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Good Partners are Hard to Find: The Search for and Selection of Collaborators in the Health Sciences

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Abstract

Choosing the most appropriate collaborators is becoming increasingly crucial to biomedical research as many research questions evolve into complex and multidisciplinary projects. Despite a growing emphasis on translational and interdisciplinary research, little is known about how biomedical researchers form collaborations. We conducted 27 semistructured interviews with scientists from the University of Pittsburgh, used grounded theory methodology to identify major themes, and compared these themes to the literature in order to develop a model of how biomedical researchers establish collaborations. We identify and discuss four major aspects of collaboration: motivation for collaboration, evaluation of prospective collaboration partners, search and selection, and barriers to collaboration formation.

1. Introduction

The trend towards specialization in science drives an increasing degree of interdisciplinarity because the combination of knowledge from different fields is necessary to cope with complex scientific problems [1,2]. One indication of that trend is the exponential increase of the terms "interdisciplinarity" and "multidisciplinary" in the titles covered by Science Citation Index [3]. Initiatives such as the Roadmap and the Clinical and Translational Science Award (CTSA) program of the National Institutes of Health (NIH) promote increased collaboration in order to accelerate the transfer of research results from basic science to clinical application.

While successful senior researchers are likely to have developed the ability to assemble effective interdisciplinary teams within their chosen problem areas, for junior scientists and researchers seeking to engage new problems and approaches, developing the necessary collaborative relationships can be a daunting challenge. A clear understanding of when and how successful biomedical researchers search for and evaluate potential collaborators is necessary in order to conceive and design informatics tools that facilitate collaboration formation. The research question in this project therefore was: What challenges do researchers face when attempting to form collaborations? This study—an effort in the informatics initiative of the University of Pittsburgh's CTSA award—is a first step towards developing a model for how collaborations in biomedical research are established.

2. Methods

No study so far has focused exclusively on the problems researchers face when forming collaborations in biomedical science. We used an ethnographic approach (i.e., semistructured interviews and grounded theory) to develop an understanding of the problem domain. Grounded theory (GT) [4-6] is not hypothesis-driven, but rather is an inductive attempt to discover the theory implicit in the data. In other words, the theory (or hypothesis) emerges gradually as data and interpretations accumulate [7]. We chose Grounded Theory primarily because it is an inductive methodology that allows us to develop a theoretical account of the general features of collaboration in biomedical science while grounding the account in empirical interview data with biomedical researchers at the same time. Specifically, using theoretical sampling, we could go back to the field to collect more data with researchers to fill in any conceptual gaps in the process of developing emerging categories and themes. While doing analysis, the open and axial coding processes allow us to explore the data without making any prior assumptions about what we might discover.

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We performed 27 semistructured interviews with biomedical researchers purposively sampled from the six health science schools at the University of Pittsburgh (i.e., Graduate School of Public Health, School of Dental Medicine, School of Health and Rehabilitation Sciences, School of Medicine, School of Nursing, School of Pharmacy). The interviews focused on current and previous collaborations, locating collaborators, and solving problems in research. The sample was selected to represent a range of fields (e.g., basic, clinical, translational science) and different seniority levels (e.g., entry-level, senior scientists) (Table 1).

Table 1. Interviewed researcher affiliation, gender, seniority, collaborator count and perceived collaborative load (* "<" = too few; ">" = too many; "=" = just right).

School affiliation	Gender	Seniority	# of Collaborators	Perceived collaborative load*
Medicine	M	Junior	3-4	<
Medicine	F	Junior	4	<
Medicine	M	Senior	4	<
Medicine	F	Junior	7	<
Dental	M	Junior	7	<
Rehabilitation	M	Senior	9	<
Public Health	F	Junior	10	<
Pharmacy	F	Junior	25	<
Pharmacy	M	Junior	6	=
Medicine	M	Senior	6-8	=
Medicine	F	Junior	8	=
Nursing	F	Junior	8	=
Rehabilitation	M	Senior	8	=
Pharmacy	M	Junior	9	=
Pharmacy	M	Senior	9	=
Medicine	M	Junior	10	=
Medicine	M	Senior	10	=
Dental	M	Senior	15	=
Nursing	F	Junior	20	=
Medicine	F	Junior	20	=
Public Health	M	Senior	30	=
Rehabilitation	M	Junior	30-50	=
Public Health	M	Senior	16-20	>
Medicine	M	Senior	24	>
Public Health	F	Senior	40	>
Public Health	M	Senior	7	n/a
Dental	M	Senior	15	n/a

Four faculty researchers and one staff member conducted the interviews individually in informal contexts (e.g., in the cafeteria over lunch). The interviews were only partially structured to allow for flexible exploration of the topics. The interviews were conducted in an "ethnographic spirit" where the interviewer is a conversational participant focusing each session on gleaning insights into important aspects of collaboration formation [8]. Transcripts were prepared immediately after the conclusion of the interviews.

