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Online submission

All submissions must be made via our online submission system. Using this system, authors can upload manuscript files (text, figures, videos) directly to our office and check on the status of their manuscripts during the review process. In addition, reviewers can access the manuscript online, which speeds up the review process. Revised manuscripts should be uploaded via the link provided in the editor's decision letter. Please do not submit revisions as new manuscripts.

Before a manuscript is submitted, please review our editorial policies, and ensure that the submission complies with our policy requirements.

We encourage all authors to register for an ORCID iD (ORCiD) and include their ORCiD in their author profile at or before manuscript submission. For more details on Springer Nature's support of ORCiD, please follow this link.

Submission policies

Submission to *Communications Engineering* is taken to imply that there is no significant overlap between the submitted manuscript and any other papers from the same authors under consideration or in press elsewhere. (Novelty is not compromised by either abstracts or unrefereed web preprints). The authors must include copies of all related manuscripts with any overlap in authorship that are under consideration or in press elsewhere. If a related manuscript is submitted elsewhere while the manuscript is under consideration at *Communications Engineering*, a copy of the related manuscript must be sent to the editor.

The primary affiliation for each author should be the institution where the majority of their work was done. If an author has subsequently moved, the current address may also be stated.

If the manuscript includes personal communications, please provide a written statement of permission from any person who is quoted. E-mail permission messages are acceptable.

Follow this link for further information on the review process and how editors make decisions.

After acceptance, a copy editor may make changes to the manuscript so that the text and figures are readable and clear to those outside the field, and so that papers conform to our style. Contributors are sent proofs and are welcome to discuss proposed changes with the editors, but *Communications Engineering* reserves the right to make the final decision about matters of style and the size of figures.

The editors also reserve the right to reject a paper even after it has been accepted if it becomes apparent that there are serious problems with the scientific content or with violations of our publishing policies.

Costs

Communications Engineering does not charge submission fees or page charges. However, authors submitting to *Communications Engineering* are required to publish their work open access, through payment of an article processing charge (APC), in the case of eventual acceptance.

Please see the pages on open access and article processing charges for APC pricing and details of our free funding support service.

General information for preparing manuscripts

This guide outlines key points for preparing primary research manuscripts for submission to *Communications Engineering*.

The corresponding author should be familiar with the journal's editorial policies and is solely responsible for communicating with the journal and managing communication between coauthors. Before submission, the corresponding author ensures that all authors are included in the author list and agree with its order, and that they are aware the manuscript is to be submitted.

If you wish to participate in double-blind peer review, please prepare your manuscript in a way that conceals the identities of all the authors and tick the appropriate box during online submission. Please note that editors do not ensure that the paper is properly anonymised; that is the responsibility of the authors.

Cover letter

Authors should provide a cover letter that includes the affiliation and contact information for the corresponding author. The cover letter is an excellent opportunity to briefly discuss the context and importance of the submitted work and why it is appropriate for the journal. Please avoid repeating information that is already present in the abstract and introduction. The cover letter is not shared with the referees, and should be used to provide confidential information, such as conflicts of interest, and to declare any related work that is in press or submitted elsewhere. It is also appropriate to include suggested or excluded referees in the cover letter. We strive to ensure that the diversity of our reviewers reflects that of the broad scientific community including,

though not limited to, gender, ethnicity and race, geographic location and career stage. We ask that you keep this in mind when suggesting potential reviewers.

Due to our policy on transparent peer review, you must clearly state in your cover letter whether you wish to opt in or opt out of the publication of the reviewer reports when submitting the final version of your manuscript for publication.

Editorial policy checklist

If your manuscript is sent for review, you will also be asked to complete the Nature Portfolio Editorial Policy Checklist. This checklist is not sent to the reviewers but must be received by the editors before the paper can be sent for review. To download the full version of the policy checklist, save this link to your computer as a PDF.

Photovoltaic research

Research manuscripts related to photovoltaic cells that are sent for external review should include certain experimental details as detailed in our reporting summary for solar cell manuscripts. This summary will be made available to editors and reviewers during manuscript assessment and will be published with all accepted manuscripts. To improve the transparency of reporting and the reproducibility of published results in certain other research areas, you may be asked to complete a different checklist and provide the requested information prior to peer review.

All primary research articles will include any completed Nature Portfolio Reporting Summary as a supplementary file.

Format of manuscripts

Manuscripts submitted to *Communications Engineering* do not need to adhere to our formatting requirements at the point of initial submission; formatting requirements only apply at the time of acceptance. For information on length and formatting consult the page on *Communications Engineering* content types.

