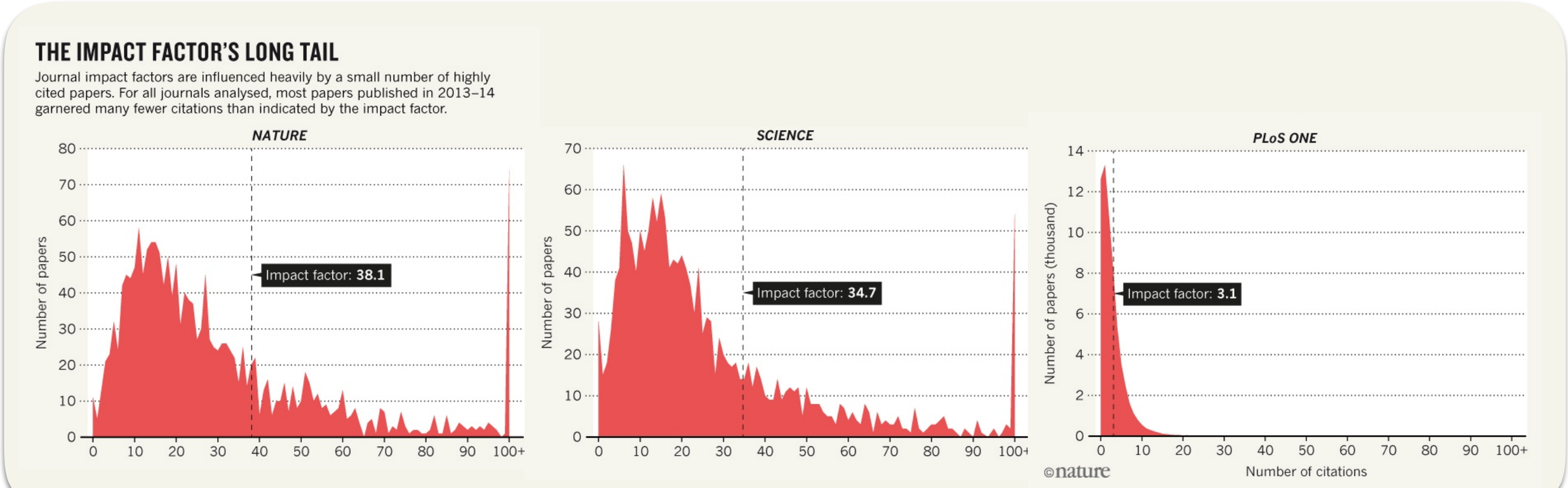
nature biomedical engineering

The diversifying nature of impact

Pep Pàmies, Chief Editor
Nature Biomedical Engineering

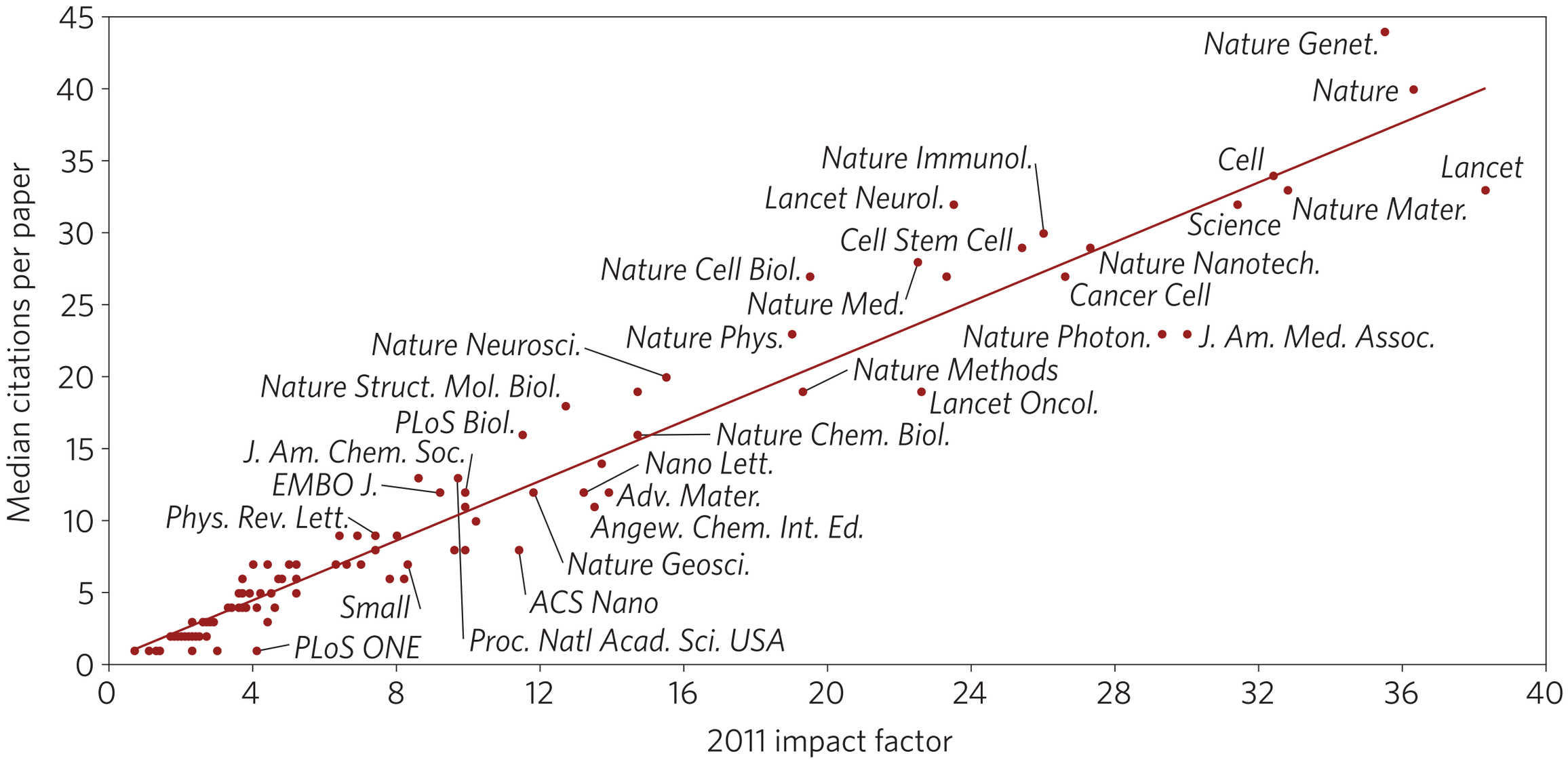
SPRINGER NATURE

Dissecting the impact factor



