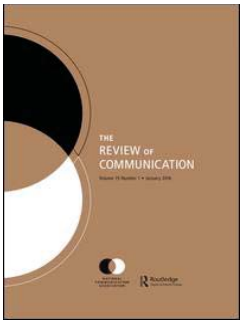

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Is there a role for communication studies in translational research?

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ABSTRACT

As a concept and as a form of practice in the biomedical sciences, "translational research" is both everywhere and yet nowhere, and the challenges to translational success are significant. This essay introduces the notion of translational research in its contemporary sociopolitical context and proceeds to identify problems of communication at the core of translational research. Widely discussed and yet poorly understood, even by those who conduct it, translational research would benefit from the sustained attention of scholars working at the intersection of medical/health humanities and health communication studies.

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The phrase "translational research" resonates from the halls of government through the bureaucracies of funding agencies and into biomedical laboratories everywhere. The putative practice of translational research is meant to occupy the contested space within which "biomedicine"—the juxtaposition of the biological (bench) and medical (bedside) domains—is undertaken. For the purposes of this essay, the terms "translational research" and "translational biomedicine" will be used interchangeably to refer to the quest to develop effective clinical treatments from research findings at the laboratory bench. Over the past 20 years, translational research has gained a strong foothold in the rhetoric, praxis, and funding of biomedical research. While "it seems important to almost everyone," Steven H. Woolf has aptly observed that "translational research means different things to different people."[1] Everybody wants "results" from translational medicine—mainly treatments and ideally cures for diseases. Accordingly, we are witnessing some fascinating new dynamics in the relationship between science and society, and between scientists and citizens: a new social contract is emerging for how medical science works in the contemporary world.[2]

Medical scientists, whether they like it or not, must promise specific results early in the research process, must produce results sooner and not later, and must promote their results so as to assist in the "translation" of basic research into potentially clinically relevant outcomes (so-called T1 translation). Simultaneously, front-line healthcare professionals are entreated to help "translate" results not only from the bench to the bedside (T2 translation to patients), but also to develop and abide by evidence-based guidelines and so move "from the bench to the bedside to el barrio" (T3 translation to practice),[3] whereby practice-based research helps integrate new evidence into routine clinical care.[4]

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Biomedical researchers' energy and attention are primarily focused on T1 translation. Enormous sums of public monies flow into basic science laboratories. In the United States, as elsewhere, legislators want to see a return on investments, and so the intra- and extramural programs of the funding agencies demand translational research. Medical research philanthropies and private companies and patient advocacy groups also want results, and so they, too, demand translational research. Of course, the very idea of translating research results into clinical applications is not a new one; indeed, it may be coextensive with the history of medical research. But it is increasingly recognized that translation is neither easy nor inevitable, that the tangible results of biomedical research are difficult to discern, and yet that results are critically important in order to justify continued investment in research. Moreover, we have as yet no agreed-upon way of tracking what is supposed to count as translational research, or even whether translational research is successful—not least because there is no firm agreement on the nature, scope, and outcomes of translational research.[5]

In this essay, I explore ways in which interdisciplinary communication scholarship may help us to understand translational research more deeply and systematically, and perhaps even aid us in reducing the translational gap in biomedical research. The interdisciplinary scholarship I have in mind combines the rich suite of methods used in communication studies with the analytical work of humanities—especially narrative, history and philosophy of science and medicine, and ethics. This combination is essential to realizing our translational ambitions. Consider this an essay in the philosophy of medicine designed to surface new issues for conceptual, empirical, and ethical exploration where health humanities meets health communication studies in the realm of translational biomedicine.

Translational research in sociopolitical context

Biomedical research and development (R&D) are a hugely expensive undertaking. In the United States, the National Institutes of Health (NIH) spend over U.S.$30 billion annually on biomedical R&D, while the pharmaceutical industry spends another U.S.$45B on R&D. The bulk of the private investment in biomedical R&D is actually in development, while the reverse is true of the public (NIH) investment.[6] What, exactly, does this funding—whether private or public—generate as a result?[7]

Well, that is not entirely clear. Metrics matter. The investments yield lots of publications and new grant submissions, to be sure. What else? As many scholars and commentators have noted, we are not seeing the kinds of translational leaps that have been envisioned; we are not seeing massive therapeutic breakthroughs; we are not seeing qualitatively new drugs or other therapies correlative with focused funding and funding increases.[8] We are, however, seeing new and renewed promises that success is imminent—and new and renewed doubts about that putative success.[9]