Title

If possible, this should be 15 words or fewer and should not contain technical terms, abbreviations or punctuation and active verbs.

Authors

Corresponding author(s) should be identified with an asterisk.

Abstract

Provide a general introduction to the topic and a brief non- technical summary of your main results and their implication.

Text length and formatting

Attention to the following details for research articles can help expedite publication if we invite a revision after external review. For information on other article types, please see our content types page.

Article formatting guidelines: an abstract of approximately 150 words, unreferenced; main text of no more than 5,000 words and 10 display items (figures, tables). As a guideline, Articles generally allow up to 70

references. Section headings should be used and subheadings may appear in 'Results'. Avoid 'Introduction' as a heading.

We encourage authors to incorporate the manuscript text and figures into a single PDF or Microsoft Word file. Suitably high resolution figures may be inserted within the text at appropriate positions or grouped at the end. Each figure legend should be presented on the same page as its figure. The reference list should include article titles. If providing a PDF, please number all lines. If you upload a Word document the system will number the lines for you. We can accept LaTeX files at the acceptance stage, but before then please supply compiled PDFs.

Manuscripts published in *Communications Engineering* are not subject to in-depth copy editing as part of the production process. Authors are encouraged to seek copy editing or language editing services for their manuscripts, either before submission, or at the revision stage, should they feel it would benefit their manuscript. Such services include those provided by our affiliates Nature Research Editing Service and American Journal Experts. Please note that the use of Nature Research Editing Service is at the author's own expense and in no way implies that the article will be selected for peer review or accepted for publication.

Methods

The Methods section appears in all online original research articles and should contain all elements necessary for interpretation and replication of the results. Methods should be written as concisely as possible and typically do not exceed 3,000 words but may be longer if necessary. We encourage you to deposit any step-by-step protocols used in your study in Protocol Exchange, an open resource maintained by the

Nature Portfolio. These protocols are linked to the Methods section upon publication.

Authors must ensure that their Methods section includes adequate experimental and characterization data necessary for others in the field to reproduce their work. Descriptions of standard protocols and experimental procedures should be given. Commercial suppliers of reagents or instrumentation should be identified only when the source is critical to the outcome of the experiments. Sources for kits should be identified. Experimental protocols that describe the synthesis of new compounds should be included. The systematic name of the compound and its bold Arabic numeral are used as the heading for the experimental protocol. Thereafter, the compound is represented by its assigned bold numeral. Authors should describe the experimental protocol in detail, referring to amounts of reagents in parentheses, when possible (e.g. 1.03 g, 0.100 mmol). Standard abbreviations for reagents and solvents are encouraged. Safety hazards posed by reagents or protocols should be identified clearly. Isolated mass and percent yields should be reported at the end of each protocol.

References

These may only contain citations and should list only one publication with each number. Include the title of the cited article or dataset.

References should be numbered sequentially, first throughout the text, then in tables, followed by figures; that is, references that only appear in tables or figures should be last in the reference list. Only one publication is given for each number. Only papers or datasets that have been published or accepted by a named publication, recognized preprint server or data repository should be in the numbered list;

preprints of accepted papers in the reference list should be submitted with the manuscript. Published conference abstracts and numbered patents may be included in the reference list. Grant details and acknowledgements are not permitted as numbered references. Footnotes are not used.

Communications Engineering uses standard *Nature* referencing style. All authors should be included in reference lists unless there are six or more, in which case only the first author should be given, followed by '*et al.*'. Authors should be listed last name first, followed by a comma and initials (followed by full stops) of given names. Article and dataset titles should be in Roman text, only the first word of the title should have an initial capital and the title should be written exactly as it appears in the work cited, ending with a full stop. Book titles should be given in italics and all words in the title should have initial capitals. Journal and data repository names are italicized and abbreviated (with full stops) according to common usage. Volume numbers and the subsequent comma appear in bold. The full page range should be given (or article number), where appropriate.

Published papers:

Printed journals
Schott, D. H., Collins, R. N. & Bretscher, A. Secretory vesicle transport velocity in living cells depends on the myosin V lever arm length. *J. Cell Biol*. **156**, 35-39 (2002).

Online only
Bellin, D. L. *et al*. Electrochemical camera chip for simultaneous imaging of multiple metabolites in biofilms. *Nat. Commun*. **7**, 10535; 10.1038/ncomms10535 (2016).

For papers with more than five authors include only the first author's name followed by '*et al.*'.

