

Verify Original Results through Reanalysis before Replicating

A Commentary on “Making Replication Mainstream” by Rolf A. Zwaan, Alexander Etz, Richard E.
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Abstract

In determining the need to directly replicate, it is crucial to first verify the original results through independent reanalysis of the data. Original results that appear erroneous and that cannot be reproduced by reanalysis offer little evidence to begin with, thereby diminishing the need to replicate. Sharing data and scripts is essential to ensure reproducibility.

Zwaan, Etz, Lucas, and Donnellan (2017) provide an important and timely overview of the discussion whether direct replications in psychology have value. Along with others (see, e.g., Royal Netherlands Academy of Arts and Sciences, 2018), we agree wholeheartedly that replication should become mainstream in psychology. However, we feel that the authors missed a crucial aspect in determining whether a direct replication is valuable. Here, we argue that it is essential to first verify the results of the original study by conducting an independent reanalysis of its data or a check of reported results, before choosing to replicate an earlier finding in a novel sample.

A result is successfully reproduced if independent reanalysis of the original data, using either the same or a (substantively or methodologically) similar analytic approach, corroborates the result as reported in the original paper. If a result cannot be successfully reproduced, the original result is not reliable and it is hard, if not impossible, to substantively interpret it. Such an irreproducible result will have no clear bearing on theory or practice. Specifically, if a reanalysis yields no evidence for an effect in the original study, it is safe to assume that there is no effect to begin with, raising the question of why one would invest additional resources in any replication.

Problems with Reproducibility in Psychology

Lack of reproducibility might seem like a non-issue; after all, it may seem like a guarantee that running the same analysis on the same data would give the same result. However, there is increasing evidence that reproducibility of published results in psychology is relatively low.

Checking of reproducibility of reported results in psychology is greatly impeded by a common failure to share data (Vanpaemel, Vermorgen, Deriemaeker, & Storms, 2015; Wicherts, Borsboom, Kats, & Molenaar, 2006). Even when data are available, they are often of poor quality or not usable (Kidwell et al., 2016). Yet some issues with reproducibility can be assessed by scrutinizing papers. Studies repeatedly showed that roughly half of all published psychology articles contains at least one inconsistently reported statistical result, wherein the reported p -value does not match the degrees of freedom and test statistic; in roughly one in eight results this may have affected the statistical conclusion (e.g., Bakker & Wicherts, 2011; Nuijten, Hartgerink, Van Assen, Epskamp, & Wicherts, 2016; Veldkamp, Nuijten, Dominguez-Alvarez, van Assen, & Wicherts, 2014; Wicherts, Bakker, &

Molenaar, 2011). Furthermore, there is evidence that roughly half of psychology articles report means that are inconsistent with the given sample size and number of items (Brown & Heathers, 2017), coefficients in mediation models often do not add up (Petrocelli, Clarkson, Whitmire, & Moon, 2012), and in 41% of psychology articles reported degrees of freedom do not match the sample size description (Bakker & Wicherts, 2014).

Problems that can be detected without having the raw data, are arguably just the tip of the iceberg of reproducibility issues. Studies that intended to reanalyze data from published studies also often ran into problems (e.g., Ebrahim et al., 2014; Ioannidis et al., 2009). Beside the poor availability of raw data, papers usually do not contain details about the exact analytical strategy. Researchers often seem to make analytical choices that are driven by the need to obtain a significant result (John, Loewenstein, & Prelec, 2012; Agnoli, Wicherts, Veldkamp, Albiero, Culbelli, 2017). These choices can be seemingly arbitrary (e.g., choice of control variables or rules for outlier removal; see also Simmons, Nelson, & Simonsohn, 2011; Bakker, Van Dijk, & Wicherts, 2012), which makes it hard to retrace the original analytical steps to verify the result.

Suggested Solution

Performing a replication study in a novel sample to establish the reliability of a certain result is time-consuming and expensive. It is essential that we avoid wasting resources on trying to replicate a finding that may not even be reproducible from the original data. Therefore, we argue that it should be standard practice to verify the original results before any direct replication is conducted.

A first step in verifying original results can be to check whether the results reported in a paper are internally consistent. Some initial screenings can be done quickly with automated tools such as “statcheck” (Epskamp & Nuijten, 2016; <http://statcheck.io>), “*p*-checker” (Schönbrodt, 2015), and “GRIM” (Brown & Heathers, 2017). Especially if such preliminary checks already flag several potential problems, it is crucial that data and analysis scripts are made available for more detailed reanalysis. One could even argue that if data are not shared in such cases, the article should be retracted.

If a result can successfully be reproduced with the original data and analyses, it is interesting to investigate its sensitivity to alternative analytical choices. One way to do so is to run a so-called multiverse analysis (Steege, Tuerlinckx, Gelman, & Vanpaemel, 2016), in which different analytical choices are compared to test the robustness of the result. When a multiverse analysis shows that the study result is only present in a limited set of reasonable scenarios, you may not want to invest additional resources in replicating such a study. Note that a multiverse analysis still does not require any new data, and is therefore a relatively cost-effective way to investigate reliability.

Reanalysis of existing data is a crucial tool in investigating reliability of psychological results, so it should become standard practice to share raw data and analysis scripts. Journal policies can be successful in promoting this (Kidwell et al, 2016; Nuijten, Borghuis, Veldkamp, Dominguez-Alvarez, Van Assen, & Wicherts, 2017; Giofrè, Cumming, Fresco, Boedker, & Tressoldi), so we hope that more journals will start requiring raw data and scripts.

In our proposal, the assessment of replicability is a multi-step approach that first assesses whether the original reported results are internally consistent, then sets out to verify the original results through independent reanalysis of the data using the original analytical strategy, followed by a sensitivity analysis that checks whether the original result is robust to alternative choices in the analysis, and only then involves the collection of new data.