In the United States, at least, politicians have long threatened to limit or redirect research funding. From 1975, when Democratic Senator William Proxmire began to issue monthly "Golden Fleece" awards for instances of government funding that he deemed inappropriate or excessively expensive, the first of which went to the National Science Foundation (NSF) "for squandering $84,000 to try to find out why people fall in love";[10] through 1993, when Congress passed the *Government Performance and Results Act* (which remains in effect) requiring federal agencies to articulate—and

measure—how funding allocations would lead to "results";[11] and into the present, whereby Tea Party politicking demands small government and off-loading of heretofore public investments to the private sector. In 2010, then incoming Republican Majority Whip Eric Cantor, crowd-sourced the retrospective review of NSF-funded grants to Tea Party constituents via his *YouCut* Program, instructing them to search the NSF awards database for grants that waste taxpayer dollars and to report them to Washington.[12] Threats to the public support of research, in the context of these kinds of considerations, amount to demands for results, and now, or else.

Scientists have by and large responded either favorably or, effectively, neutrally to these demands; that is, they have either welcomed or merely accepted them as the way science funding works now and for the foreseeable future. Playing the new funding game, whether in earnest or resignedly or as a last resort, has become a matter of course, such that scientists increasingly (are compelled to) promise cures or treatments or other kinds of breakthrough discoveries, and funding agencies increasingly (are compelled to) support translational research initiatives.[13]

Within privately funded biomedical R&D, corporations and trade groups emphasize the need for results, and work to overcome regulatory and funding obstacles that they see as limiting the potential for research to be translated into innovations that matter in the world. The world's largest biotechnology trade association, BIO, recently changed its name from the Biotechnology Industry Organization to the Biotechnology Innovation Organization. The CEO and President of BIO emphasized that its "members are some of the most innovative people on the planet. Biotech companies and research institutions are filled with scientists and entrepreneurs who 'see' a different future. And then they innovate to change the course of history."[14] That is, innovation is bound up with translation into real-world solutions.

Within the domain of publicly funded biomedical research, the most notable examples of translational research initiatives are the NIH's Roadmap Initiative[15] and commitment to "re-engineer" the research enterprise via the Clinical and Translational Science Awards (CTSAs) program and the National Center for Advancing Translational Sciences established in 2011. These initiatives target the infrastructural and human capital dimensions of translation—that is, they target the so-called pathway or pipeline from bench to bedside (to practice).

A 2010 article in *Newsweek* proclaimed that "the road from promising scientific breakthrough to real-world remedy has become all but a dead end."[16] The authors continued:

> There is very little downside, for a president or Congress, in appeasing patient-advocacy groups as well as voters by supporting biomedical research. But judging by the only criterion that matters to patients and taxpayers—not how many interesting discoveries about cells or genes or synapses have been made, but how many treatments for diseases the money has bought—the return on investment to the American taxpayer has been approximately as satisfying as the AIG bailout.

There are a number of posited reasons for this state of affairs, including the possibility that we simply do not have the appropriate infrastructure to capitalize on basic discoveries in the laboratories—the ones that lead to publications in *Cell*, *Nature*, and *Science*—and so promising discoveries languish in "the valley of death"[17] between academic laboratory and hospital or clinic. Hence the global emphasis on translational medicine, whereby it

is assumed that academic laboratory findings are indeed remarkably promising, and so we need to accelerate their translation by focusing on the arrows from bench to bedside and back again.

Translational research as an architectural problem

If we locate the problem of translation in the mechanisms whereby laboratory findings are made to matter in the real world, then we enhance translation from bench to bedside back to bench and back to bedside by creating integrated clinician–scientist training programs, focused academic centers, academically supported incubators for spin-off companies, and comprehensive political lobbying efforts. That is, we reduce the problem of translation to one of architecture (within an appropriately permissive regulatory environment, of course): (bench) researchers need to be able to talk to (bedside) clinicians to understand clinical phenomenology, identify research needs, and create and test meaningful patient-centered therapeutics that can be refined and improved until (and after) regulatory approval, and we can facilitate these communicative dynamics via laboratory and curricular architecture. This is a nice story; and, to be sure, this is an area in which social scientists, including communication scholars, could find a lifetime of research projects and interventions.[18]

