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CROUCHING AUTHORS, HIDDEN PITFALLS: COLLABORATION IN RESEARCH

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Abstract. Academic research has become increasingly collaborative, not just in the hard sciences and engineering but also in the social sciences. In this paper, we review studies that have documented this increasing collaboration, showing that collaboration, especially in the form of co-authorship, has risen across the board in almost all academic disciplines and across institutions and geographic regions of the world. What accounts for this rise? We identify four potential benefits to collaboration: greater learning opportunities, gains from a more complex division of labor, enhanced motivation and discipline, and reductions in the development cycle of projects. However, four potential pitfalls can hinder the collaborative process: decreased individual productivity, partner opportunism, communication and coordination challenges, and conflicting time horizons. Because we think these problems can ruin a research project, we offer strategies on how to overcome them: clearly defining the scope and logic of the project, agreeing upon responsibilities, enforcing deadlines and giving and receiving timely feedback, and using coordination mechanisms that facilitate the collaborative process. We conclude by discussing the implications our review has not only for aspiring academics but also for the organization of academic enterprises.

Keywords: Academic research, Collaboration, Pitfalls and Benefits to Collaboration.

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INTRODUCTION

The scientific community celebrates individual achievements by conferring prestige and honors on scientists who win out in the competitive game of being the first to publish innovative research. Paradoxically, however, modern scientific expertise rests

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heavily upon work carried out by teams, rather than scholars working on their own. Tension between the forces of competition and cooperation thus infuses every aspect of scholarly activities: recruiting, hiring, promotions, grant writing, leadership in scientific organizations, and so forth. For example, competition for places at top universities pits junior scholars against one another, but in their graduate programs, they work with other students and their senior professors to manage complex research projects. Thus, it is understandable that graduate students and junior scholars would be perplexed by how to manage such tensions.

In our paper, we examine why collaboration has become so pervasive, pointing out its many benefits. We reviewed social science articles published since 2000 that focused on research teamwork, in sociology journals and in general interest journals that cover scientific trends, such as the American Association for the Advancement of Science's journal, *Science*. To document empirical trends, we concentrated on articles that used comprehensive bibliometric data sources.

Many contemporary research projects involve scholars from multiple disciplines, thus exacerbating some of the problems we have identified. We will make note of such instances. However, our review focuses on what we believe to be issues endemic to small group collaboration, regardless of the number of disciplines involved. We also note that successful collaboration is not a sure thing, and we identify some common barriers to successful teamwork. Based on our diagnoses of common problems, we offer some strategies for structuring and managing relationships in collaborative efforts.

I - EMPIRICAL TRENDS

By almost any measure, collaboration in academic research has been increasing (Leahey 2016). Two caveats are in order. First, many of the empirical studies we cite, especially the ones that are comprehensive in scope, only include data up to the year 2000. To our knowledge, comprehensive and representative studies have not been updated, although some studies on subfields have used more recent data. Nonetheless, we have no reason to believe that collaboration has slowed or decreased since 2000. Second, many of the studies that examine collaboration were carried out in the hard sciences and engineering. We recognize the differences between these fields and the social sciences – including the scale of most research projects, technical demands, and start-up costs – and, therefore, have written our pitfalls and strategies sections in a way that is applicable to social studies' researchers.

Increasing Collaboration in All Scientific Fields

Relying on bibliometric data sources and using co-authorship as a measure of collaboration, researchers have documented a steady increase in research collaboration. Wuchty - Jones - Uzzi (2007) used the Institute for Scientific Information's Web of Science (WOS) database to examine the prevalence of research collaboration over time and found that co-authorship in science and engineering and in the social sciences has steadily increased.

Another bibliometric data source, the JSTOR corpus, paints a similar picture. The percentage of JSTOR-indexed scholarly papers that were co-authored increased from less than 10 percent in 1900 to approximately 60 percent in 2000 (West et al. 2013).

Three of Wuchty et al.'s (2007) findings are worth noting. First, the percentage of papers in science and engineering that were co-authored in the mid-1950s (approximately 50 percent) is almost equivalent to the percentage of co-authored papers in the social sciences in 2000, indicating that collaboration in the natural sciences and engineering began much earlier than in the social sciences. Second, global trends in scientific research have had a pervasive effect across all the sciences. The increase in the percentage of co-authorship in the social sciences (from 17.5 percent in 1955 to 51.5 percent in 2000) resembles the increase in collaboration in science and engineering in the same era (from about 50 percent to a little over 80 percent). Third, while co-authorship increased slightly in the arts and humanities from 1975 to 2000, co-authored papers still only accounted for less than 10 percent of all papers in 2000. Only in the humanities does scholarship still rely extensively on solo endeavors.