Books:
Smith, J. Syntax of referencing in *How to reference books* (ed. Smith, S.) 180-181 (Macmillan, 2013).

Online material:
Manaster, J. Sloth squeak. *Scientific American Blog Network* http://blogs.scientificamerican.com/psi-vid/2014/04/09/sloth-squeak (2014).

Hao, Z., AghaKouchak, A., Nakhjiri, N. & Farahmand, A. Global integrated drought monitoring and prediction system (GIDMaPS) data sets. *figshare* http://dx.doi.org/10.6084/m9.figshare.853801 (2014).

Acknowledgements

Acknowledgements should be brief, and should not include thanks to anonymous referees and editors, or effusive comments. Grant or contribution numbers may be acknowledged. Assistance from proof-readers and editors not affiliated with the journal should also be acknowledged here.

Author contributions

Communications Engineering requires an Author Contribution Statement that specifies the individual contributions of each co-author. For example: "A.P.M. 'contributed' Y and Z; B.T.R. 'contributed' Y," etc. Please see the Authorship section of our editorial policies for more details.

Competing interests

A competing interests statement is required for all accepted papers published in *Communications Engineering*. If there is no conflict of interest, a statement declaring this will still be included in the paper.

Data availability

Communications Engineering requires a Data Availability Statement to be included in the submitted manuscript (see the section on Reporting standards and availability of data, materials, code and protocols in our editorial and publishing policies page for more information).

We strongly encourage authors to make their data available via an online repository, rather than only being available from the authors on request.

Computer code

Any previously unreported custom computer code used to generate results reported in the manuscript that are central to the main claims must be made available to editors and referees upon request. Any practical issues preventing code sharing will be evaluated by the editors who reserve the right to decline the manuscript if important code is unavailable. At publication, Nature Portfolio journals consider it best practice to release custom computer code in a way that allows readers to repeat the published results.

For all studies using custom code that is deemed central to the conclusions, a statement must be included in the Methods section, under the heading "Code availability", indicating whether and how the

code can be accessed, including any restrictions.

We strongly encourage authors to make their code available via an online source, rather than only being available from the authors on request.

Supplementary Information

Any Supplementary Information should be submitted with the manuscript and will be sent to referees during peer review. It is published online with accepted manuscripts. We request that authors avoid "data not shown" statements and instead make their data available via deposition in a public repository (see 'Availability of materials and data' for more information). Any data necessary to evaluation of the claims of the paper that are not available via a public depository should be provided as Supplementary Information.

Supplementary Information is not edited, typeset or proofed, so authors should ensure that it is clearly and succinctly presented at initial submission, and that the style and terminology conform to the rest of the paper. Authors should include the title of the manuscript and full author list on the first page.

The guidelines below detail the creation, citation and submission of Supplementary Information. Please note that modification of Supplementary Information after the paper is published requires a formal correction, so authors are encouraged to check their Supplementary Information carefully before submitting the final version.

1. Please submit supplementary figures, small tables and text as a

single combined PDF (with the pieces in the order: figures, tables, text). Tables longer than one page may be provided as an Excel or similar file type. For optimal quality video files please use H.264 encoding, the standard aspect ratio of 16:9 (4:3 is second best) and do not compress the video. We encourage submission of step-by-step synthesis procedures for chemical compounds and data on compound characterization.

2. Designate each item as Supplementary Figure, Table, Movie, Audio, Note or Method as appropriate. Number Supplementary Figures and Tables as, for example, "Supplementary Table 1". This numbering should be separate from that used in tables and figures appearing in the main article. Supplementary Notes or Methods should not be numbered; titles for these are optional.
3. Refer to each piece of supplementary material at the appropriate point(s) in the main article. Be sure to include the word "Supplementary" each time one is mentioned.
4. Remember to include a brief title and legend (incorporated into the file to appear near the image) as part of every figure submitted, and a title as part of every table.
5. File sizes should be as small as possible, with a maximum size of 50 MB, so that they can be downloaded quickly.

Further queries about submission and preparation of Supplementary Information should be directed to email: commseng@nature.com.

Related manuscripts

It is a requirement of submission that you alert us to any related manuscripts with overlapping authorship that are under consideration (including under appeal) or in press at other journals (see our editorial

policies on duplicate submissions for details). Copies of these manuscripts should be clearly marked and included as separate files with your submission. Abstracts or other unrefereed preprints do not compromise novelty.