But it is worth complicating this simple story. In their review of the then-extant literature on the challenges of translational research, Caren Heller and Inmaculada de Melo-Martín categorized the challenges as involving research workforce, research operations, and organizational silos. They then explored the first 12 CTSAs funded by the NIH, mapping the content of the successful CTSA proposals against the three sets of challenges. Their analysis confirmed that while the funded CTSAs addressed the first two sets of challenges (workforce issues and operational concerns), the CTSAs failed to respond adequately to the challenges of organizational silos; chief amongst these are the "lack of communication, coordination, and connection between basic scientist and clinical investigator" and the "lack of systematic implementation of interdisciplinary centers by universities."[19]

Most of the initial CTSA proposals recognized the need to augment interdisciplinary collaboration and interprofessional communication; to be fair, by now, most of the CTSAs have resulted in large interdisciplinary Clinical and Translational Science Centers (CTSCs) designed to facilitate communication, connection, and collaboration between clinician and scientist.[20] But there are at least two outstanding problems in this space that have yet to receive comprehensive attention: communication, connection, and collaboration between scientists themselves, and communication, connection, and collaboration between scientists, clinicians, and patients/publics.

Metaphor as obstacle: the translational pipeline

The notion or metaphor of a pipeline is especially prominent in the discourse of translational research. Figures representing the translational enterprise often depict a more or less linear pathway or pipeline from bench to bedside.[21] In many cases, the pathway is bidirectional, with arrows between bench and bedside pointing in both directions, as insight from clinical studies (Phase I through Phase IV) may need to feed back into the lab to

refine or refocus therapeutic strategies. Even so, some unidirectional pipelines persist in the literature. Consider Carl Kieburtz and C. Warren Olanow's description of the trajectory of "translational experimental therapeutics" as a one-way pathway from *in vitro* and *in vivo* experiments through animal experiments and drug activity studies, to an Investigational New Drug application to the U.S. Food and Drug Administration, which leads to clinical studies from Phase I (initial human studies) through Phase IV (postmarketing surveillance).[22] In their narrative accompanying this table, Kieburtz and Olanow note that failures can happen at any point in the trajectory, and this might lead us back to the drawing board; otherwise, the process is fairly straightforward.

Kieburtz and Olanow's depiction of the pipeline is actually quite a detailed account of their conception of the trajectory from the laboratory to the clinic (T1) and beyond (T2, T3). It is evident that this pathway is truncated, in that both T2 and T3 translation are left out of the picture. While there is significant ongoing research in regard to T2 and T3 translation qua "knowledge translation" and "knowledge integration,"[23] especially in regard to the development—and, just as importantly, the adoption[24]—of evidence-based guidelines, this whole domain is fraught with uncertainty. But Kieburtz and Olanow (and many other commentators) neglect T2 and T3 altogether. Ignoring the complexities of T2 and T3 translation may be justifiable, at least if we are willing to appreciate the complexities of T1 translation. But in the current sociopolitical climate, the complexities of T1 translation are either downplayed or simply elided. And so while successful instances of T1 translation are few and far between, public and private investment in this domain continues to grow.[25]

Those who depict translational research as a pipeline from bench to bedside invoke infrastructural (architectural) problems. These may be primarily internal (such as a leak in the pipeline causing attrition) or primarily external (such as a regulatory bottleneck). And so the bulk of reactions to difficulties in translational research address either or both of these sorts of problems. But sealing leaks and alleviating regulatory bottlenecks, while they may repair the translational infrastructure, may not by themselves solve the challenge of translation. For the challenge of translation may be more fundamental, requiring more elaborate interventions.

Consider the chief task of a pipeline: to facilitate transportation of some substance from one end to the other. Within the metaphor of the translational pipeline, at least with regard to T1 translation, this "substance" is preclinical data, the starting point is the bench, and the endpoint is the bedside. Now picture a robust infrastructure for translation—a smooth, level, well-lubricated pipeline with no leaks, no blockages, and no bottlenecks. With this phantasm in mind, it is nonetheless possible to imagine a variety of challenges to the realization of the pipeline's chief task: too little substance to be transported, for instance, or uselessness or toxicity of the substance as it reaches its destination. Moreover, the pipeline may incur operating costs that are not commensurate with the value of the task, and/or the construction of the pipeline may have debilitating opportunity costs. And these challenges might arise under the banal circumstances of everyday activity; additionally we might contemplate the prospect of unforeseen catastrophic events besetting the pipeline.