The trend is similar within subfields in the hard sciences and the social sciences. For example, the share of co-authorship in the fields of particle physics, nanoscience and nanotechnology, and biotechnology and applied microbiology increased from about 80 percent in 1990 to about 95 percent in 2010 (Freeman - Ganguli - Murciano-Goroff 2014). Co-authorships in most social science subfields substantially increased between 1980 and 2013 (Henriksen 2016). The share of co-authored papers in 20 of the Web of Science's Social Science Citation Index's (SSCI) 56 subject categories increased by at least 40 percent in the 34-year period. In 2013, 10 of the 56 social science subfields had co-authorship rates of at least 90 percent, and 44 of the 56 subfields had co-authorship rates of at least 50 percent.

Henriksen (2016) identified a few social science subfields, such as psychiatry and biomedical social science, that relied on quantitative and experimental research and have higher co-authorship rates than other social science fields, such as history and cultural studies. Co-authorship in the leading economics journals has been steadily increasing (Hudson 1996). Specifically, the share of co-authored papers in the leading 15 economics journals increased from 30 percent in 1977 to 54 percent in 1997 (Sutter - Kocher 2004). Co-authorship in the top three political science journals increased sevenfold from the 1950s to the mid-1990s, and the percentage of co-authorship of papers in WOS's twenty-three public administration journals jumped from 40 percent in 1973 to 84 percent in 2007 (Corley - Sabharwal 2010; Fisher - Cobane - Vander Ven et al. 1998).

Within the social sciences, the trend in sociology is similar. The share of co-authored English-language journal articles in *Sociological Abstracts* increased from about 20 percent in 1963 to approximately 40 percent in 1999 (Moody 2004). Using a stratified random sample of articles published in two leading sociology journals, the *American Sociological Review* (ASR) and the *American Journal of Sociology* (AJS), Hunter and Leahey (2008) found that the share of co-authored papers in these journals was 11 percent in the 1935-1940 interval; in 2000-2005, the share was almost 50 percent. Co-authorship has become the new normal in sociological research.

Increasing Team Size

In addition to the increase in the prevalence of co-authorship in almost all academic fields, the average number of authors on a paper has increased over time and across disciplines. Team size has increased from 1.9 authors per paper in 1955 to 3.5 authors in 2000 (Wuchty et al. 2007). In the social sciences, team size increased from about 1.25 in 1956 to a little over 2 authors per paper in 2000. In some social science categories, such as psychology and social science health, average team size is typically around three authors per paper and, in some subfields, is around five authors (Henriksen 2016). Average team size has also increased in sociology, from approximately 1.3 authors in 1980 to 1.9 authors in 2013 (*ibidem*). Among co-authored papers in ASR and AJS, the average number of authors increased from 2.1 in the 1935-1940 interval to 2.6 in 2000-2005 (Hunter - Leahey 2008).

Collaboration Across Disciplines and Regions

Research collaboration has also become more prevalent across institutions and sectors and has become more international. In the sciences and engineering, the share of all articles written by authors from multiple institutions rose from one third in 1981 to one half in 1995. In that same span, the share of papers published by authors from different sectors rose from 20 to 25 percent (Shrum - Chompalov - Genuth 2007: 7). Multi-institutional collaboration has also increased in the social sciences. In economics, the share of all co-authored publications written by authors from different institutions rose from around 50 percent in 1977 to around 70 percent in 1997 (Sutter and Kocher 2004). In sociology, the share of co-authored papers in ASR and AJS written by authors from different institutions rose from 52 percent in the 1960s to 65 percent in the 1980s, but, interestingly, leveled off after the 1980s (Hunter - Leahey 2008). The share of co-authored papers written by authors living in different U.S. cities only saw a slight uptick between 1990 and 2010, echoing Hunter and Leahey's (2008) finding that collaboration between authors from different U.S. geographic regions (and institutions) started to level off in the 1980s and 1990s. These findings suggest that coordination and communication challenges, among others, may hinder research collaboration across geographic areas (see also Evans - Lambiotte - Panzarasa 2011).