The authors subsequently annotated all transcripts with memos, i.e., notes identifying initial hypotheses, theories and questions [7]. Following Glaser [9] and Dick [7], we searched for and reviewed relevant literature as themes emerged. Our aim was to compare the existing literature about the formation of collaborations to the themes in order to identify promising theoretical and practical questions. Then, one researcher [HS] reviewed all transcript-memo pairs, extracted all memos, and organized them by common themes related to the research questions. The themes were reviewed by all three authors.

Interview data collection was ended when the incremental contribution of additional interviews for identification of new themes was determined to be low.

In addition to data generated by GT, we summarized salient variables describing study participants, such as demographics, position, and perceived collaborative load (Table 1).

3. Results

Table 1 describes the study participants. The self-reported number of collaborators is influenced by what an interviewee considered as a collaborator. However, collaboration is ill-defined not only in the interviewees minds but also in the literature [2]. For instance, the line between collaboration and mentoring is blurred because sometimes mentoring is not considered as a form of collaboration, but rather as a social relationship of an apprenticeship [10-12].

3.1. Motivation

What motivations alter the likelihood that researchers will actively look for collaborators? In general, researchers try to manage "collaborative load" balancing individual and collaborative work. Motivating factors that emerged from our data are:

- **seniority:** Junior researchers are more likely to actively look for collaborators.
- **collaborative needs:** Researchers actively seek (or stop seeking) collaborators to balance the costs and benefits for collaboration.
- **research direction:** A change often requires finding new collaborators.
- **diversification:** A researcher's perceived need to broaden a research portfolio triggers search for diverse collaborators.
- **suggestions by third party:** A funding agency may suggest a collaboration.

- **lack of local researchers:** Lack of availability increases the likelihood for an active search for external collaborators.
- **expertise acquisition:** A researcher may look for particular skills, knowledge or methods.

These motivations are consistent with the literature and its emphasis on the importance of seniority, personal social networks, and the influence of funding agencies in collaboration formation [2,13,14].

3.2. Evaluation

Researchers evaluate potential collaborators using various criteria which they use as predictors for success:

- **publications:** The track record of prospective collaborator is an indicator of credibility.
- **provisions:** Collaboration formation is constrained by one partner with conditions, e.g., co-authorship, access to equipment/subjects.
- **unique traits:** Competitive advantage is gained by acquiring hard to find skills/methods/etc.
- **complementarity:** Complementary, but not similar, skills are a basis for collaboration.
- **division of labor:** Anticipated task distribution between the collaborators supports collaboration.
- **proximity:** Collaboration is more likely with local researchers.
- **competition vs. cooperation:** Competing researchers can become collaborative partners when it is mutually advantageous.
- **work styles and personalities:** A match in personal style is crucial for successful collaborations.
- **accessibility:** The perceived likelihood of a potential collaborator responding affects the efforts to form a collaboration.

Other studies support our findings about how prospective collaborative partners are being evaluated, including aspects of the "complementarity" [15], division of labor [2,12], work style and personality overlap [15], collaborative strategies [16], role of publishing [2], and physical proximity [15]. Others support that researchers trust personal recommendations when assessing compatibility with potential collaborators [13,17]. Our findings indicate that different collaboration types require different evaluation criteria, e.g., a collaboration based on sharing physical resources is less likely to be constrained by work style compatibility [2,13].

3.3. Search and Selection

The researchers who were interviewed used various strategies to approach potential partners, make themselves available as collaborators, and facilitate the first encounter with a prospective collaborator:

- **existing social connections:** Established researchers use their social network.
- **"hub" people:** Deans, administrator, former mentors often facilitate new collaborations.
- **physical proximity:** Opportunity for low risk or informal encounters—"bumping into people"—was important.
- **common activities:** Serving on PhD and research committees to meet other faculty was useful.
- **making oneself available:** "Having lunch in the hallway" to meet potential partners was helpful.
- **informal social interactions:** Social meetings often preceded collaboration.
- **search locally:** Searching bibliographical databases with geographic constraints allowed local collaborators to be identified.
- **published work:** Discussing an existing publication served as an enabling structure to provide a basis for interaction.
- **low-cost personal contacts:** Other contacts made during formal organized networking activities—conferences, journal clubs, etc.—were important.
- **common personal friend:** Researchers avoid potential rejection by contacting through a friend.
- **serendipitous nature of information:** Some researchers combine existing knowledge with information obtained serendipitously.
- **face-saving attempts during first encounter:** Some researchers fear showing a lack of knowledge, and may check out other resources in order to phrase questions properly.
- **direct vs. indirect contact methods:** Personal office visits were more successful than unsolicited email or cold calls.
- **job interview:** The intensive experience of a personal interview can be a source for collaborators.
- **"luring":** Some scientists offered incentives such as co-authorship for collaboration.

Feld supports our finding that shared activities can provide the basis for social network formation [18,19]. Professional conferences can create increased visibility and credibility for researchers serving as basis for per-

sonal interaction [2,13,15,20]. Katz found that students often retain close relationships with their mentors [2]. Several studies stress the importance of personal contacts over email or phone calls [15,21-23].