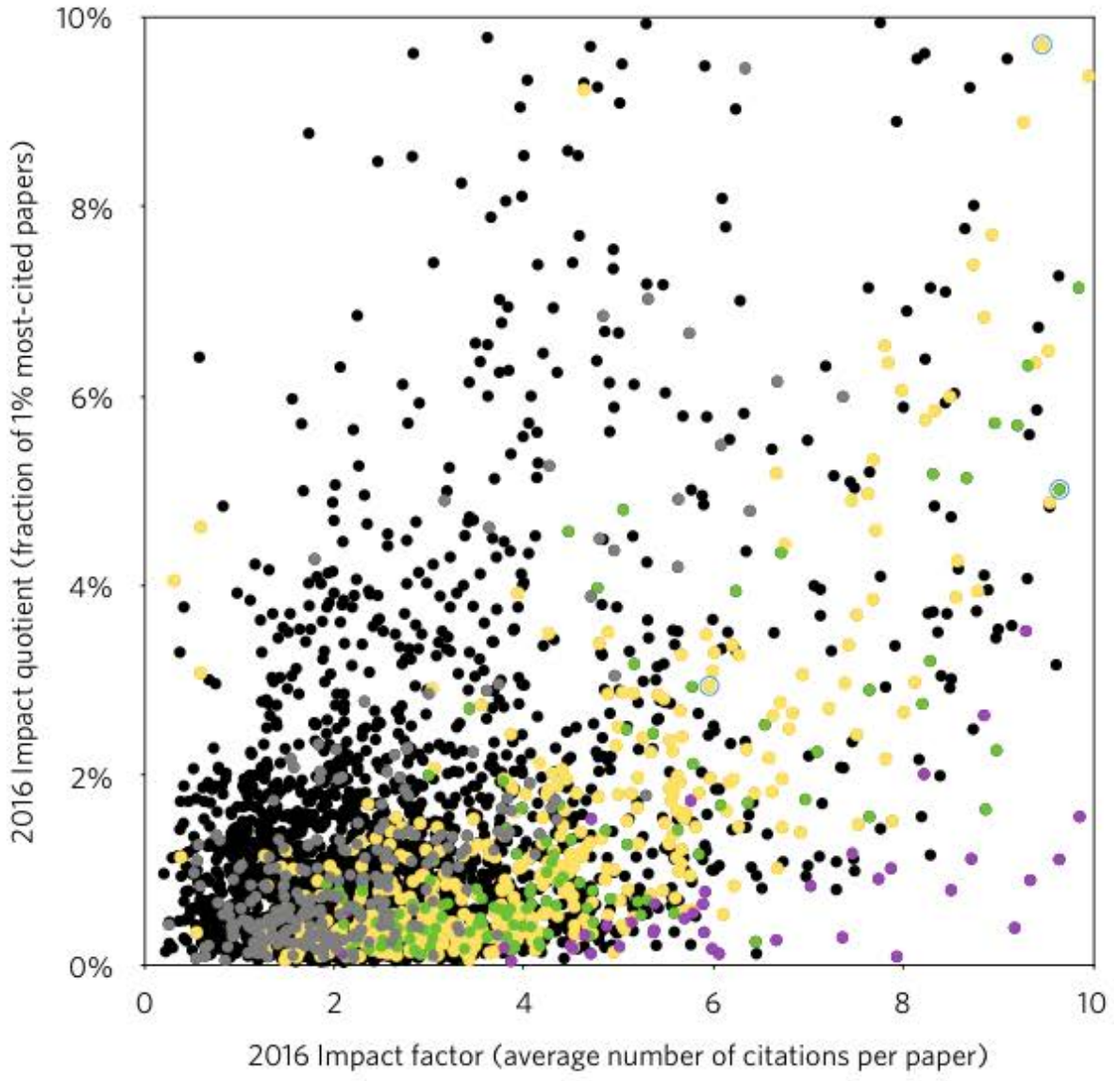
Nature **535**, 210–211 (2017)

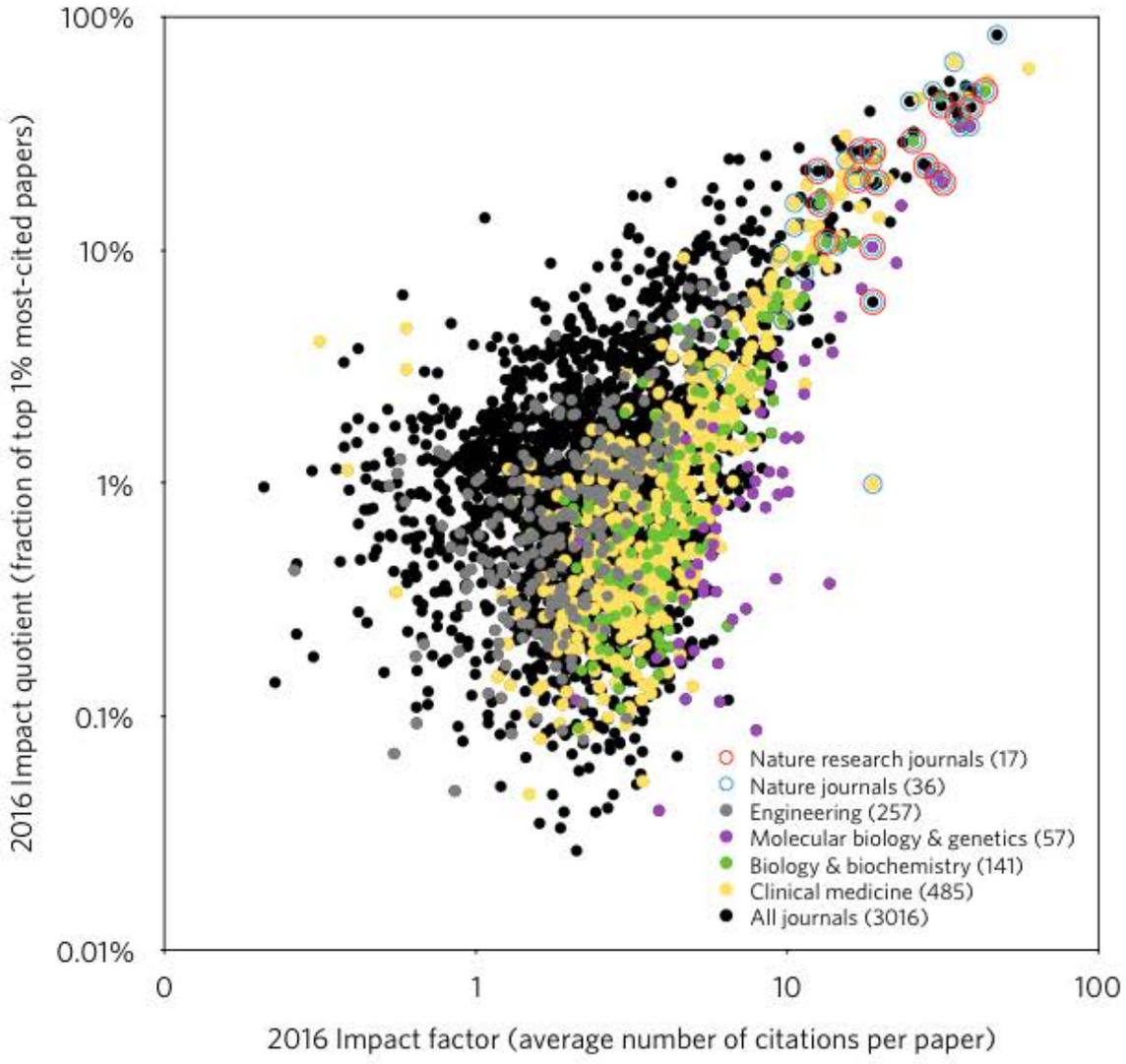
Impact factors are for journals



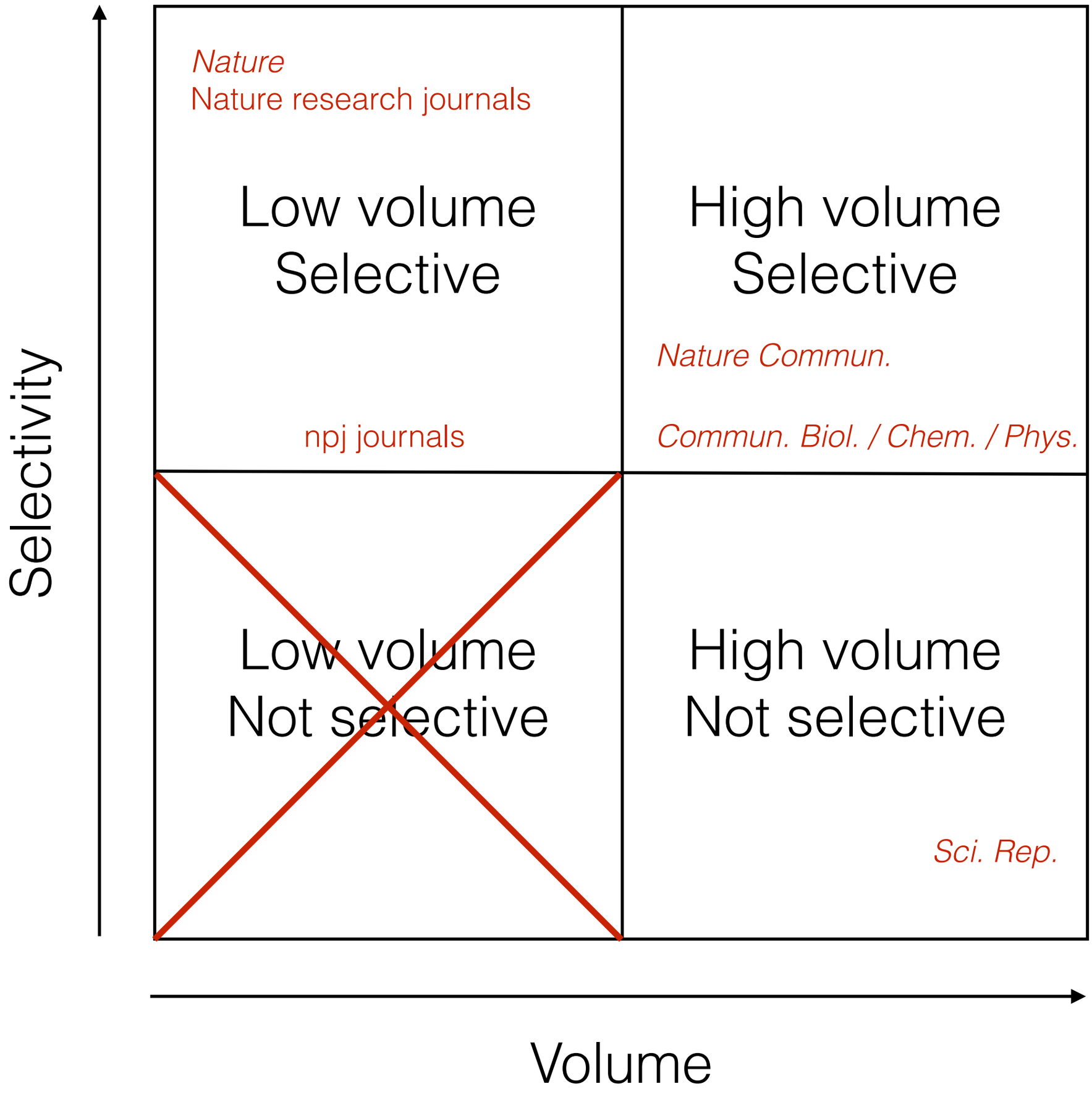
Nature Materials editorial, January 2013