Any number of these challenges may in fact be present in the domain of translational research in biomedicine. While it is difficult to imagine a dearth of preclinical data as such, we may experience a dearth of relevant and valuable preclinical data warranting moving forward. The data themselves may prove inadequate for translational purposes[26] or, indeed, damaging to the translational enterprise (e.g. negative results that never see the

light of day, and/or biased results, and/or nonreplicable findings). Scientists may fail to communicate even very good data effectively, whether in their own (sub)discipline or beyond. Moreover, the functioning of the pipeline may be too expensive and/or its construction may have delegitimized or even destroyed alternative prospects (such as preventive strategies to keep people healthy in the first place). And the pipeline itself may be besieged by or under threat of acts of political violence, such as funding cuts. But while the challenges are plausible, are they actual? Are these the kinds of substantive problems faced by the translational enterprise, above and beyond and in addition to the infrastructural problems noted above? In a word, yes.

Translational research as a communication problem

I noted above that there are two outstanding problems related to communication, connection, and collaboration between scientists themselves, and between scientists, clinicians, and patients/publics. Think of these as problems affecting the entirety of the pipeline, involving what goes into it (the beginning of T1), what comes out of it (the end of T1 and into T2 and T3), and what happens in between.

Health communication scholars—along with other social scientists, ethicists, and philosophers—are already attending to the output end of the pipeline, especially in regard to how physicians communicate with patients, families, prospective and in-study research participants, and other stakeholders in the clinical research enterprise.[27] One especially important area that appears to have been neglected in the health communication literature, however, is the therapeutic misconception—roughly, a patient's unfounded belief (often based on communications from the enrolling clinician) that enrollment in an early stage clinical trial will improve her or his health.[28] Additionally, as translational promises continue to increase, the prospect for those numerous promises to go unfulfilled is unabated. Health communication scholars could seriously reduce the potential for disappointment by providing health researchers (whether scientists or clinicians) with resources for improving health literacy without overselling clinical and translational science. Moreover, health communication scholars could and should expand their attention to the whole domain of patient advocacy, whether patient self-advocacy or organized patient advocacy (which, alas, may function as a prolific generator of false hopes).[29]

Less attention has been focused at the other end of the pipeline, where barriers of all sorts guard against genuine communication/connection/collaboration (CCC) between bench scientists. Of course, the institutional enactment of translational research emphasizes CCC between bench scientists and clinicians—that is one of the key raisons d'être for CTSCs. But *CCC between bench scientists themselves* is a phenomenon toward which we pay little more than lip-service. Incentives in the academic science community work against CCC; so, too, do institutional structures in those universities still based on a siloed model of organization by disciplinary department. Add to this the complex politics of model organisms and animal models, the persistence of bias throughout the scientific enterprise, as well as the purported and widely touted lack of reproducibility of scientific findings.[30] Together, these factors coproduce a kind of epistemic crisis in contemporary biomedical science.[31]

In order to make good on translational promises, we must attend to what is being pumped through the pipeline in the first place, the source language of translational

research. For if that language is nonsensical, then translation is moot. There are at least two ways in which the source language of translational research (or large chunks thereof) may be nonsensical: the findings themselves may not map on to the real world in any interesting sense, and/or the communication of those findings may require serious enhancement within the scientific community itself. I have addressed the former elsewhere,[32] so it is to the latter possibility that we must turn our attention.

How scientists communicate with each other—within and between laboratories, across disciplinary and institutional boundaries, beyond tribal allegiances to model systems and preferred theories—is the most serious determinant of the success of translational biomedicine. But scientists from different though closely related disciplines often talk past each other, using the same words, perhaps, but meaning very different things. The most well-studied example of this phenomenon is what different scientists mean when they use the word "gene"—and how those senses vary from the many ways in which regular people talk about genes.[33]