Figure legends

Figure legends should be <350 words each. They should begin with a brief title sentence for the whole figure and continue with a short statement of what is depicted in the figure, not the results (or data) of the experiment or the methods used. Legends should be detailed enough so that each figure and caption can, as far as possible, be understood in isolation from the main text.

Tables

Please submit tables in your main article document. If using Word, please include tables in editable format (not images). Tables that include statistical analysis of data should describe their standards of error or confidence interval analysis and ranges in a table legend.

Equations

Equations and mathematical expressions should be provided in the main text of the paper. Equations that are referred to in the text are identified by parenthetical numbers, such as (1), and are referred to in the manuscript as "equation (1)".

General figure guidelines

Authors are responsible for obtaining permission to publish any figures

or illustrations that are protected by copyright, including figures published elsewhere and pictures taken by professional photographers. The journal cannot publish images downloaded from the internet without appropriate permission.

Unnecessary figures should be avoided: data presented in small tables or histograms, for instance, can generally be stated briefly in the text instead. Figures should not contain more than one panel unless the parts are logically connected; each panel of a multipart figure should be sized so that the whole figure can be reduced by the same amount and reproduced at the smallest size at which essential details are visible.

Should your manuscript be accepted, you will receive more extensive instructions for final submission of display items. However, some guidelines for final figure preparation are included below if you wish to minimize later revisions and possible delays.

Figures should be numbered separately with Arabic numerals in the order of occurrence in the text of the manuscript. When appropriate, figures should include error bars. A description of the statistical treatment of error analysis should be included in the figure legend. Please note that schemes are not used; sequences of chemical reactions or experimental procedures should be submitted as figures, with appropriate captions. A limited number of uncaptioned graphics depicting chemical structures—each labelled with their name, by a defined abbreviation, or by the bold Arabic numeral—may be included in a manuscript.

Figure lettering should be in a clear, sans-serif typeface (for example, Helvetica); the same typeface in the same font size should be used for

all figures in a paper. Use 'symbols' font for Greek letters. All display items should be on a white background, and should avoid excessive boxing, unnecessary colour, spurious decorative effects (such as three-dimensional 'skyscraper' histograms) and highly pixelated computer drawings. The vertical axis of histograms should not be truncated to exaggerate small differences. Labelling must be of sufficient size and contrast to be readable, even after appropriate reduction. The thinnest lines in the final figure should be no smaller than one point wide. Authors will see a proof that will include figures.

Figures divided into parts should be labelled with a lower-case bold a, b, and so on, in the same type size as used elsewhere in the figure. Lettering in figures should be in lower-case type, with only the first letter of each label capitalized. Units should have a single space between the number and the unit, and follow SI nomenclature (for example, ms rather than msec) or the nomenclature common to a particular field. Thousands should be separated by commas (1,000). Unusual units or abbreviations should be spelled out in full or defined in the legend. Scale bars should be used rather than magnification factors, with the length of the bar defined in the legend. In legends, please use verbal explanations such as "open red triangles" rather than visual queues.

Figures for peer review

At the initial submission stage authors may choose to upload separate figure files or to incorporate figures into the main article file, ensuring that any inserted figures are of sufficient quality to be clearly legible. If this is not possible in a combined manuscript file, authors should either submit separate high resolution figure files or (preferably) deposit

image data in a suitable repository (e.g. figshare) and use their option to provide a private sharing link for the referees to access it.

When submitting a final manuscript for publication, all figures must be uploaded as separate figure files ensuring that the image quality and formatting conforms to the specifications below.

Figures for publication

Each complete figure must be supplied as a separate file upload. Multi-part/panel figures must be prepared and arranged as a single image file (including all sub-parts; a, b, c, etc.). Please do not upload each panel individually.

Please read the digital images integrity and standards section of our editorial policies. When possible, we prefer to use original digital figures to ensure the highest-quality reproduction in the journal. For optimal results, prepare figures to fit A4 page-width. When creating and submitting digital files, please follow the guidelines below. Failure to do so, or to adhere to the following guidelines, can significantly delay publication of your work.

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- Provide images in RGB color and at 300 dpi or higher resolution.