IQ vs. IF





Nature Biomedical Engineering editorial, July 2017


Selectivity
Nature
Nature research journals
Low volume
Selective
High volume
Selective
Nature Commun.
npj journals
Commun. Biol. / Chem. / Phys.
Low volume
Not selective
High volume
Not selective
Sci. Rep.
Volume

Impact beyond citations

The translational achievements, commercialization prospects and eventual clinical and societal impacts of biomedical work accrue over a long time. They should be better captured and publicized.

When assessing published work, focusing on citations is easy, yet short-sighted — even more so if the work has impact prospects that extend well beyond academia. Such impacts can be myriad. For example, better understanding of disease can lead to changes in health policy; a more accurate diagnostic assay may be incorporated into clinical workflows and ultimately extend the lives of patients; a cheaper and easy-to-use medical device can make healthcare more accessible to patients in low-resource communities; and the commercialization of faster clinical imaging technologies coupled with artificial intelligence could make health systems more efficient and save taxpayer money. None of these outcomes are properly captured by citations to academic papers.

Citations to published work provide a rough measure of academic interest. Yet there is considerable academic impact that

To this end, we asked the authors of the 13 research articles published in the first and second issues of *Nature Biomedical Engineering* (the January and February 2017 issues) for feedback on any early direct impact of the published work. The responses revealed that the work in three of the papers has helped raise funding for clinical trials, that technologies reported in six of the papers have been licensed to university spin-offs or led to the launch or commercial growth of start-up companies, and that patents have been filed for most of the studies. Half of the teams have told us that medical or biotechnology companies have expressed interest in the published findings. Notably, nearly all authors mentioned that the publication of their work has triggered new academic collaborations, and that media attention after publication has been helpful in many ways.

Naturally, more media attention goes

Such early signs of impact are promising, and speak to the value of applied biomedical work beyond traditional academic boundaries. Differently from citations, which can be attributed to a specific piece

The diversification of impact

Industrial collaborations

Media attention

Technology transfer

Guidelines or standards

Public debate

Citations

Translational

Products or services

Clinical

Spin-off companies

Patents

Government policy

Cultural and artistic

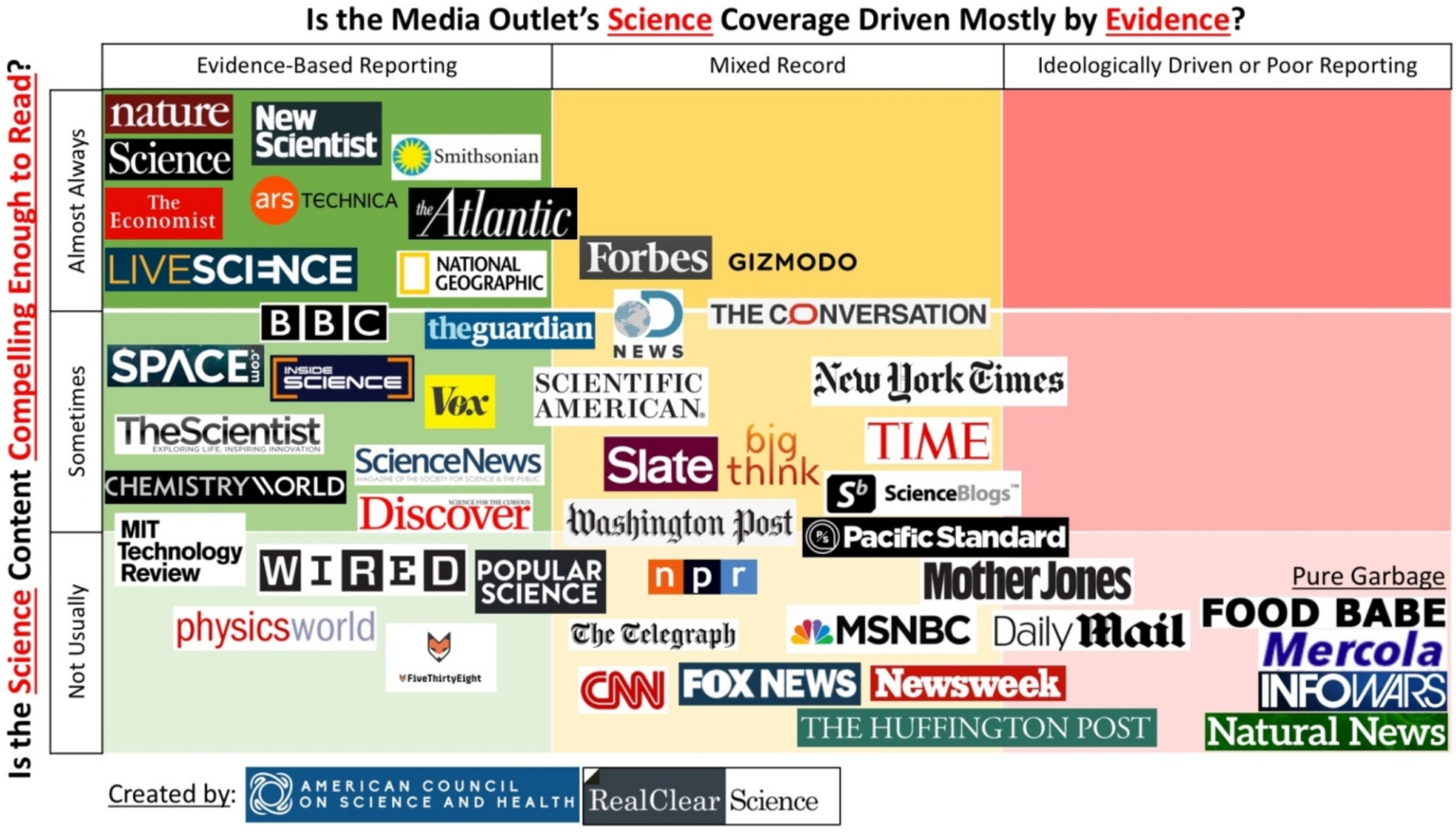
Educational

Jobs

Commercial interest

Nature 533, S20 (2016)

The value of a brand



Nature **543**, 150 (2017)

Convergence of fields

PUBLISHED: 10 JANUARY 2017 | VOLUME: 1 | ARTICLE NUMBER: 0001

editorial

Discovery and technology for human health

Nature Biomedical Engineering will bring the convergence of fields in the health and physical sciences into the spotlight.

Breakthrough discovery and invention often emerge at the interface between disciplines. As scientific research becomes ever more collaborative (R. van Noorden, *Nature* **525,** 306–307; 2015), scientific and technological developments rooted in interdisciplinarity are poised to increasingly fuel human endeavour. Biomedical engineering — an inherently interdisciplinary subject area that aims to improve human health — indeed thrives on the convergence of research fields.

