanese and American researchers recently thought to have discovered new chemistry which turned out to be a replication of diligent work published as early as in 1904 [8]. This highlights how easy it is to miss similarities to old results [9] and that in this instance erroneous novelty of findings can get even past the reading of experienced peer reviewers (a further incentive to follow Advice 6). To avoid these and other pitfalls, always discuss what you read with your colleagues. This may be done formally within journal club settings or informally during lunch or office conversations. Importantly, this does, of course, have a bearing with regard to Advice 6 insofar as it will help to continue peer review after the work was published.

Advice 10: The Golden Rule: set aside reading time

Especially when you are a young scientist with a less tight time schedule, establish a defined period of time each week when you do nothing but read and guard this time religiously. Apply all above advice sensibly to economize your reading, but always try to obey The Golden Rule. You may be tempted to use your reading window for other activities such as writing, but remember that qualified reading forms the basis of writing of papers or grant applications.

This advice is similar to that of Hamming to aside time for "Great Thoughts" [10]: use your reading time to gather food for thought and to identify and work on problems which are of central rather than of tangential importance [11].

Perspectives

What and *how* you read are key determinants of your research career. While maintaining focus on material immediately pertinent to your primary research area, leave time for reading scientific papers from other disciplines and fields. The latter is very important to keep an eye on new developments in other fields that may be the real key to original, and sometimes revolutionary [12], research in your own area.

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