The Rise in Collaborative Psychological Science

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Scientific knowledge has traditionally been advanced by individuals, and the reward structure in science reflects this tradition. Graduate students and junior faculty are admonished to establish their independence to show their genius, while avoiding any attributional ambiguity by collaborating with others. When a candidate for tenure fails to heed this advice and publishes instead as a member of a scientific team, faculty review committees and university administrators are inclined to raise questions about the candidate's contributions and scientific merit. Reading the work, speaking to the candidate, and attending carefully to their knowledge, methodological sophistication, innovativeness, and perspicacity is apparently not enough. This emphasis in academe on the solitary production of knowledge does not stop with tenure, either. Individual contributions are stressed in the determination of raises and in the selection of recipients for scientific awards ranging from early career contributions to the Nobel Prize (English, 2005).

The landscape of science has changed, however. One major change, discussed in my previous column, is that there are now seven hub disciplines in science, one of which is psychological science. A second change is the increasing dominance of teams in the production of scientific knowledge, and the increasing impact of scientific discoveries that reflect the work of teams relative to individuals. That's right: The standard of the solitary scientist advancing knowledge against which psychological scientists are compared when doling out raises, tenure, status, and awards is outdated.

Evidence for this claim, provided in a recent article by Wuchty, Jones, and Uzzi (2007), is surprisingly broad. Wuchty and colleagues examined all U.S. patents registered since 1975 and all research articles in the Institute for Scientific Information database, which dates back to 1955 for science and engineering, 1956 for the social sciences, and 1975 for the humanities. The dataset is large, consisting of 2.1 million patent records and 19.9 million research articles.

When Wuchty and colleagues compared the percentage of papers published by solitary versus multiple authors over the past half century, they found that team science had increased in all areas: the social sciences (which includes psychology), other sciences and engineering, patents, and humanities. In 1955, for instance, only 17.5 percent of the papers published in the social sciences were by teams, whereas by 2000 this number had risen to 51.5 percent (Wuchty et al., 2007). Not surprisingly, larger teams of scientists were and continue to be involved in the production of knowledge in the sciences and engineering than in the social sciences. The *rate* of increase in the percentage of papers published by multiple authors over the past half century, however, is as high for the social sciences as it is for other sciences and engineering.

Analyses of the mean number of authors per published paper (or registered patent) also revealed consistent increases in team science over the past half century (Wuchty et al., 2007). Analyses based on disaggregated data, which were reported in their supplementary materials, showed that the growth in team size in the social sciences was greatest in psychological science (75.1 percent) — a growth rate

comparable to that found for chemistry (67.6 percent), engineering (63.6 percent), and computer science (81.2 percent).

Even if more papers are published by scientific teams than by individuals, is it possible that the most important scientific discoveries continue to be made by solitary scientists? To address this question, Wuchty and colleagues analyzed the scientific impact of papers published by solitary versus multiple authors. The results showed that research papers and patents by teams were more highly cited than were those produced by solitary individuals. This citation advantage of teams over individuals is found in all broad research areas — social sciences, other sciences and engineering, patents, and the humanities. Moreover, the citation advantage of teams increases as the mean number of team members increases. Of course, more authors means there are more opportunities for self-citations, which could contribute to the citation impact of multi-authored papers. However, the citation advantage of team science and the increasing citation advantage with team size are evident even when controlling for self-citations (Wuchty et al., 2007).

The citation advantages of teams were evident 50 years ago and they have increased in magnitude every decade since then. For instance, using as the base (i.e., a ratio of 1.0) the citation impact of sole-authored papers published in the social sciences in 1960, papers by two authors published in the social sciences that year received 1.88 times more citations, papers by four authors received 2.99 times more citations, and papers by six or more authors that year received 4.88 times more citations. By contrast, using as the base the citation impact of sole-authored papers published in the social sciences in 2000, papers by two, four, and six or more authors published in the social sciences that year received 2.50, 5.04, and 13.01 times more citations, respectively. To the extent that citation impact is a reasonable, although imperfect, metric of research quality (e.g., Asknes, 2006), these data indicate that team science is becoming more prevalent and may even be producing better quality research.

Wuchty and colleagues (2007) examined one other possible advantage of sole-authored science. Specifically, they tested whether a few key concepts that drive a field are more likely to be generated by the solitary genius than by teams of scientists. To do this, analyses were limited to the authorship of papers that received exceptionally high numbers of citations. Results showed that a half century ago sole-authored papers were more likely to be among this elite group, but in contemporary science team-authored papers are much more likely to be in this elite group.

These are correlational data, and no one would suggest based on these data that simply adding coauthors will improve the quality or citation impact of the research. There are several reasons why the size of scientific teams might be on the rise, however. First, the cost of conducting cutting edge science and the variety of expertise required to conduct this research have increased in many fields. Although clearly a factor, Wuchty et al. (2007) found this could not account entirely for the increases they observed.

Second, as more complex psychological questions that exceeded the expertise of individual investigators were being asked, multidisciplinary and interdisciplinary research began to gain momentum. The contextual conditions that have fostered the current momentum are manifold. The 20th century saw a growth and maturation of psychological science and related disciplines to the point that they now provide a solid base from which to launch successful interdisciplinary expeditions. Advances in mathematical tools for dealing with large and complex data structures have helped the psychological sciences bridge to other disciplines. At the same time, the development of new and powerful methods

and measurement tools promoted productive interdisciplinary research across the neurosciences, cognitive sciences, behavioral sciences, and social sciences.

Additional explanations having less to do with the quality of the science are also possible (e.g., Bentley, 2007; Wray, 2007), but it is clear that the most influential research in psychology and in the sciences more generally is now more likely to be the product of a scientific team than of a solitary scientist. It is worth asking, therefore, whether insisting that budding psychological scientists avoid collaborative research to establish their independence may be counterproductive if the goal is to maximize the quality and impact of their research. Indeed, graduate training and the contingency structure in science may need a serious makeover if our students and faculty are to develop optimally and we are to do all we can to advance psychological science.

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