Freeman et al.'s (2014) finding that international collaboration in physics, nano-science, and biotechnology is increasing is reflective of a larger trend, even among the social sciences, of more co-authorship between scholars of different regions of the world (Beigel et al. 2014). Nonetheless, their findings mask a broader finding, which is that, while inter-regional collaboration has increased over the last four decades, this growth in co-authorship has been unevenly distributed. Scholars based in North America and Europe have increased their collaboration with scholars from other regions of the world (from about 5 percent of all papers in the early 1980s to about 15 percent in 2009), but North American and European scholars still collaborate with scholars of other regions at lower rates than scholars based in other regions of the world (*ibidem*).

Summary

Numerous studies have documented the rise of collaborative research, challenging the myth that scientific inquiry and progress is a lone endeavor (Singh - Fleming 2010). Although researchers in the hard sciences and engineering continue to be the most collaborative, we suspect that the rise of «big data» will have a long-term impact on collaboration rates in the social sciences (Wagner-Pacifici - Mohr - Breiger 2015). By «big data» we mean studies using databases covering millions of cases, often followed over time, and requiring the use of complex research designs and statistical analyses. For example, labor market researchers in Sweden and Denmark have access to government-collected national registry databases that cover all workers and employers in the society, involving millions of data records (SAS 2017). Finally, while co-authorship data are the most widely used and best measures of collaborative research, these data do not capture the informal collaborative work (e.g., data sharing, informal conversation, student contributions etc.) that undergirds much of academic research; therefore, collaboration and teamwork are likely more common than the data suggest (Evans -Lambiotte - Panzarasa 2011; Leahey 2016). Given the increasing ubiquity of collaboration in most academic fields, we now turn to the reasons this is occurring.

II - WHY DO SCHOLARS COLLABORATE?

The increasing dominance of team-based research, in terms of number of publications, their impact, and informal collaboration, suggests that collaborative research carries advantages over solo research. Why might that be? We have identified at least four potential benefits of working in teams: greater learning opportunities, gains from a more complex division of labor, enhanced motivation and discipline, and reductions in the development cycle of projects. In addition to individual benefits and expectations, community and institutional expectations may encourage collaboration, and some funding agencies are now requiring evidence of collaboration before awarding grants.

More Learning Opportunities

Working in teams enables individuals to extend their skill sets and acquire new skills from other scholars. Rather than having to wait for feedback on their work, members of teams can enjoy real-time information about the fruits of their labors. Individual scholars often do not have the full range of skills that is necessary to conduct research alone, especially large-scale, complex projects. Acquiring these skills on one's own can be time-consuming, and collaboration allows researchers to share complementary skills and research techniques, especially if they come from different disciplines or sub-disciplines (Katz - Martin 1997; Woolley et al. 2015). Studies have shown that, above all, researchers are interested in collaborating with others from whom they can learn and gain more knowledge and expertise (Freeman et al. 2014; Melin 2000). Furthermore, collaboration not only allows researchers to acquire technical know-how

but also tacit knowledge, an understanding of how things work that is hard to verbalize and is often learned from experience, routines, and imitation (Aldrich - Ruef 2006: 76; Sawyer 2017: 59). Collaborating with others allows them to tap into knowledge not yet published or documented, potentially leading to innovative ideas not possible otherwise (Katz - Martin 1997).

In addition to gaining complementary knowledge and skills, collaboration allows researchers to expand their social networks, potentially leading to ties with private industry and government agencies and, consequently, to new funding streams (Bozeman - Gaughan 2007; Bozeman - Dietz - Gaughan 2001). Freeman et al. (2014) found that papers co-authored by authors who met at conferences had higher citation rates, whereas coauthored papers where one of the authors contributed funding had lower citation rates. Freeman et al.'s results suggest that collaborations based on ideas, rather than on funding, lead to better quality papers. Incorporating novel ideas (as measured by which journals a paper cites) has been shown to be positively associated with higher impact (Mukherjee et al. 2017; Uzzi et al. 2013), reinforcing our argument that learning from others is one of the main benefits of collaboration.

Collaboration seems to enhance the «Medici Effect» (Bikard et al. 2015; Johansson 2004; Sawyer 2017), which occurs when novel ideas emerge from the interactions of scholars from different perspectives, disciplines, cultures, and backgrounds. Research collaboration naturally exhibits homophily (in terms of ethnic background, institutional home, and academic discipline) and thus teams must deliberately and transparently work to increase heterogeneity. In teams comprising more diverse researchers, perhaps because of differing ethnic backgrounds or different institutional homes, research papers are published in higher quality journals and are cited more often (Freeman - Huang 2015).