Even if scientists are using the same language, they tend to publish only for other scientists in their field—and those fields are becoming increasingly narrow and specialized. At the same time, we have seen a massive growth in numbers of academic publications (8–9% per year[34]), now appearing in an increasing number of scientific specialty (and subspecialty and subsubspecialty) journals. Some commentators worry about a "crisis" in peer review undermining editorial quality control, whether in small open-access journals or the putatively dependable giants.[35] Driving the push for huge numbers of publications (and, potentially, for subpar peer review) is the incentive system in science, namely "publish or perish"—whereby quantity of publications prevails over quality. Except perhaps historically, assessing quality is exceptionally challenging, hence the preference for something more readily measurable. But the mere fact that something is measurable does not make actually measuring it scientifically or socially significant; not at all. So we have a constantly growing literature representing enormous numbers of data points, the quality of which is largely un- or underevaluated during peer review.[36] And we also have evidence that no one is actually *reading* the literature once published[37]—not least because everyone is out to publish! Systemically and systematically changing the ways in which scientists communicate with one another is critical for advancing the translational agenda.

Conclusion

At its root, science is interpretive; the world does not scream out its findings, and certainly not in historical and epistemological context. The history and philosophy of science and the social studies of science make sense of science; they situate scientific research epistemically and socially, reveal assumptions, highlight operative values, identify and sometimes clarify ambiguity, and generally illuminate what is happening and what is at stake in the sciences. Medical humanities scholarship does the same in the realm of medicine. We need more humanities and social sciences in our science labs, from study inception through dissemination and beyond. Infused by these perspectives, communication studies brings the additional capacity for clear, credible, precise analysis and articulation of the legitimacy and limitations of scientific findings in multiple domains. We need ever more of this labor in order to rescue significant science from the cacophonous din of science more broadly, and to realize the human potential of translational research.

Notes

1. Steven H. Woolf, "The Meaning of Translational Research and Why It Matters," *Journal of the American Medical Association* 299, no. 2 (2008): 211.
2. Jane Maienschein et al., "The Ethos and Ethics of Translational Research," *The American Journal of Bioethics* 8, no. 3 (2008): 43–51; Miriam Solomon, *Making Medical Knowledge* (Oxford: Oxford University Press, 2015).
3. Carol R. Horowitz et al., "Community-based Participatory Research from the Margin to the Mainstream: Are Researchers Prepared?" *Circulation* 119, no. 19 (2009): 2364.
4. John M. Westfall, James Mold, and Lyle Fagnan, "Practice-based Research—'Blue highways' on the NIH Roadmap," *Journal of the American Medical Association* 297, no. 4 (2007): 403–6.
5. Maienschein et al., "The Ethos and Ethics of Translational Research."
6. Joseph V. Kennedy, "The Sources and Uses of US Science Funding," *The New Atlantis* Summer (2012): 3–22.
7. Note that calls for genuinely translational research tend to emphasize the importance of public–private (or academic–corporate) research alliances. See Dale Yu, "Translational Research: Current Status, Challenges and Future Strategies," *American Journal of Translational Research* 3, no. 5 (2011): 422–33. It is critical to bear in mind that such ventures can also be sites of ethical turmoil. See Sheldon M. Krimsky, *Science in the Private Interest* (Lanham, MD: Rowman & Littlefield, 2004).
8. See Despina G. Contopoulos-Ioannidis, Evangelia E. Ntzani, and John P. A. Ioannidis, "Translation of Highly Promising Basic Science Research into Clinical Applications," *The American Journal of Medicine* 114, no. 6 (2003): 477–84; John P. A. Ioannidis, "Materializing Research Promises: Opportunities, Priorities and Conflicts in Translational Medicine," *Journal of Translational Medicine* 2, no. 5 (2004), doi:10.1186/1479-5876-2-5 (accessed April 29, 2016); Heidi Hörig, Elizabeth Marincola, and Francesco M. Marincola, "Obstacles and Opportunities in Translational Research," *Nature Medicine* 11 (2005): 705–8; Despina G. Contopoulos-Ioannidis et al., "Life Cycle of Translational Research for Medical Interventions," *Science* 321, no. 5894 (2008): 1298–9; Mary Carmichael, "Why Don't More Medical Discoveries Become Cures?" *Newsweek*, May 14, 2010, http://www.newsweek.com/why-dont-more-medical-discoveries-become-cures-72475; Malcolm R. Macleod et al., "Biomedical Research: Increasing Value, Reducing Waste," *The Lancet* 383, no. 9912 (2014): 101–4.
9. Failures of translation are legion, and some researchers have begun to explore how such failures could illuminate the pathway to more successful ventures in future. This important insight harkens back to philosophical work on false models as a means to better theories. But a lot depends on whether the failures of translation are systematic and predictable rather than idiosyncratic. See John P. A. Ioannidis, "Translational Research May Be Most Successful When It Fails," *Hastings Center Report* 45, no. 2 (2015): 39–40; Alex John London and Jonathan Kimmelman, "Why Clinical Translation Cannot Succeed Without Failure," *eLife* 4 (2015), doi:10.7554/eLife.12844 (accessed April 29, 2016); William C. Wimsatt, "False Models as Means to Truer Theories," in *Neutral Models in Biology*, ed. Antoni Hoffman (Oxford: Oxford University Press, 1987), 23–55.
10. William Proxmire, "Turning Points in Wisconsin History: Sen. William Proxmire Uncovers Wasteful Government Spending, 1975–1987," *Wisconsin Historical Society*, http://www.wisconsinhistory.org/turningpoints/search.asp?id=1742.
11. "Government Performance and Results Act of 2003," https://www.gpo.gov/fdsys/pkg/STATUTE-107/pdf/STATUTE-107-Pg285.pdf; "GPRA Modernization Act of 2010," https://www.gpo.gov/fdsys/pkg/PLAW-111publ352/pdf/PLAW-111publ352.pdf.
12. Brandon Keim, "Republican Congressmen Crowdsource Attack on Science," *Wired.com*, December 7, 2010, http://www.wired.com/2010/12/nsf-youcut-review/.
13. See J. M. Ladd et al., "The 'How' and 'Whys' of Research: Life Scientists' Views of Accountability," *Journal of Medical Ethics* 35, no. 12 (2009): 762–7. At the US National Science Foundation (NSF), the emphasis has been on "transformative research," as the scope of the NSF's fields falls well beyond the usual domains in which "translation" might happen