References

- Agnoli, F., Wicherts, J. M., Veldkamp, C. L. S., Albiero, P., & Cubelli, R. (2017). Questionable research practices among Italian research psychologists. *PLoS One*, 12(3), e0172792. doi:10.1371/journal.pone.0172792
- Bakker, M., & Wicherts, J. M. (2011). The (mis)reporting of statistical results in psychology journals. *Behavior Research Methods*, 43(3), 666-678. doi:10.3758/s13428-011-0089-5
- Bakker, M., van Dijk, A., & Wicherts, J. M. (2012). The rules of the game called psychological science. *Perspectives on Psychological Science*, 7(6), 543-554. doi:10.1177/1745691612459060
- Bakker, M., & Wicherts, J. M. (2014). Outlier removal and the relation with reporting errors and quality of research. *PLoS One*, 9(7), e103360. doi:10.1371/journal.pone.0103360
- Brown, N. J. L., & Heathers, J. A. J. (2017). The GRIM Test: A Simple Technique Detects Numerous Anomalies in the Reporting of Results in Psychology. *Social Psychological and Personality Science*, 8(4), 363-369. doi:10.1177/1948550616673876
- Ebrahim, S., Sohani, Z. N., Montoya, L., Agarwal, A., Thorlund, K., Mills, E. J., & Ioannidis, J. P. (2014). Reanalysis of randomized clinical trial data. *JAMA*, 312(10), 1024-1032. doi:10.1001/jama.2014.9646
- Epskamp, S., & Nuijten, M. B. (2016). statcheck: Extract statistics from articles and recompute p-values. Retrieved from <https://cran.r-project.org/web/packages/statcheck/>. (R package version 1.2.2)
- Giofrè, D., Cumming, G., Fresc, L., Boedker, I., & Tressoldi, P. (2017). The influence of journal submission guidelines on authors' reporting of statistics and use of open research practices. *PLoS One*, 12(4), e0175583. doi:10.1371/journal.pone.0175583
- Ioannidis, J. P., Allison, D. B., Ball, C. A., Coulibaly, I., Cui, X., Culhane, A. C., . . . Jurman, G. (2009). Repeatability of published microarray gene expression analyses. *Nature genetics*, 41(2), 149-155.
- John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the prevalence of questionable research practices with incentives for truth-telling. *Psychological Science*, 23, 524-532.
- Kidwell, M. C. Lazarevic, L. B. Baranski, E. Hardwicke, T. E. Piechowski, S. Falkenberg, L.-S., Kennett, C., Slowik, A., Sonnleitner, C., Hess-Holden, C., Errington, T. M., Fiedler, S., Nosek, B. A. et al. (2016). Badges to Acknowledge Open Practices: A Simple, Low-Cost, Effective

Method for Increasing Transparency. *PLoS biology*, 14(5), e1002456. DOI:

10.1371/journal.pbio.1002456

Nuijten, M. B., Hartgerink, C. H. J., Van Assen, M. A. L. M., Epskamp, S., & Wicherts, J. M. (2016).

The prevalence of statistical reporting errors in psychology (1985-2013). *Behavior Research Methods*, 48(4), 1205-1226. doi:10.3758/s13428-015-0664-2

Nuijten, M. B., Borghuis, J., Veldkamp, C. L. S., Dominguez-Alvarez, L., Van Assen, M. A. L. M., &

Wicherts, J. M. (2017). Journal data sharing policies and statistical reporting inconsistencies in psychology. *Collabra: Psychology*, 3(1), 1-22. doi:10.1525/collabra.102

Petrocelli, J., Clarkson, J., Whitmire, M., & Moon, P. (2012). When $ab \neq c - c'$: Published errors in the

reports of single-mediator models: Published errors in the reports of single-mediator models. *Behavior Research Methods*, 1-7. doi:10.3758/s13428-012-0262-5

Royal Netherlands Academy of Arts and Sciences (2018). Replication studies. Improving

reproducibility in the empirical sciences. Amsterdam: KNAW.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed

flexibility in data collection and analysis allows presenting anything as significant.

Psychological Science, 22, 1359 –1366. doi:10.1177/0956797611417632

Steege, S., Tuerlinckx, F., Gelman, A., & Vanpaemel, W. (2016). Increasing Transparency Through a

Multiverse Analysis. *Perspectives on Psychological Science*, 11(5), 702-712.

doi:10.1177/1745691616658637

Vanpaemel, W., Vermorgen, M., Deriemaeker, L., & Storms, G. (2015). Are we wasting a good

crisis? The availability of psychological research data after the storm. *Collabra*, 1(1), 1-5.

doi:10.1525/collabra.13

Veldkamp, C. L. S., Nuijten, M. B., Dominguez-Alvarez, L., van Assen, M. A. L. M., & Wicherts, J. M.

(2014). Statistical reporting errors and collaboration on statistical analyses in psychological

science. *PLoS One*, 9(12), e114876. doi:10.1371/journal.pone.0114876

Wicherts, J. M., Bakker, M., & Molenaar, D. (2011). Willingness to share research data is related to

the strength of the evidence and the quality of reporting of statistical results. *PLoS One*, 6(11),

e26828. doi:10.1371/journal.pone.0026828

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Wicherts, J. M., Borsboom, D., Kats, J., & Molenaar, D. (2006). The poor availability of psychological research data for reanalysis. *American Psychologist*, 61, 726-728. doi:10.1037/0003-066X.61.7.726

Zwaan, R. A., Etz, A., Lucas, R. E., & Donnellan, M. B. (2017). Making Replication Mainstream. *Behavioral and Brain Sciences*, 1-50.