Gains from a More Complex Division of Labor

Increased collaboration is due, in part, to the complexity of scientific research and the increasing specialization of scholars, and scholarly production has increased rapidly over the last few decades (Jones 2011). Specialty areas within disciplines are large and «even small subfields... have multiple journals» (Leahey - Reikowsky 2008). Additionally, interdisciplinary and applied research are increasingly promoted by funders and seen as valuable by researchers (Leahey - Beckman - Stanko 2017; Woolley et al. 2015).

The increasing number of scholarly publications over the last half century presents a challenge for scholars: how to engage with, and contribute to, an exponentially expanding base of knowledge. If researchers respond to this challenge by withdrawing to a narrow band of expertise (Jones 2011), they lessen their ability to draw on multiple fields and subdisciplines. However, scholars can compensate for individual narrowness by working in diverse teams. Research suggests that increasing specialization is positively associated with collaboration rates (Leahey 2016; Moody 2004), and scholars who are more specialized publish more often (Leahey 2006).

Specialization and the increasing complexity and interdisciplinary nature of research projects push scholars to share the workload on projects, allowing members to specialize and use their expertise on parts of projects most relevant to them. Rather than getting

bogged down in solving problems for which they have no special competence, team members can defer to others with the required skills. A need for specialization often occurs on research projects that require quantitative analysis, especially if the project entails using advanced statistical techniques, or projects that require data collection (Hunter - Leahey 2008; Moody 2004). In addition to seeking complementary technical expertise, scholars also collaborate to gain access to special data or equipment, the latter potentially quite useful in the hard sciences (Freeman et al. 2014; Melin 2000).

Enhanced Motivation and Discipline

Despite research becoming increasingly collaborative, researchers continue to spend a good portion of their time working alone. Solo researchers often encounter difficult problems that sap their drive and confidence, with no one to turn to for comfort and support. Although the wide-spread availability of social media now connects researchers all over the globe, it is no substitute for the camaraderie facilitated by team-based collaboration. Members of teams make implicit commitments to fulfill obligations and meet deadlines, imposing an external constraint that disciplines and motivates members.

In addition to enhanced motivation and discipline, collaboration also provides scholars intellectual companionship that makes the work more enjoyable and builds up their social and management skills (Katz - Martin 1997). Scholars, in addition to mentioning complementary skills and knowledge, often give social reasons for why they collaborate in the first place, e.g. working with old friends or past collaborators (Melin 2000). Freeman et al. (2014) found that one of the biggest benefits researchers cited was that the «research experience was more pleasant». Finally, building up social skills via collaboration can have long-term benefits, not just for the individual but also for the team, because studies have shown that certain social skills (e.g., the ability to infer how others are feeling) are positively associated with group performance (see, for example, Woolley et al. 2010).

Reduction in the Development Cycle of Projects

A major problem for solo researchers is lower productivity, compared to what teams can produce. Unless scholars have large personal research budgets, constraints on who and what they can personally supervise restrict them to a limited number of projects. In research teams, members can work on several projects at once, because they are specializing in one dimension of the project and can work on that aspect while others are working on separate parts or even different projects.

Summary

Ultimately, collaboration allows scholars to get more from their scholarly efforts than they would achieve by going it alone. Campbell (1994) characterized the practice of science as «the struggle for citations», giving scholars strong incentives for finding others

with whom to work, given that coauthored works are cited more often. Collaboration allows scholars to go beyond their own skill sets and to not only complement them in the short term but also to add to their own knowledge base (Rawlings - McFarland 2011). Competition for research dollars and publication outlets has increased the pressure on scientists to specialize, posing a threat to any large-scale projects that don't have a complex division of tasks staffed by highly trained specialists, particularly if multiple disciplines are involved. Collaboration is an inherently social activity and one of the side benefits of engaging with others in such work is that the commitments made tend to reinforce scholars' pledges to completing the project. Finally, although they will not earn full credit on all the projects for which they collaborate, spreading out the commitments over a portfolio of projects enables scholars to achieve more, in the aggregate.

III - WHAT CAN GO WRONG?

