**<Do large science teams produce reliable/replicable research outcomes?>**

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One of the most important features that distinguish modern society from pre-modern one is how we produce and apply knowledge. As a human activity to discover reliable knowledge in a systematic way, doing science is often related not only to the production of pure knowledge around the world but also to the life-world domains that impact us directly. Even though it is not the only way of doing it (e.g., paleontologists and astronomers rely on fossil records and radial signals, respectively), it is hard to deny that conducting experiments is naturally associated with doing science. In theory, scientific knowledge produced by scientists using experiments should be replicated by other scientists if scientific knowledge is truly cumulative; but it is not always the case. More and more researchers/scientists are under pressure to discover and publish new findings in competitive environments often dubbed as "publish or perish" culture and research validating previous findings is not often highly appreciated.

A crucial trend in contemporary science is the increase in collaboration. This is contrasting to a popular image of solitary scientists in the $17^{th}$-$18^{th}$ centuries struggling with experimental equipment alone. Since Price (1963) first documented the growth of team science, recent studies have confirmed it (e.g., Wuchty et. al. 2007; O'Brien 2012; Leahey 2016). Collaboration already became an essential part of contemporary science partly due to the amounts of capital - both in terms of experimental instruments and various level of researchers including postdocs and graduate students - are required for doing science but benefits from collaborative research include synergies based on the division of labors from researchers with different types of expertise and potentially better visibility of research to broader research community after its publication (Leahey 2016). In addition to this, some argue that collaborative research activities from a larger team can produce more reliable research in a sense that

errors and bad ideas could be filtered out in advance (Clark & Llorens 2012, Bikard et al. 2015). Thus, various policy recommendations and methods to promote collaboration in science have been proposed (to name a few, Hicks et al 1996, Stokols et al, 2008, Bennett et al 2012).

However, some recent studies point out not only the obstacles that might hamper the effective collaborative research efforts (which can be overcome with appropriate managing skills) but also inherent issues of doing "big science" with large size teams. For example, drawing upon scientific publications, patents, and software codes spanning from 1954 to 2014, Wu et al (2018) argue that large teams tend to conduct research conservatively in a sense of choosing their research topics, whereas small teams tend to produce disruptive work more frequently than larger teams. This suggests that the dynamics govern a large team is different from a small team and we might not have to prefer a large team to a small team when it comes to doing science.

The question I would like to propose here goes one step further from this point. Does centralized "big science" produce more reliable results that can be replicated in the future? A possible answer to this question can be "it depends." I hypothesize that research results from large research teams in which a narrow scope of methods, experimental conditions, prior knowledge is shared by many scientists can be less reliable than research results produced by a research community comprising of small teams with diverse scopes of methods, experimental conditions, prior knowledge.

To test this possibility, I am planning to analyze the replicability of research published in medical journals, especially using the randomized clinical trial (RCT) which is often considered as the gold standard in medical research. The dependency of authors in terms of previous co-authorship relations, the dependency of prior knowledge in terms of bibliographic similarity, and the dependency of methods in terms of content similarity are to be measured. In other words, I will perform network

and text analysis to construct the predictors and run a logistic regression model to test whether those factors predict the reliability of scientific claims. (As for the data, I am waiting for the response from the collaborators, James Evans, and Yoav Benjamini.)

**References**

Bennett, L. Michelle, and Howard Gadlin. "Collaboration and team science: from theory to practice." Journal of Investigative Medicine 60, no. 5 (2012): 768-775.

Bikard, Michaël, Fiona Murray, and Joshua S. Gans. "Exploring trade-offs in the organization of scientific work: Collaboration and scientific reward." Management science 61, no. 7 (2015): 1473-1495.

Clark, Benjamin Y., and Jared J. Llorens. "Investments in scientific research: Examining the funding threshold effects on scientific collaboration and variation by academic discipline." Policy Studies Journal 40, no. 4 (2012): 698-729.

Leahey, Erin. "From sole investigator to team scientist: Trends in the practice and study of research collaboration." Annual review of sociology 42 (2016): 81-100.

Hicks, Diana, and J. Sylvan Katz. "Science policy for a highly collaborative science system." Science and public policy 23, no. 1 (1996): 39-44.

O'Brien, Timothy L. "Change in academic coauthorship, 1953–2003." Science, Technology, & Human Values 37, no. 3 (2012): 210-234.

Price, Derek J. de Solla (Derek John de Solla). Little Science, Big Science. New York: Columbia University Press, 1963.

Stokols, Daniel, Kara L. Hall, Brandie K. Taylor, and Richard P. Moser. "The science of team science: overview of the field and introduction to the supplement." American journal of preventive medicine 35, no. 2 (2008): S77-S89.

Wu, Lingfei, Dashun Wang, and James A. Evans. "Large teams develop and small teams disrupt science and technology." *Nature* 566, no. 7744 (2019): 378.

Wuchty, Stefan, Benjamin F. Jones, and Brian Uzzi. "The increasing dominance of teams in production of knowledge." Science 316, no. 5827 (2007): 1036-1039.