- Use the same typeface (Arial or Helvetica) for all figures. Use symbol font for Greek letters.
- Use distinct colors with comparable visibility and avoid the use of red and green for contrast. Recoloring primary data, such as fluorescence images, to color-safe combinations such as green and magenta or other accessible color palettes is strongly encouraged. Use of the rainbow color scale should be avoided.
- Figures are best prepared at the size you would expect them to appear in print. At this size, the optimum font size is between 5pt and 8pt.
- We prefer vector files with editable layers. Acceptable formats are: .ai, .eps, .pdf, .ps and .svg for fully editable vector-based art; layered .psd and .tif for editable layered art; .psd, .tif, .png and .jpg for bitmap images; .ppt if fully editable and without styling effects; ChemDraw (.cdx) for chemical structures.
- Please refer to the Nature Portfolio style guide for formatting of chemical structures.

Chemical and chemical nomenclature and abbreviations

Molecular structures are identified by bold, Arabic numerals assigned in order of presentation in the text. Once identified in the main text or a figure, compounds may be referred to by their name, by a defined abbreviation, or by the bold Arabic numeral (as long as the compound is referred to consistently as one of these three).

When possible, authors should refer to chemical compounds and biomolecules using systematic nomenclature, preferably using IUPAC. Standard chemical and chemical abbreviations should be used.

Unconventional or specialist abbreviations should be defined at their first occurrence in the text.

Characterization of chemical and biomolecular materials

Communications Engineering is committed to publishing technically sound research. Manuscripts submitted to the journal will be held to rigorous standards with respect to experimental methods and characterization of new compounds. Authors must provide adequate data to support their assignment of identity and purity for each new compound described in the manuscript. Authors should provide a statement confirming the source, identity and purity of known compounds that are central to the scientific study, even if they are purchased or resynthesized using published methods.

1. Chemical identity

Chemical identity for organic and organometallic compounds should be established through spectroscopic analysis. Standard peak listings (see formatting guidelines below) for 1H NMR and proton-decoupled 13C NMR should be provided for all new compounds. Other NMR data should be reported (31P NMR, 19F NMR, etc) when appropriate. For new materials, authors should also provide mass spectral data to support molecular weight identity. High-resolution mass spectral (HRMS) data are preferred. UV or IR spectral data may be reported for the identification of characteristic functional groups, when appropriate. Melting-point ranges should be provided for crystalline materials. Specific rotations may be reported for chiral compounds. Authors should provide references, rather than detailed procedures, for known

compounds, unless their protocols represent a departure from or improvement on published methods.

2. Combinational compound libraries

Authors describing the preparation of combinatorial libraries should include standard characterization data for a diverse panel of library components.

3. Biomolecular identity

For new biopolymeric materials (oligosaccharides, peptides, nucleic acids, etc), direct structural analysis by NMR spectroscopic methods may not be possible. In these cases, authors must provide evidence of identity based on sequence (when appropriate) and mass spectral characterization.

4. Biological constructs

Authors should provide sequencing or functional data that validates the identity of their chemical constructs (plasmids, fusion proteins, site-directed mutants, etc) either in the manuscript text or the Methods section, as appropriate.

5. Sample purity

Evidence of sample purity is requested for each new compound. Methods for purity analysis depend on the compound class. For most organic and organometallic compounds, purity may be demonstrated by high-field 1H NMR or 13C NMR data, although elemental analysis (±0.4%) is encouraged for small molecules. Quantitative analytical

methods including chromatographic (GC, HPLC, etc) or electrophoretic analyses may be used to demonstrate purity for small molecules and polymeric materials.

6. Spectral data

Detailed spectral data for new compounds should be provided in list form (see below) in the Methods section. Figures containing spectra generally will not be published as a manuscript figure unless the data are directly relevant to the central conclusions of the paper. Authors are encouraged to include high-quality images of spectral data for key compounds in the Supplementary Information. Specific NMR assignments should be listed after integration values only if they were unambiguously determined by multidimensional NMR or decoupling experiments. Authors should provide information about how assignments were made in a general Methods section.

Example format for compound characterization data. mp: 100–102 °C (lit.[ref] 99–101 °C); TLC ($CHCl_3$:MeOH, 98:2 v/v): R_f = 0.23; $[\alpha]_D$ = -21.5 (0.1 M in n-hexane); ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.30 (s, 1H), 7.55–7.41 (m, 6H), 5.61 (d, J = 5.5 Hz, 1H), 5.40 (d, J = 5.5 Hz, 1H), 4.93 (m, 1H), 4.20 (q, J = 8.5 Hz, 2H), 2.11 (s, 3H), 1.25 (t, J = 8.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.4, 165.0, 140.5, 138.7, 131.5, 129.2, 118.6, 84.2, 75.8, 66.7, 37.9, 20.1; IR (Nujol): 1765 cm^{-1}; UV/Vis: λ_{max} 267 nm; HRMS (m/z): $[M]^+$ calcd. for $C_{20}H_{15}C_{l2}NO_5$, 420.0406; found, 420.0412; analysis (calcd., found for $C_{20}H_{15}C_{l2}NO_5$): C (57.16, 57.22), H (3.60, 3.61), Cl (16.87, 16.88), N (3.33, 3.33), O (19.04, 19.09).