Many studies have shown the benefits of collaboration, but many have also documented the potential costs (Leahey 2016). We identified four classes of problems: decreased productivity, partner opportunism, communication and coordination challenges, and conflicting time horizons. We are mindful of different citation practices across disciplines, particularly regarding authorship order. Fortunately, those differing norms will not affect most of the points we wish to make.

Decreased Productivity

The division of labor and a reduction in the development cycle of research projects that we have described allow researchers to publish more papers and ones that are more highly cited (Bikard et al. 2015; Lee - Bozeman 2005; but see Corley - Sabharwal 2010). Much of this research also suggests that collaboration, while boosting scholars' overall publication counts, may dampen their fractional counts – the amount of credit a scholar receives, based on the number of co-authors (Bikard et al. 2015; Leahey 2016; Lee - Bozeman 2005). Bikard et al. (2015) found that collaboration can, in certain cases, decrease an individual's fractional productivity by over 30 percent, suggesting that although researchers may be able to publish more if they work in teams, team work may result in fewer citations for their publications.

Why might collaboration dampen individual productivity? First, collaborative work almost always entails more administrative work, including coordinating with other scholars, managing more research assistants, and dealing with problems that inevitably arise from maintaining multiple manuscripts, datasets, and software versions. These administrative tasks can come at the expense of focusing on the research itself. Second, fractional productivity is a function of how credit is allocated in a research project, which is often a complicated and emotion-laden subject among collaborators. Most academics abide by a few well-known rules when it comes to credit allocation (e.g., order of authorship is indicative of who did more on a project), but there are not clear guidelines or norms (or systematic data) for reporting how the work was divided

or how much each author contributed (Bikard et al. 2015; Leahey 2016). The cost-benefit calculus of how much to put into a project relative to the potential impact it will have is not unique to collaborative projects, but because credit allocation is more uncertain when working with others, this potential pitfall likely affects collaborators more so than solo researchers. The third reason that collaboration may lead to lowered productivity involves coordination challenges that inevitably come with collaborative work. We discuss these challenges below.

Partner Opportunism

Even well-intentioned parties to a relationship can engage in behaviors that undermine the collaborative process. More darkly, given that collaborative relationships are founded on a bedrock of trust, self-interested and self-seeking parties can exploit relationships to further their own goals. Partner opportunism can take several forms, including the free rider and lemon problems. «Free riding» occurs when people receive benefits from a group to which they belong but to which they made little or no contribution. The «lemon problem» occurs because of asymmetric information between individuals on a team, with members unable to determine a priori who truly has the skills to contribute and who is merely claiming to have such skills. Although we intuitively know that free riding and the lemon problem are challenges in any collective endeavor, it is difficult to know empirically how often and to what extent co-authors did very little of the work, especially since so few academic journals require authors to specify credit allocation (Leahey 2016; Olson 1965).

Social psychology researchers have found that free riding, or social loafing, does occur in group work and leads to productivity loss (Diehl - Stroebe 1987; Sawyer 2017). More specific to collaborative research, there is some evidence to suggest that the type of collaboration may determine whether free riding is more likely. Specifically, senior scholars may benefit more from collaborations, not because junior members of the team do not receive any credit, but because senior co-authors may free ride, imposing a cost on the fractional productivity of the junior scholar (Bikard et al. 2015). Junior scholars thus face a conundrum: collaboration with more senior scholars increases visibility, but it can result in decreased productivity. The suggestions outlined in our strategies section are intended to lessen this potential cost.

Communication and Coordination Challenges

The division of labor in research activities and the trend toward more multi-institutional, interdisciplinary, and global collaboration means that coordinating a research project and communicating with collaborators are more important than ever before. For collaboration to be worth a researcher's time, the benefits of acquiring knowledge, skills, and expertise from collaborators need to outweigh the coordination costs that all teams face (Bikard et al. 2015; Cummings - Kiesler 2005). If the research is not well coordinated, goals are not clearly outlined, and tasks are not clearly assigned, productivity, both at the individual and group levels, is likely to suffer.

In addition to the challenges that come with dividing up tasks fairly, sharing resources (e.g., data, instruments, software), and delineating tasks and roles, irregular and ineffective communication is likely to sink a project (Cummings - Kiesler 2007). One of the biggest coordination challenges is ensuring that team members have opportunities to communicate regularly to discuss common problems and work through solutions. Freeman et al. (2014) found that two of the biggest challenges researchers face are «insufficient time for communication» and «problems coordinating with team members' schedules» (29). Despite the advances made in communication technologies, research continues to suggest that geographic distance still exacts great coordination costs. For example, research that spans multiple universities has been shown to have higher communication and coordination costs (Cummings - Kiesler 2005, 2007).