3.4. Barriers

Our interviewees indicated a variety of barriers to the formation of collaborations:

- **lack of situational awareness:** Not knowing what is going on, especially as a newcomer to an organization is problematic.
- **limited transactive memory:** Not knowing what other people know makes collaboration difficult.
- **undersized social network:** Short tenure in organization is a problem.
- **lack of physical proximity:** Opportunities are missed for low-cost personal contacts.
- **not getting access:** There is competition for people's time and attention.
- **social overload:** Senior researchers often decline attempts for collaboration.
- **status differences:** Junior scientists find their lower status a concern.
- **lack of mutual advantage:** Collaborations need to be win-win situations.
- **interferences with research:** External activities such as clinical duties may reduce collaborative opportunities.
- **low quality of electronic databases:** Published or web-accessible profiles may be incomplete or out of date.
- **little terminology knowledge:** Use of wrong terms to search for collaborators outside one's own field may hamper the process.

Hollingshead argues that transactive memory is an important part of work relationships [24]. Others indicate that researcher profiles that are missing publications or out-of-date are not helpful to researchers looking for collaborators [25-27]. Researchers need to be able effectively to search for collaborators in domains outside their own [27,28].

4. Discussion

The formation of collaborations is a complex activity with many dimensions that we characterized with four themes. The first theme, motivation for collaboration, describes variables related to the likelihood that a researcher is actively looking for collaborators. Collaboration seekers, for the most part, have no way of predicting the desire for collaboration of potential partners. While a collaboration seeker can use publications to assess research interest, she or he can not evaluate the current collaborative load or detect changes in research direction not yet reflected in publications of a prospective partner. Current expertise location systems emphasize overlap in research interest, without providing "status indicators" in researchers' profiles that signal their current desire for new collaborators or the types of collaborations that would appeal to them. Thus, collaboration seekers are confronted with potential rejection despite their best efforts to find a partner.

The second theme, evaluation criteria for prospective collaboration partners, describes variables used by researchers to determine the likelihood of successful collaboration formation. Some of the more salient variables can be easily obtained, such as the publication record of a prospective partner; others can be negotiated in a straight forward way, such as co-authorship or access to equipment. However, variables like work style and personality, which played a big role for our interviewees, are more difficult to assess. Social contacts, such as a common friend or colleague, can address this need by providing a recommendation that both partners can trust. Identification of trusted third-party social contacts is currently not well supported in the biomedical research realm, but may be enabled by networking sites, e.g., LinkedIn (www.linkedin.com/).

The third theme, search and selection, describes how researchers search for, select, and facilitate first encounters with prospective collaborators. Social networks in the form of personal friends, former mentors, or administrators are crucial for collaboration formation. While the published work can identify common interests, the "mating dance" between collaborators includes many other aspects, such as awareness, trust, incentives, and fear of showing a lack of knowledge. Practices such as informal social contacts, contacts through a common friend, personal office visits, and shared professional activities all address, in some way, these issues. However, currently little work is being done to exploit information technology to facilitate the early phases of collaboration formation.

The fourth theme, barriers to collaboration formation, identifies variables that hamper collaboration. Junior researchers and newcomers are faced with many barriers because they lack situational awareness and have a small transactive memory. These barriers are compounded when they try to establish collaboration with senior researchers who face social overload. Some of the identified barriers, such as out-of-date electronic profiles, can be addressed by an or-

ganization. There are, however, few mechanisms in place to help researchers develop their understanding of the "lay of the land" with regard to collaboration within the complex environment of the health science research institutions.

Our interviews were conducted among biomedical scientists. Therefore, claims of generalizability are difficult to make, especially given the specific history, culture and structure of the biomedical research enterprise in the US. For instance, federal funding agencies, such as the NIH, play a very prominent role in shaping researcher behavior and priorities. (The current trend towards multidisciplinary research is an example.) Second, non-research oriented organizations, such as for-profit hospital systems, function both as data providers and employers of some researchers. This circumstance can influence collaborative behavior, for instance when the organization attempts to preserve its competitive advantage through policies limiting collaboration. Clearly, the history and tradition of collaborative work in a discipline can influence individual behavior. As a recent book suggests [29], some research areas, such as high-energy physics and astronomy, have a much stronger tradition of collaboration and data sharing than other fields. While the four aspects of collaboration articulated in this paper may be seen as a viable starting point to evaluate how the formation of collaborations can be supported, additional work is needed to understand the degree to which they can be generalized.

5. Conclusion

Knowing how to fund, manage, facilitate, and conduct collaborative research will become core scientific and policy competencies in the future [30]. By identifying motivations, criteria, practices, and challenges, this study make an important contribution to our understanding of how researchers operate in today's multidisciplinary research environment. These findings will help to formulate requirements for systems supporting collaboration seeking and expertise location. They also suggests that electronic systems for supporting research, and specifically those for facilitating collaboration formation, can and will become increasingly important in the future.

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