(http://www.nsf.gov/about/transformative_research/). Of course, "transformative research" is a notion as ripe for analysis as "translational research."

14. Business Wire, "Organization Will Still Use BIO Name," *Business Wire*, January 4, 2016, http://www.businesswire.com/news/home/20160104006245/en/Biotechnology-Industry-Organization-Biotechnology-Innovation-Organization.
15. See Woolf, "The Meaning of Translational Research"; Maienschein et al., "Ethos and Ethics"; Nancy S. Sung et al., "Central Challenges Facing the National Clinical Research Enterprise," *Journal of the American Medical Association* 289, no. 10 (2003): 1278–87; Elias A. Zerhouni, "Translational and Clinical Science—Time for a New Vision," *New England Journal of Medicine* 353 (2005): 1621–3.
16. Carmichael, "Why Don't More Medical Discoveries Become Cures?"
17. Declan Butler, "Translational Research: Crossing the Valley of Death," *Nature* 453 (2008): 840–2; see also Carmichael, "Why Don't More Medical Discoveries Become Cures?"
18. See Steven P. Wainwright et al., "From Bench to Bedside? Biomedical Scientists' Expectations of Stem Cell Science as a Future Therapy for Diabetes," *Social Science & Medicine* 63, no. 8 (2006): 2052–64; Caren Heller and Inmaculada de Melo-Martín, "Clinical and Translational Science Awards: Can They Increase the Efficiency and the Speed of Clinical and Translational Research?" *Academic Medicine* 84, no. 4 (2009): 424–32; Bryn Lander and Janet Atkinson-Grosjean, "Translational Science and the Hidden Research System in Universities and Academic Hospitals: A Case Study," *Social Science & Medicine* 72, no. 4 (2011): 537–44; Myfanwy Morgan, et al., "Implementing 'Translational' Biomedical Research: Convergence and Divergence Among Clinical and Basic Scientists," *Social Science & Medicine* 73, no. 7 (2011): 945–52. Of especial interest is the need to unpack the cognitive, linguistic, and praxis aspects of the clinician–investigator: the MD/PhD who inhabits both worlds (bedside and bench), speaks both languages (clinical and biological-biomedical-preclinical), and for whom translation is a mode of being—putatively.
19. Heller and de Melo-Martín, "Clinical and Translational Science Awards," 425.
20. Whether these Centers *work* is a difficult and complex question to address, not least because the metrics of success are unclear.
21. In addition to many of the hundreds of images revealed by a Google image search on "translational research," see also the Figure in Westfall, Mold, and Fagnan, "Practice-based Research," 405; and Table 1 in Carl Kieburtz and C. Warren Olanow, "Translational Experimental Therapeutics: The Translation of Laboratory-Based Discovery into Disease-Related Therapy," *Mount Sinai Journal of Medicine* 74, no. 1 (2007): 7–14. Other metaphors have been proposed, such as a translational web emphasizing the dynamic interconnectedness of key elements, but these alternatives have not caught on. See Dwayne D. Kirk and Jason Scott Robert, "Assessing Commercial Feasibility: A Practical and Ethical Prerequisite for Human Clinical Testing," *Accountability in Research* 12, no. 4 (2005): 281–97.