For example, biomedical engineers working on cellular self-assembly and bioprinting take advantage of knowledge that cuts across tissue engineering, materials science and regenerative medicine. Those devising better approaches to deliver immunotherapeutic drugs need to integrate concepts from cancer immunotherapy and

Hence, clinical developments often inspire further improvements in methodology and generate hypotheses to be tested in the laboratory. Conversely,

inspiration from ancient whirligigs, Manu Prakash and colleagues designed a hand-held spinning disk out of paper and string that can rival the performance of a standard (yet vastly more expensive) centrifuge (Article 0009). And fluorescent nanoparticles designed by Jinming Gao and colleagues to mimic the functionality of a transistor so as to light up tumours only in the presence of acidic extracellular pH will help surgeons find tumour nodules and guide tumour

Biomedical Engineering
Driven by the convergence of fields

Tissue engineering and regenerative medicine

Therapy and diagnostics (delivery and imaging)

Nanotechnology and biotechnology

Cancer immunotherapy and nanomaterials

Neuroscience and machine–brain interfaces

Machine learning and pathology

nature research

Biomedical Engineering
Some solvable problems?

The mass-transfer and complexity problems in making artificial organs

The targeting problem in drug delivery

The 'mouse problem' in drug discovery and therapy

The trillions-of-cells problem in cell therapies

What we are looking for

A remarkable **degree of advance**

(conceptual, fundamental, methodological,

technological, therapeutic, translational or clinical),

broad, direct **implications** for human, disease, health or

healthcare,

and **breadth and depth**.

And obviously, sufficient evidence for the claims.

The peer-review process

We involve as many experts as needed (most often three).

We don't count reviewer votes, but assess arguments.

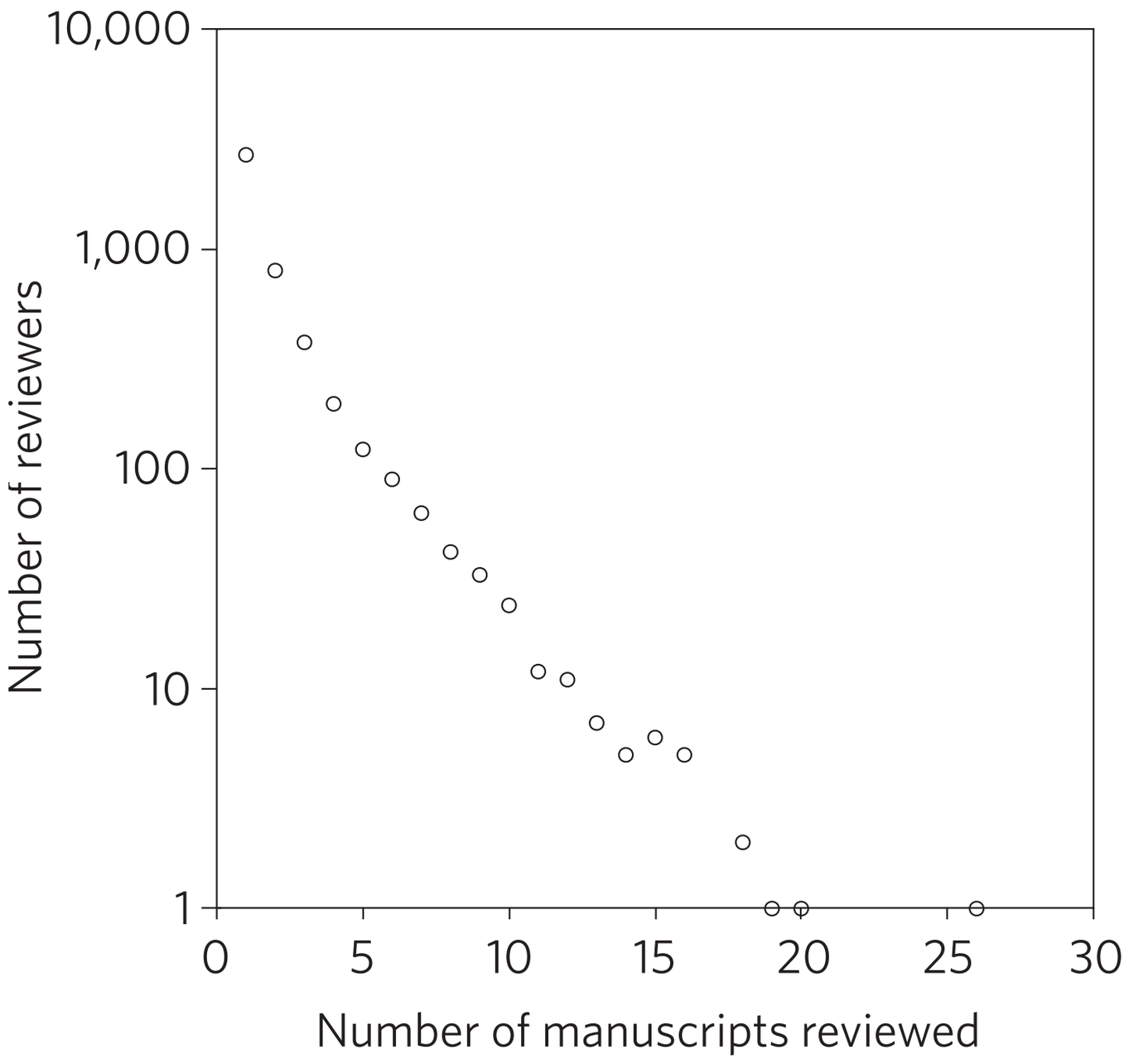
For invited revisions, authors receive guidance as to what is expected.

Soft deadlines are set for the submission of revisions.

We may overrule a reviewer's opinion if necessary.

We offer double-blind peer review as an option.

Distribution of reviewer workload



Nature Materials editorial, September 2012

The peer-review process

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Corresponding Author:

Date:

Life Sciences Reporting Summary

Nature Research wishes to improve the reproducibility of the work we publish. This form is published with all life science papers and is intended to promote consistency and transparency in reporting. All life sciences submissions use this form; while some list items might not apply to an individual manuscript, all fields must be completed for clarity.

For further information on the points included in this form, see Reporting Life Sciences Research. For further information on Nature Research policies, including our data availability policy, see Authors & Referees and the Editorial Policy Checklist.

Experimental design

1. Sample size

   Describe how sample size was determined.

   Describe the statistical methods that were used to predetermine sample size OR if no sample size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.

2. Data exclusions

   Describe any data exclusions.

   If no data were excluded from the analyses, state this OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.

3. Replication

   Describe whether the experimental findings were reliably reproduced.

   For each experiment, note whether any attempts at replication failed OR state that all attempts at replication were successful.

4. Randomization

   Describe how samples/organisms/participants were allocated into experimental groups.

   Describe how samples were allocated to groups. If allocation was not random, describe how covariates were controlled. If this is not relevant to your study, explain why.

5. Blinding

   Describe whether the investigators were blinded to group allocation during data collection and/or analysis.

   Describe the extent of blinding used during data acquisition and analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.

Note: all studies involving animals and/or human research participants must disclose whether blinding and randomization were used.

6. Statistical parameters

   For all figures and tables that use statistical methods, confirm that the following items are present in relevant figure legends (or the Methods section if additional space is needed).

n/a	Confirmed	
☐	☐	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement (animals, litters, cultures, etc.)
☐	☐	A description of how samples were collected, noting whether measurements were taken from distinct samples or whether the same sample was measured repeatedly.
☐	☐	A statement indicating how many times each experiment was replicated
☐	☐	The statistical test(s) used and whether they are one- or two-sided (note: only common tests should be described solely by name; more complex techniques should be described in the Methods section)
☐	☐	A description of any assumptions or corrections, such as an adjustment for multiple comparisons
☐	☐	The test results (e.g. *p* values) given as exact values whenever possible and with confidence intervals noted
☐	☐	A summary of the descriptive statistics, including central tendency (e.g. median, mean) and variation (e.g. standard deviation, interquartile range)
☐	☐	Clearly defined error bars

See the web collection on statistics for biologists for further resources and guidance.

nature research | life sciences reporting summary

June 2017

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Corresponding Author:

Date:

Editorial Policy Checklist

This form is used to ensure compliance with Nature Research editorial policies related to research ethics and reproducibility in the life sciences. For further information, please see our Authors & Referees site. All questions on the form must be answered.