The costs of coordinating are not just a function of geographic distance, as coordination challenges also occur in face-to-face meetings. Such challenges have been explored by social psychologists who have identified cognitive reasons for ineffective coordination and communication. Two of these cognitive processes seem most relevant when it comes to collaborative research. The first is «social inhibition» (or «evaluation apprehension»), arising when group members may not contribute an idea for fear of what others will think. Second, research teams may exhibit «information bias» (or, relatedly, fixating on a topic), where the search for consensus that occurs within groups may inhibit new and creative ideas or solutions (Bikard et al. 2015; Paulus 2008; Sawyer 2017). The costs of social inhibition and information bias can be lowered if group leaders take the time at the beginning of meetings to establish norms regarding participation, such as nonjudgmental recording of proffered ideas and making certain that everyone in a group has had a chance to offer their opinions.

Conflicting Time Horizons

Orientations to and experiences of time can differ dramatically across individuals (Lippmann - Aldrich 2017). Mohammed - Harrison (2013) identified four dimensions along which temporal orientation can differ, including time urgency (a preoccupation with the passage of time, deadlines, and speed), time perspective (focusing heavily on the past, present, or future), polysynchronicity (engaging in more than one task concurrently), and pacing style (working steadily from start to finish, quickly finishing tasks well before a deadline, or waiting until the last minute). These orientations bear obvious relationships to individual work styles, but also have important effects on the functioning of scholarly teams. When team members fail to achieve «temporal consensus» (how tasks should be managed over a set period of time), coordination becomes more difficult and satisfaction with performance declines (Gevers - Peeters 2009). Under some conditions, however, temporal diversity among team members can be beneficial, as different members' approaches to time can allow for the completion of complex tasks (Mohammed - Nadkarni 2011).

Many aspects of a research project require a simultaneous focus on the past, present, and future. While some individuals may be able to simultaneously balance these foci, in many cases a focus on one occurs at the expense of the others (Koselleck 1985). How does temporal focus diversity in scholarly teams allow for the simultane-

ous consideration of past, present, and future? And how might heterochrony among team members work to the group's advantage? Alternatively, are there ways in which temporal focus diversity can harm group functioning, as shown in research by Gevers - Peeters (2009)? Team members may misattribute individual differences in time orientation to more visible individual differences, such as gender or functional background. Such misattributions complicate the process of properly managing a team with a high degree of temporal diversity and may undermine its effectiveness.

Summary

Collaborative research is a highly complex undertaking and, inevitably, things can go wrong. We have described four common problems that can arise when scholarly teams are formed. First, scholars must be prepared for a reduction in their individual scholarly output as they sacrifice their own interests for the goals achieved by the team. Nonetheless, some scholars object to subordinating their interests to the collective good. Second, as in other human endeavors, opportunism is an ever-present possibility and shirking, free riding, and social loafing raise the governance costs of collaboration. Third, communication and coordination challenges arise in any complex endeavor and are particularly troublesome in scientific work, given the amount of uncertainty most research projects encounter. Finally, conflicting time horizons among the members of teams sometimes lead to misunderstandings and team failures.

IV - STRATEGIES FOR STRUCTURING AND MANAGING COLLABORATIVE RELATIONSHIPS

We believe the key to successful collaborative relationships lies in preparing for them ahead of time, rather than attempting to deal with problems as they arise. In fact, some research suggests that the effectiveness of collaborative work is determined before any of the work is carried out (Bronson - Merryman 2013: 199-202; Hackman 2011). We have identified four structural elements that increase the likelihood of creating and sustaining collaborative relationships: clearly defining the scope and logic of the project; agreeing upon responsibilities; enforcing deadlines and giving and receiving timely feedback; and using coordination mechanisms that facilitate the collaborative process. The availability and feasibility of these four strategies varies by career stage.