7. Crystallographic data for small molecules

Manuscripts reporting new three-dimensional structures of small

molecules from crystallographic analysis should include a .cif file and a structural figure with probability ellipsoids for publication as Supplementary Information. These must have been checked using the IUCR's CheckCIF routine, and a PDF copy of the output must be included with the submission, together with a justification for any alerts reported. Crystallographic data for small molecules should be submitted to the Cambridge Structural Database and the deposition number referenced appropriately in the manuscript. Full access must be provided on publication.

8. Macromolecular structural data

Manuscripts reporting new structures should contain a table summarizing structural and refinement statistics. Templates for such tables describing cryo-EM, NMR and X-ray crystallography data are available here. To facilitate assessment of the quality of the structural data, a stereo image of a portion of the electron density map (for crystallography papers) or of the superimposed lowest energy structures (≳10; for NMR papers) should be provided with the submitted manuscript. If the reported structure represents a novel overall fold, a stereo image of the entire structure (as a backbone trace) should also be provided.

Gene nomenclature

Authors should use approved nomenclature for gene symbols, and use symbols rather than italicized full names (for example *Ttn*, not *titin*). Please consult the appropriate nomenclature databases for correct gene names and symbols. A useful resource is Entrez Gene, available from NCBI.

Approved human gene symbols are provided by HUGO Gene Nomenclature Committee (HGNC), e-mail: hgnc@genenames.org; see also www.genenames.org. Approved mouse symbols are provided by The Jackson Laboratory, e-mail: nomen@informatics.jax.org; see also www.informatics.jax.org/mgihome/nomen.

For proposed gene names that are not already approved, please submit the gene symbols to the appropriate nomenclature committees as soon as possible, as these must be deposited and approved before publication of an article.

Statistical guidelines

Comprehensive information on the statistical analyses used must be included in the paper. The Methods must include a statistics section with the following information.

Every article that contains statistical testing should state the name of the statistical test, the *n* value for each statistical analysis, the comparisons of interest, a justification for the use of that test (including, for example, a discussion of the normality of the data when the test is appropriate only for normal data), the alpha level for all tests, whether the tests were one-tailed or two-tailed, and the actual *P* value for each test (not merely "significant" or "$P < 0.05$"). It should be clear what statistical test was used to generate every *P* value. Use of the word "significant" should always be accompanied by a *P* value; otherwise, use "substantial," "considerable," etc.

Data sets should be summarized with descriptive statistics, which should include the n value for each data set, a clearly labelled measure of centre (such as the mean or the median), and a clearly labelled

measure of variability (such as standard deviation or range). Ranges are more appropriate than standard deviations or standard errors for small data sets. Graphs should include clearly labelled error bars. Authors must state whether a number that follows the ± sign is a standard error (s.e.m.) or a standard deviation (s.d.).

Authors must justify the use of a particular test and explain whether their data conform to the assumptions of the tests. Three errors are particularly common:

- Multiple comparisons: When making multiple statistical comparisons on a single data set, authors should explain how they adjusted the alpha level to avoid an inflated Type I error rate, or they should select statistical tests appropriate for multiple groups (such as ANOVA rather than a series of t-tests).
- Normal distribution: Many statistical tests require that the data be approximately normally distributed; when using these tests, authors should explain how they tested their data for normality. If the data do not meet the assumptions of the test, then a non-parametric alternative should be used instead.
- Small sample size: When the sample size is small (less than about 10), authors should use tests appropriate to small samples or justify their use of large-sample tests.

Life sciences reporting checklists

Life sciences research manuscripts sent for external review must include relevant details about several elements of experimental and analytical design. These requirements aim to improve the transparency of reporting and the reproducibility of published results. They focus on elements of methodological information that are frequently poorly

reported (see more details on these elements here). You will be notified by the journal if you must complete a reporting checklist prior to peer review. The completed checklist will be provided to the referees. Additional information about the reporting checklist and the broader Nature Portfolio initiative to support reproducible research is available here.

To improve the transparency of reporting and the reproducibility of published results in certain other research areas, you may be asked to complete a different checklist and provide the requested information prior to peer review.