Data availability

Policy information about availability of data

Data availability statement

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated source data
- A description of any restrictions on data availability

☐ A full data availability statement is included in the manuscript.

Required accession codes

Data deposition is mandated for certain types of data.

Confirm that all relevant data have been deposited into a public repository and that all accession codes are provided.

☐ Accession codes will be available prior to publication ☐ No data with mandated deposition ☐ All relevant accession codes are provided

Data presentation

Image integrity

☐ Confirm that all images comply with our image integrity policy.

Unprocessed data must be provided upon request. Please double-check figure assembly to ensure that all panels are accurate (e.g. all labels are correct, no inadvertent duplications have occurred during preparation, etc.).

Data distribution

Data should be presented in a format that shows data distribution (dot-plots or box-and-whisker plots), with all box-plot elements (e.g. center line, median; box limits, upper and lower quartiles; whiskers, 1.5x interquartile range; points, outliers) defined. Bar graphs should be used only when there is no other viable option for data presentation.

☐ Confirm that all data presentation meets these requirements.

☐ Confirm that in all cases where the number of data points is <10, individual data points are shown.

Structural data

Policy information about special considerations for specific types of data

☐ If this study did not involve data of these types, check here and skip the rest of this section.

Crystallographic data

☐ For all reports of new three-dimensional structures of small molecules, confirm that you have provided a .cif file and a structural figure with probability ellipsoids for publication as Supplementary Information.

Macromolecular structures

☐ For all macromolecular structures studied, confirm that you have provided an official validation report from wwPDB.

Electron microscopy

☐ For all electron microscopy work, confirm that you have deposited any density maps and coordinate data in EMDB.

Code availability

Policy information about availability of computer code

Code availability statement

For all studies using custom code, the Methods section must include a statement under the heading "Code availability" describing how readers can access the code, including any restrictions to access.

☐ A full code availability statement is included in the manuscript ☐ No custom code used

nature research | life sciences editorial policy checklist

May 2017

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You can appeal decisions

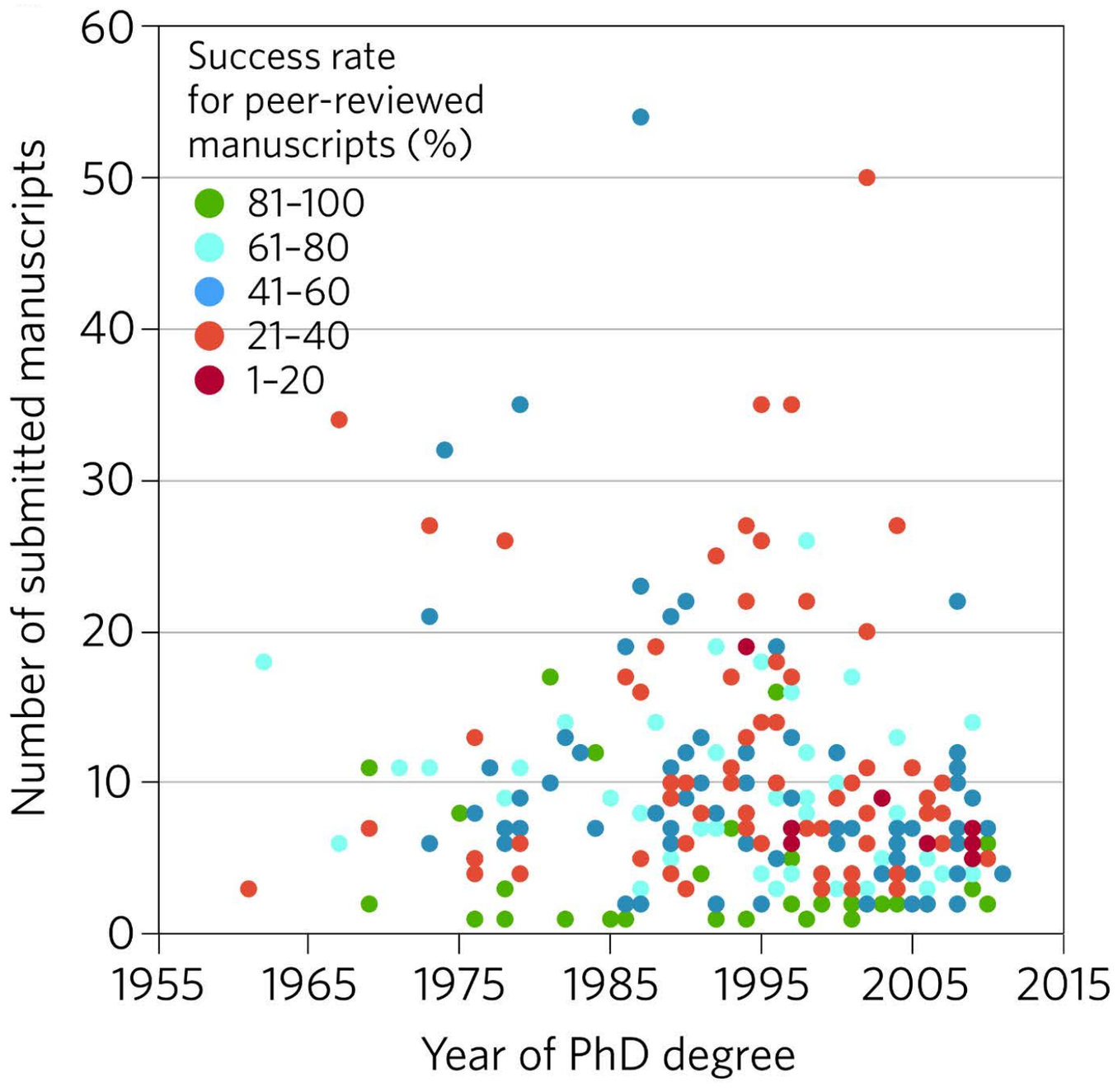
Provide additional information and/or arguments.

Avoid 'celebrity endorsements'.

After review, discern whether rejection has been primarily on technical or editorial grounds.

It is fair to ask the editor's opinion about suitability for other *Nature* journals.

Fair success rates



Nature Materials editorial, October 2015

Editorial independence

It is difficult to get a man
to understand something,
when his *salary* depends
upon his not understanding it.

Upton Sinclair

Why only a few pages?

There is so much to read.

In a competitive, crowded world, attention span is brief.

Most journals publish ‘Supplementary Information’.

What matters the most to many is the **story**.

Your papers should be...

Clear, always.

Concise, almost always.

The degree of conciseness depends on the type of content and intended **audience**.

With context, always.

The amount and generality of the context depends on the intended **audience**.

How to write a paper clearly, concisely and with apt context?