Define the Scope and Logic of the Project

At the start, the parties to a collaborative relationship should agree on a project's scope and logic of inquiry (Schippers - Edmonson - West 2014). The researchers should ask themselves a few questions that will ensure that they are all on the same page. For example, will the project be open-ended, continuing until all possible avenues of interpretation have been explored and as many papers as possible published? Or, is the project more self-contained, with target journals or conferences identified and the project ended when a paper is accepted? If multiple scientific disciplines are

involved, do members agree on what journals to target? Is the relevant data for the project already in hand or clearly identified, or will building a new dataset be a major thrust of the effort? Sharing «mental models» of the work to be done and how it should be carried out leads to effective teamwork (Salas - Cooke - Rosen 2008).

In addition to being able to answer these questions, the types of goals a team comes up with will likely affect how well the collaboration goes. Although «write a paper together and get it published» is a common goal for academic collaborations, the success of the research project may depend on having a compelling goal. Is the research question challenging and (by academic standards) somewhat consequential (Hackman - Wageman 2004)? And, is the goal focused enough so that researchers are working toward a final product but open-ended enough that researchers have some level of autonomy and can be creative when the need arises (Sawyer 2017: 52)? Interdisciplinary teams need to communicate with one another about the reward systems of their disciplines, as some may place higher values on books than journal articles and may value certain kinds of journals over others.

Agree about Responsibilities

Teams should also be deliberative and explicit about what each researcher's responsibilities are, rather than assuming everyone knows what to do (Edmonson 2014). While scholars of organizations have noted that external factors often dictate how well an organization (or group) does, individual interventions, especially by team leaders, can lead to more effective team performance (Hackman - Wageman 2004). First, teams should decide whether one person will be identified as the «leader» of the project, ultimately responsible for taking major decisions (after consulting with the team) or whether leadership responsibilities will be rotated. In either case, a leader can do many things that can increase effectiveness, including 1) ensuring that the research team comprises individuals with complementary skills, 2) designing tasks that give everyone enough autonomy to make their contributions personally fulfilling, and 3) establishing norms of how group members will interact (*ibidem*).

In collaborative work, different individuals will most likely be responsible for various aspects of the project. Teams (especially their leaders) should make each researcher's responsibilities explicit, rather than assuming they know what is expected of them. Specifying researchers' responsibilities does not necessarily mean giving everyone on the team an equal share of the work or a role that's interchangeable; rather, it means identifying each team member's competencies, clarifying what that member will do to move the project forward, and making sure everyone on the team knows the others' roles (Bronson - Merryman 2013: 204-205; Driskell et al. 2017; Salas et al. 2008). Leaders will need to ensure that some members are not trying to personally benefit by withholding privately-held information needed by the rest of the team (Edmonson 2014).

Enforce Deadlines and Give/Receive Timely Feedback

Failure to meet deadlines often sinks collaborative relationships. However, failure to even set deadlines is probably a bigger headache. Without deadlines, members have

no way of holding one another accountable for holding up their end of the relationship, as a member can always say that they're not quite finished yet or they will have their part done «soon». We noted that collaborative work brings with it the advantages of a division of labor and multiple sources of knowledge and support with respect to project tasks. To receive the benefits of collaborating with people who have complementary skills, team members must be ready to comment in a timely fashion on intermediate products produced by others. This is something that effective team leadership can help facilitate, in two ways. First, team leaders can make sure that all researchers on the team are kept in the loop about how the project is going (Hackman - Wageman 2004). And second, leaders can try to encourage everyone on the research team (and model ways) to provide good, timely feedback. This can be done by scheduling regular feedback sessions (Sawyer 2017: 61).

Use Coordination Mechanisms That Facilitate the Collaboration Process

Coordination and communication challenges can hinder the success of collaborative research. Although email and video conferencing services such as Skype have become ubiquitous, these technologies do not necessarily ensure that collaboration is successful. For example, while email and video conferencing allow researchers to communicate more easily, these kinds of tools may not be the best for task coordination, information sharing, and intra-project learning (Cummings - Kiesler 2005). One of the main challenges for teamwork is juggling multiple and simultaneous work tasks (Salas et al. 2008). Researchers, therefore, should use tools that help them manage these multiple tasks, allowing them to always know what's expected of them and see changes to the project almost instantaneously. There is now a plethora of programs and software that allow for this. Our main recommendation is for researchers to start with one that has low start-up cost – both in terms of time and money – and to not be lured by seemingly fancy features, as this can be a time sink. Sometimes, investing in an innovative technology is worth the time, but teams should be deliberate about whether the investment is worth it for their project.