22. Kieburtz and Olanow, "Translational Experimental Therapeutics."
23. See Jonathan Lomas, "Connecting Research and Policy," *Isuma: Canadian Journal of Policy Research* 1 (2000): 140–4; "The In-between World of Knowledge Brokering," *British Medical Journal* 334, no. 7585 (2007): 129–32; John N. Lavis et al., "How Can Research Organizations More Effectively Transfer Research Knowledge to Decision Makers?" *The Milbank Quarterly* 81, no. 2 (2003): 221–48; Jon F. Kerner, "Knowledge Translation Versus Knowledge Integration: A 'Funder's' Perspective," *Journal of Continuing Education in the Health Professions* 26, no. 1 (2006): 72–80.
24. McDonnell Social Norms Group, "Enhancing the Use of Clinical Guidelines: A Social Norms Perspective," *Journal of the American College of Surgeons* 202, no. 5 (2006): 826–36.
25. Of course, health communication scholars should not ignore T2 and T3 translation, ripe as these domains are for conceptual and empirical analysis. See the next section for discussion.
26. For instance, see Jason Scott Robert, "Model Systems in Stem Cell Biology," *BioEssays* 26, no. 9 (2004): 1005–12; "The Comparative Biology of Human Nature," *Philosophical Psychology* 21, no. 3 (2008): 425–36; John P. A. Ioannidis, "Extrapolating from Animals to Humans," *Science Translational Medicine* 4, no. 151 (2012): 1–4; Jessica Bolker, "Model Organisms:

There's More to Life than Rats and Flies," *Nature* 491 (2012): 31–3; Todd M. Preuss and Jason S. Robert, "Animal Models of the Human Brain: Repairing the Paradigm," in *The Cognitive Neurosciences*, 5th ed., ed. Michael S. Gazzaniga and George S. Mangun (Cambridge, MA: MIT Press, 2014), 59–66; Susan Bridgwood Green, "Can Animal Data Translate to Innovations Necessary for a New Era of Patient-Centred and Individualised Healthcare? Bias in Preclinical Animal Research," *BMC Medical Ethics* 16, no. 53 (2015), doi:10.1186/s12910-015-0043-7 (accessed April 29, 2016).

27. Consider Charles Grant III, Kenneth Cissna, and Lawrence Rosenfeld, "Patients' Perceptions of Physicians Communication and Outcomes of the Accrual to Trial Process," *Health Communication* 12, no. 1 (2000): 23–39; Pamela Sankar, "Communication and Miscommunication in Informed Consent to Research," *Medical Anthropology Quarterly* 18, no. 4 (2004): 429–46; Steven Joffe and Franklin G. Miller, "Bench to Bedside: Mapping the Moral Terrain of Clinical Research," *Hastings Center Report* 38, no. 2 (2008): 30–42; Katherine A. McComas et al., "Individuals' Willingness to Talk to Their Doctors About Clinical Trial Enrollment," *Journal of Health Communication* 15, no. 2 (2010): 189–204.
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29. See Laurie T. Martin et al., "Patient Activation and Advocacy: Which Literacy Skills Matter Most?" *Journal of Health Communication* 16, no. 3 (2011): 177–90; Rebecca Kukla, "How Do Patients Know?" *Hastings Center Report* 37, no. 5 (2007): 27–35; Susannah L. Rose, "Patient Advocacy Organizations: Institutional Conflicts of Interest, Trust, and Trustworthiness," *Journal of Law, Medicine, and Ethics* 41, no. 3 (2013): 680–7.
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