Practice

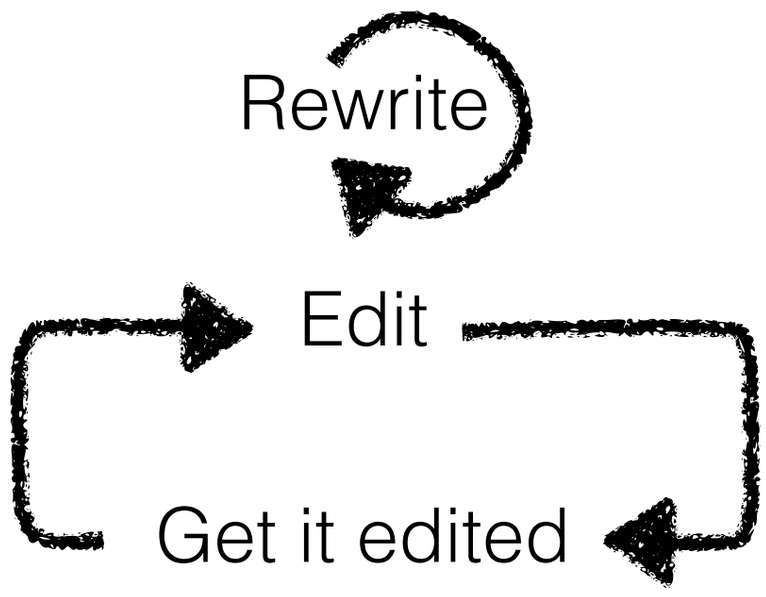
Practice

(Deliberate) practice

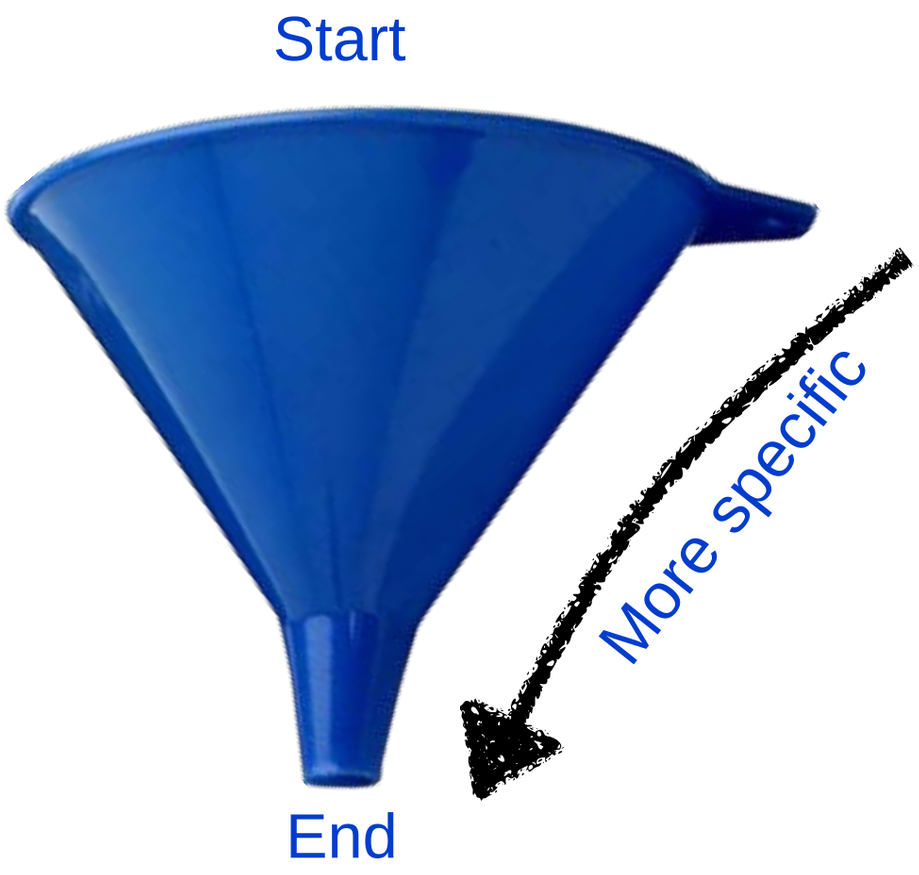
What does practice mean?

Read A lot!

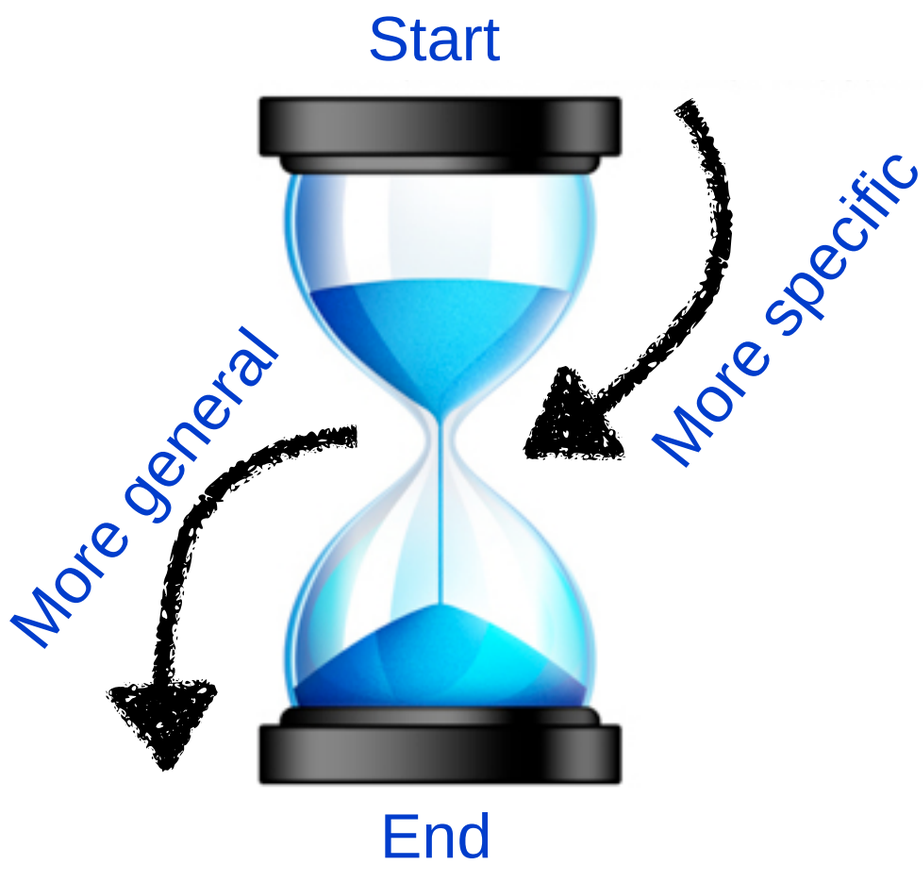
Write First, think about the story



Writing tips: structure



Funnel style



Hourglass style

Writing tips: structure

Use the introduction mostly for context: introduce the argument and set the background.

Use sketches and diagrams for complex ideas or methods.

Put related plots in the same figure.

Avoid paraphrasing previous text in the conclusions.

Add a few sentences of outlook (implications of the work) and use the conditional form (may, could, possibly,...).

Writing tips: style

Avoid using use ‘new’, ‘novel’, ‘for the first time’.

Write mostly in active voice.

~~*The passive voice should not be overused.*~~

Long sentences are OK if properly punctuated.

Use connectors (however, whereas, on the other hand,...).

Each paragraph should contain a single general idea.

Writing tips: style

Explain ideas in logical order (causal, temporal, importance,...).

Occasional simple analogies are helpful.

Do not confuse evidence, assumption and opinion.

Avoid overusing the possessive case.

A good first sentence helps.

Writing tips: figures

Scale axes appropriately (avoid large empty spaces).

Consider adding secondary data as insets.

Use legends only when helpful.

Colours, symbols and line styles should have meaning.

Define everything that is not obvious in the figure caption.

Make all plots homogeneous and consistent.

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editorial

Show the dots in plots

We encourage our authors to display data points in graphs, and to deposit the data in repositories.

'Let the data speak for themselves', the saying goes. Yet in literal terms, this rarely applies to collections of raw numbers, which can often be difficult to interpret. In fact, different presentations of the same dataset can suggest different interpretations. The type of graph, its dimensions and layout, colour palettes and gradients, the data intervals displayed in the axes, specific data comparisons, and above all, the presence or absence of individual data points, error bars and information on statistical significance, can strongly affect how the graphed dataset is interpreted.

An often misused type of visual representation is the bar graph. Bar graphs display data according to categories. However, they are also commonly used to present small samples of continuous data, especially in biomedical fields. There are reasons for this: because of their shape and area, bars are easy to see at a glance; therefore, they are effective when comparing data and visualizing trends; and they make it easy to see the relative

Figure 1 | An individual's monthly activity and sleep quality between January 2015 and December 2016 (data points), ordered from January to December, categorized according to four-month intervals, and normalized by the respective maxima within the two years. Error bars, mean ± s.d. All differences between means with $p < 0.01$ are indicated (within the same category and across categories). ##, $p < 0.01$, for Sep–Dec 2016 and any time interval before May 2016; ***, $p < 0.001$; ****, $p < 0.0001$; two-tailed paired *t*-tests. Data (available at doi:10.6084/m9.figshare.4928888) courtesy of Pep Pàmies (this journal's Chief Editor), and collected via the iOS Health app.

nature research

Editing tips

Make paragraphs and individual sentences compact.

This is ~~rather quite~~ true.

Ensure factual correctness.

Remove empty words (very, quite, somewhat, rather,...).

Get rid of overstatements and apologies.

This ~~significant~~ finding...

Unfortunately, we do not have access to...

Connect contiguous sentences.

Make sure that text flows (try reading it aloud).