Summary

We have recognized at least four problems as potential barriers to effective collaboration among scholars, and we have also identified strategies for mitigating or eliminating the problems. We noted that at the beginning of a project, face-to-face meetings can establish the ground rules and expectations for all members of the team. For example, the team can agree on what output is expected and who is to take the lead for each of the component pieces being worked on. Free riding, shirking, and social loafing are much harder when team members agree on responsibilities and create monitoring and enforcement mechanisms. Candid and timely feedback limits the damage that emergent problems can create, but requires strong leadership and commitment by all members to be effective. Finally, as in other collaborative efforts, state-of-the-art coordination and communication technologies can enable effective governance of the relationships.

V - CONCLUSION AND IMPLICATIONS

Classical images often portrayed solo scholars in isolated environments working feverishly on their magnum opus. In the natural sciences, that image was long ago superseded by the emergence of team-based research, and over the past decades, the social sciences have begun to catch up. Most graduate students and junior faculty today do research that requires collaborating with others. Accordingly, scholars need to understand not only the advantages that collaboration brings, but also the potential pitfalls and how they can overcome them. Additionally, organizations and institutions that host and fund social science research need to be aware of what they can do to reward and facilitate collaborative research.

Career Implications for Graduate Students and Junior Faculty

In their graduate training and initial positions in social science departments and research institutes, junior scholars become aware that it is not the number of publications that matters but rather their impact on the field. Authorities who must make judgments about impact increasingly rely less upon what they perceive as the subjective judgments of experts and more on quantitative indicators, such as citation counts. In our review, we have noted that collaboration influences citation counts in several ways. First, co-authored papers are cited more, and second, most of the papers judged to have made extremely important contributions have been co-authored. Thus, junior scholars learn early on that to gain recognition in their fields, they may need to subordinate their individual goals to the needs of the research team, because ultimately, they will gain more than they will from working alone.

We identified at least four advantages to working on collaborative research teams: teams provide myriad learning opportunities, reduce development cycles so that scholars can work on a portfolio of projects, enable specialists to gain from a more complex division of labor, and finally, teams can set up systems of incentives and constraints that enhance motivation and discipline. Given these advantages, it is important that junior scholars begin learning how to collaborate early in their research careers; ideally, they learn this while still in graduate school. Working with mentors who help them learn the tacit knowledge that underlies successful collaboration, junior scholars can also learn to recognize the potential costs of collaboration and how to handle them.

Some of the potential costs are unavoidable, such as decreased productivity and communication and coordination challenges, but others can be avoided with greater mindfulness and robust structures to inhibit or prevent causes such as partner opportunism and conflicts in time horizons along members of the team. If invited to join teams, scholars should investigate the governance structures within which the teams work, such as how credit is allocated and whether opportunities exist for autonomous research within the larger project. Discovering whether their time horizons are compatible with the horizons of team members can be accomplished through early testing, such as seeing whether members honor the deadlines to which they publicly committed. Our review of strategies for structuring and managing collaborative relationships strongly implies that scholars need not accept suboptimal patterns of collaboration.

They should familiarize themselves not only with the advantages and disadvantages, but also with effective strategies for enhancing the gains that should follow from working with others.

Organizational and Field Level Implications

Almost all social science research takes place within an institutional context and thus we turn now to several ways in which that context could be designed to improve the prospects for effective collaboration. First, organizations and institutions should ensure that their reward systems create incentives for collaboration and do not penalize it. Explicit policies should indicate how credit is to be allocated when co-authored papers are assessed, and mechanisms should be in place to prevent the exploitation of junior scholars when they work with senior scholars. Assessment policies should also make clear the extent to which junior scholars are expected to produce «solo» work. In the global environment for research we have described, in which the bulk of published papers and the most highly cited papers are co-authored, it seems incredibly shortsighted for departments and institutions to push junior scholars to «prove» their scholarly worth by going it alone.

Second, organizations and institutions should enable and facilitate collaborative research by ensuring that their infrastructure and resource allocation systems recognize the value of collaborative work. In the private sector, the last decade has seen the growth of incredibly sophisticated internal communication systems that enable large team-based projects to collaborate across vast distances and unit boundaries. By contrast, universities still seem to be in the dark ages when it comes to communication technologies. Finally, facilitating collective action means funding the resources for public goods projects that cannot be funded by individual scholars. For example, workshops and conferences to develop and disseminate new work are not always supported by research grants, especially in their early days. Departments and institutions could provide funding to support such collective-good activities that benefit teams of scholars.

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