Validating Research: Towards Some Solutions

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Editor-in-Chief

Science

My Background

- Training in Geophysics (*observational* field, not *lab*)
- 15 years on the faculty at MIT
- President of a ~40,000 member scientific society
- 12 years leading an oceanographic research institute
- Nearly 4 years heading a government agency

Have some views on roles of universities, funding agencies, scientific societies, and journals in contributing to solution.

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Spectrum of Reproducibility*

- Low End (minimum standard)
  - Repeatability: Another group can access the data, analyze it using the same methodology, and obtain the same result.
- High End (gold standard)
  - Replication: The study is repeated start to finish, including new data collection and analysis, using fresh materials and reagents, and obtain the same result.

*Ioannidis and Khoury, *Science*, Special Issue on Data Replication & Reproducibility, **334**, December 2011.

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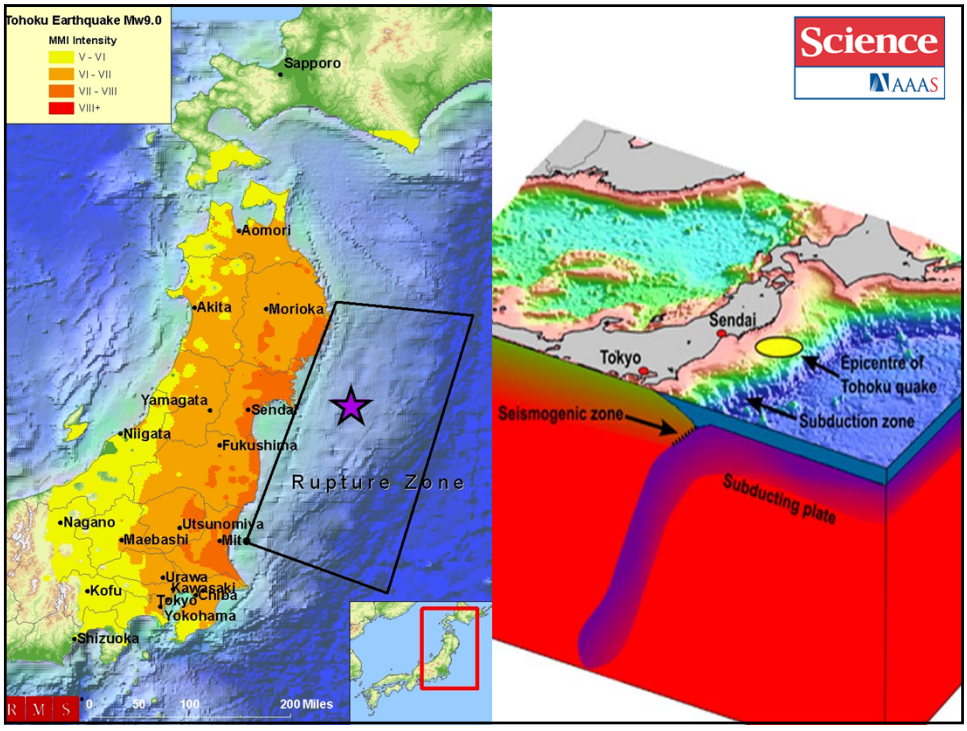

Reasons for Lack of Reproducibility

- Information withheld (not enough space, not deemed important, etc.)
- Tacit knowledge the practitioner doesn't even know he/she possesses
- System not sufficiently known (not all independent variables controlled)
- False positives

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What *Science* is Doing

- Recently announced a set of new initiatives to increase reader and reviewer confidence in studies published in *Science*
- Adding additional members to the BoRE (Board of Reviewing Editors) from the statistics community with the help of the American Statistical Association

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Reproducibility: Preclinical Studies

A Call for Transparent Reporting to Optimize the Predictive Value of Preclinical Research *

Story C. Landis, Susan G. Amara, Khusru Asadullah, Chris P. Austin, Robi Blumenstein, Eileen W. Bradley, Ronald G. Crystal, Robert B. Darnell, Robert J. Ferrante, Howard Fillit, Robert Finkelstein, Marc Fisher, Howard E. Gendelman, Robert M. Golub, John L. Goudreau, Robert A. Gross, Amelie K. Gubitz, Sharon E. Hesterlee, David W. Howells, John Huguenard, Katrina Kelner, Walter Koroshetz, Dimitri Krainc, Stanley E. Lazic, Michael S. Levine, Malcolm R. Macleod, John M. McCall, Richard T. Moxley III, Kalyani Narasimhan, Linda J. Noble, Steve Perrin, John D. Porter, Oswald Steward, Ellis Unger, Ursula Utz and Shai D. Silberberg

- A pre-experiment plan for handling data (not on the fly)
- Sample-size estimation to ensure appropriate S/N
- Randomization in sample treatment
- Blind conduct of the experiment

Nature*, **490, 187, 2012.

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Reproducibility: All Studies

- Upon acceptance, ask reviewers/editors to select papers with unusually excellent treatment of data and samples to volunteer to write up their approach in as general terms as reasonable
- Collect a compendium of treatments across all fields of science that will provide input for NINDS-style workshops later in 2014 selected areas (TBD)

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The Role of Journals

- Prestigious journals have some leverage in enforcing standards because scientists want to publish there.
- But traditional journals are facing more competition from new publishing models (OA, preprint servers), not all of which have same requirements on authors for reproducibility.
- Journals are likely the first to know when research they published is not reproducible; have obligation to alert the scientific community.

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Role of Universities

- Responsible for training future and current researchers in the scientific method and best practices to improve reproducibility.
- Can reward researchers who produce reproducible results and withhold rewards from researchers who produce non-reproducible research.

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Role of Funding Agencies

- Make panels alert to criteria for reproducibility at proposal stage as it needs to be part of the experimental plan and will have budget implications.
- Consider whether reproducing key experiments is worth funding.
- Preferentially support PIs who produce reproducible research.

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Role of Scientific Societies

- Consider honoring those who consistently produce reproducible research.
- Devote special sessions at scientific meetings to the topic of best practices in reproducibility.
- Adopt reproducibility guidelines for society publications.

This needs to be a team effort.

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