Editing tips

Avoid excessive jargon.

Use acronyms sparingly.

Simplify sentences.

Remove ambiguities.

~~*It is possible that the conclusions were mistaken.*~~

Define uncommon terms.

Avoid hype

When reading or writing about biomedical findings, be mindful of factual accuracy and wary of unapparent caveats.

Scientific write-ups and science news are supposed to be objective accounts of past work, or of future plans based on current results. Yet subjectivity and unintentional bias can creep in. For example, a therapy tested in mice is claimed to be 'straightforward to translate' on the basis of clinical trials of presumably comparable therapies; an approach is deemed general without supporting evidence in more than one system or set of conditions; results are presented as statistically significant in an underpowered study on the basis of *P* values that are slightly below 0.05.

Bias and exaggeration are inherently human. Researchers, reviewers, editors and science journalists can get overly excited by promising results, and may find it difficult to avoid overstating the significance of exciting findings or ideas. Sometimes, hype is not easy to detect, especially when information is limited. The need to 'sell' criteria can lead to wrong conclusions. Such deficiencies can lie undetected for a long time, particularly if the findings happen to meet

Credit: newspaper background, Macida/E+/Getty images

is to assume that overstatements and inaccuracies always sneak in, and therefore to purposely look for them. Ask co-authors

Avoid hype

Avoid sensationalism, shaky evidence, neglect of relevant information, and insufficient accuracy or clarity.

Assume that overstatements and inaccuracies always sneak in, and therefore to purposely look for them.

Ask co-authors or informed colleagues to double-check graphs, schematics, tables and prose.

When evidence is preliminary or at the proof-of-concept level, state so and discuss possible limitations and how they could be overcome.

Avoid hype

If a study is designed to test safety, feasibility, improved outcome or patient benefit, make this clear and discuss any caveats.

When reporting on findings in fields that are prone to be hyped in the media (such as cancer immunotherapy, genome editing and precision medicine), be especially mindful of discussing any caveats, such as side effects, risks and costs.

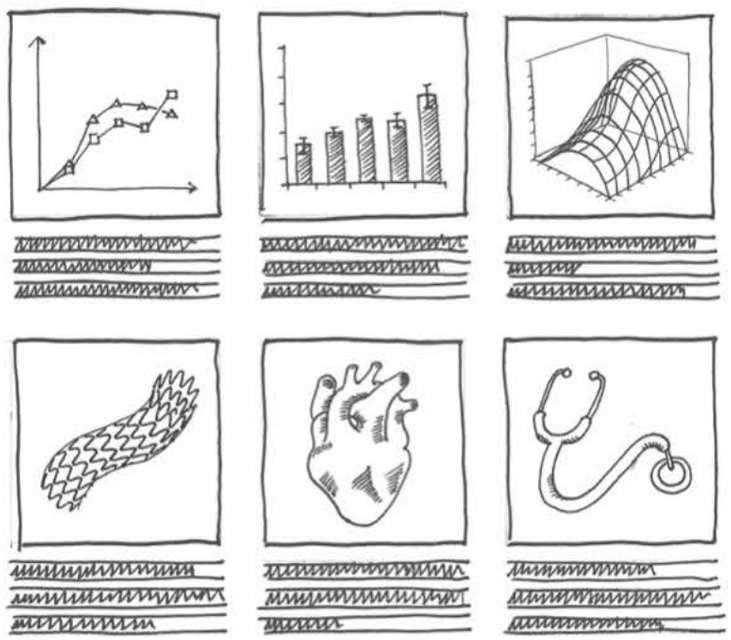
A case study is not solid proof that the therapy, diagnostic method or device works. A mechanism associated with a phenomenon doesn't necessarily explain it.

Storytelling in research

The communication of research findings, in both written and oral forms, would benefit from concepts used in cinematographic storytelling.

Raw data alone does not make a story. Neither does a rigorous yet plain description of the data. Raw data and purely descriptive text are particularly useful when they have to be mined by computers, but they do not effectively communicate research for others to interpret, learn or build on. Even specialists on the topic may need guidance on the interpretation of the data and on the overall purpose of the experiments (or simulations or theory). Experts also appreciate a narrative that exposes the background and rationale of the work, as well as its broad relevance and implications.

Yet many scientists and the public consider that scientific papers, and even oral communication of research, should be presented in a wholly objective and dry form, and that such reports should avoid any discussion of the authors' motives for the research and their interpretation of its outcomes. This is bad advice. Data should indeed be objective and informative, and



learn and retain facts best when the stories that wrap the facts sustain the reader's attention. In that regard, cinematography is particularly successful, and not only because the combination of dynamic imagery and sound can be more engaging than static text and figures on a page. Cinematographic

(especially when there are parallel threads to the main story), and their context and implications.

Composition and framing can also be applied, both to figures and to the text. Graphs that need more attention (because of complexity or difficulty of interpretation, for example) can be made more visually prominent, and related data laid out so as to indicate logical relationships. Multi-panel figures should be composed to best guide the reader through the data, in concordance with the story (for example, it is easier for the eye to compare data in bar graphs when they appear side-by-side than when they are stacked). And the study should be framed to convey the motivation and provide the most appropriate context. In particular, it should be clear from the introduction whether the purpose of the study is to test a hypothesis, to validate previous results, to improve known outcomes or to provide new methodology. Context can be narrated

Storytelling in research

An engaging narrative that explains the findings, provides context and assists interpretation while avoiding hype can greatly enhance the reach of the work.

Research is a human endeavour, and hence the communication of research findings shouldn't exclude the researchers' motivations, analysis and vision.

The communication of research findings, in both written and oral forms, would benefit from concepts used in cinematographic storytelling.

Storytelling in research

The outline of a paper can be the analogue of the storyboard in film-making.

Composition and framing can also be applied, both to figures and to the text.

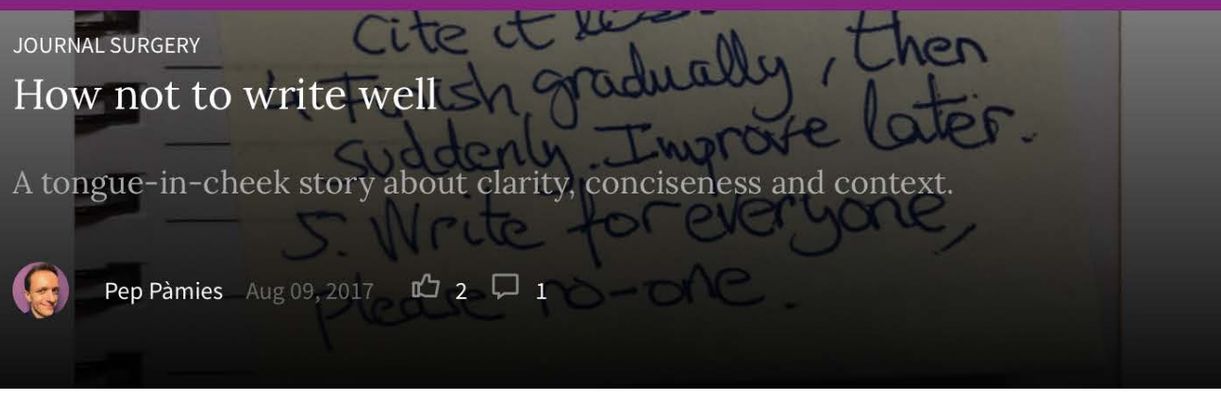
Applying the concepts of camera motion and lighting to narrative can help the writer or speaker transition between related results and discussion.

As an author, you are the director of your own research story. Make it engaging.

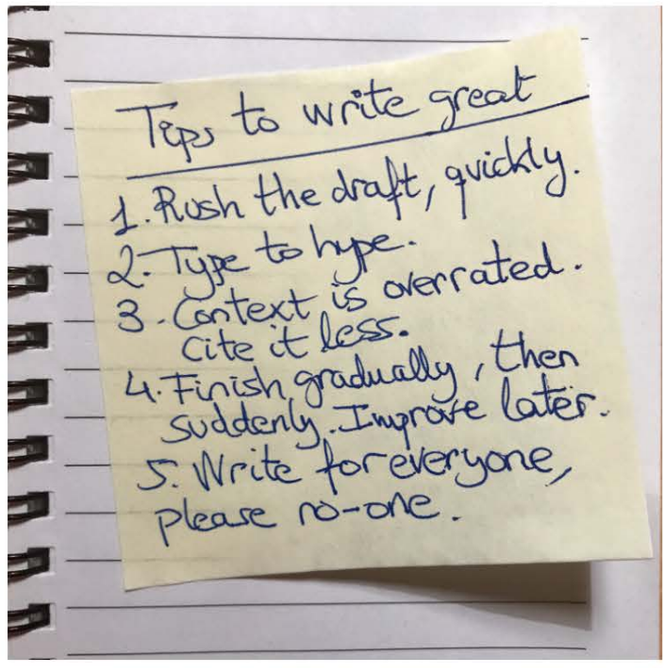
JOURNAL SURGERY

How not to write well

A tongue-in-cheek story about clarity, conciseness and context.



Pep Pàmies Aug 09, 2017 2 1



Being in front of a blank page can be both exciting and daunting; often, this is followed by procrastination. One thing is certain though: there will be revisions. It is then best to get on with it and rush the first draft; it can always be improved later.

Writing a scientific paper doesn't require storytelling abilities. Conveying hard-won scientific facts should instead be done in a form that appeals to the expert; if it puts

Writing a scientific paper doesn't require storytelling abilities. Conveying hard-won scientific facts should instead be done in a form that appeals to the expert; if it puts off the beginner, then so be it. In truth, there is no need to sugar-coat a great deal of facts with a story. How facts are linked to each other and interpreted as a whole is for the reader to work out.

All reports start with a title — the first chance to impress. There are three easy ways to come up with a suitable heading: make it long, fill it with jargon and empty words, and overstate the claims or purpose. Here is an example: 'On an overarching framework utilizing solely specialized standards that expedites unprecedented and unparalleled applicability opportunities'. The recipe is clear: vagueness, low information density and exaggeration of significance. You will get noted.

There are of course more opportunities to win due attention. The next is the abstract. Again, it is easier to write a lofty synopsis: the passive voice should be overused; the importance of the work ought to be emphasized by using grandiose terms such as 'paradigm shift', 'striking finding' and 'general platform'; as many details as possible ought to be included; and everything that is new must be noted as such (by using 'new', 'novel' and 'for the first time').

Avoiding reader dullness should be a priority. For this, take a lesson from the demands of brain games: deciphering real meaning, connecting the dots, guessing causality and prompting dictionary use. For example, do not be shy about using multiple acronyms; they are easy to remember, in particular if you manage to work out how to add SMART, GR8 or FANNY into the text. Do not pay attention to punctuation; commas and semicolons, brackets, hyphens, and en dashes and em dashes are for poets and linguists; in scientific writing, the meaning of facts is independent of punctuation (true facts are real life things in fact). Add ambiguity — it keeps things precisely interesting. When exposing facts or ideas, whether they are ordered according to causal logic, temporal sequence or importance is irrelevant as

independent of punctuation (true facts are real life things in fact). Add ambiguity — it keeps things precisely interesting. When exposing facts or ideas, whether they are ordered according to causal logic, temporal sequence or importance is irrelevant as long as they are freely connected with, for example, 'therefore', 'due to', 'while', 'indeed', 'in order to' and other meaningless transition words. Also, do not forget to spice up the text with pompous discourse by utilizing sublime locutions.

Structure and flow can frustrate an infecting narrative. On the one hand, organized sections and headings and smooth discussion can give the impression that the work is trivial or was easy to carry out. On the other hand, understanding brilliant ideas and hard facts needs effort and skill on the part of the reader. Indeed, learning involves struggle, and what is easily understood is immediately forgotten.

Crucially, context can get in the way of conveying new results. Hence, keep it at a minimum. The results should stand out on their own. Yet when fearing that fellow specialists may not appreciate the gist of the work, repeat the same main points in the abstract, at the end of the introduction, in the discussion, and again when concluding; excellent results never bore. Also, add numerous references to background work (especially your own), and do not forget that great papers cite great papers.

Naturally, drafts are meant to be revised. Let the reviewers and editors help you. The former may belong to a group that always ask for more facts, and editors are prone to also nagging about the premium of space and the need for more discussion. In the event that reviewers or an editor complain, do not blame yourself. Such feedback may be opinion rather than factual, and should you suspect so, do not be afraid to disregard the requests. Ultimately, don't spend too much time considering the potential readers of your work; you won't be able to please everyone.

Not writing well is easy when you know the tricks. Please do not pass them on.

Cover letters

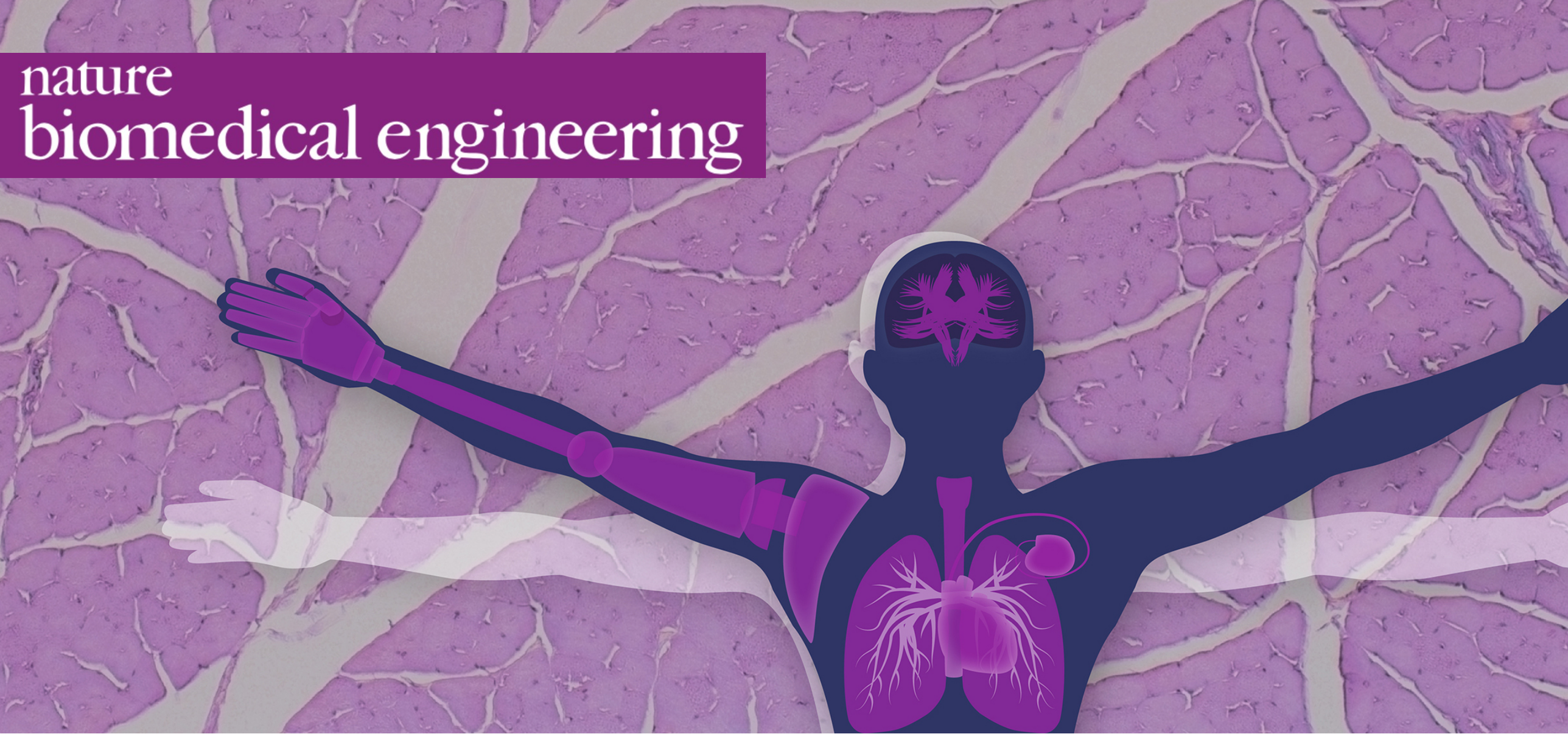
Avoid hype.

Repeating the abstract is useless.

Explain the main findings, avoiding peripheral circumstances.

It should be **clear**, **concise**, and provide **context**.

nature
biomedical engineering



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