The Third Wave in Science and Technology Studies

Future Research Directions on Expertise and Experience

Edited by
David S. Caudill · Shannon N. Conley
Michael E. Gorman · Martin Weinel

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Editors
David S. Caudill
Villanova University
Villanova, PA, USA

Shannon N. Conley
James Madison University
Harrisonburg, VA, USA

Michael E. Gorman
University of Virginia
Charlottesville, VA, USA

Martin Weinel
Cardiff University
Cardiff, UK

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Foreword

I've spent 40 or more years studying the sociology of gravitational waves, culminating in the acclaimed detection of September 14, 2015. For nearly all of that time, gravitational wave detection was an orphan subject thought by most scientists to be a huge waste of money because of the craziness of the ambition and the near impossibility of success. The sweetness of the eventual success was hugely enhanced by this history of scorn.

What we are engaged in here, in this volume, is not the discovery of gravitational waves, but it has in common the initial rejection followed by growing success. The language of the "Third Wave" began in what Rob Evans and I thought was a modest little paper[1] suggesting that a way out of the logical difficulty of making judgments of competence, from within a social constructivist framework, was to turn attention from the construction of truth to the analysis of expertise: the acquisition of expertise could be observed even if truth was always made by competing parties. We worried that the very notion of expertise would disappear if the democratization of science—making the right to take part in the construction of scientific truth open to anyone—continued to proceed inside Science and Technology Studies (STS). We thought people would look at what we had written, say to us, "Interesting paper," and move on. But to our surprise, we were violently attacked for supposedly re-introducing technocracy and reverting to the bad old days of the 1950s in the social analysis of science.

That is where there is common ground with gravitational wave detection—the sense of "outsiderness," which had very palpable consequences, including marginalization and even non-admission to conferences, and rejection of papers and grants, and the need, at one point, to make a collective decision

about whether the professional pressures ought to cause us to abandon the whole thing. On the upside, once the decision to persevere had been made, rejection was energizing, and a whole program has grown out of what would otherwise have been just another paper languishing on a curriculum vitae; instead, that paper has become the second-most cited in the history of the journal, and citations of it together with our book *Rethinking Expertise* (2007) are already well over 4000. The resulting developments include a new understanding of expertise as a social but real, and sometimes ubiquitous, phenomenon; under the SEE (Studies in Expertise and Experience) model, it is no longer hogtied by the criteria of truth and efficacy, and the paradoxes—for example, disagreeing experts and a changing truth—have been dissolved. We have the idea of *interactional expertise*, which seems more and more necessary if the world is to be understood. We have found we can use the Imitation Game to explore these things. And we are learning to unpick the consequences of these things for the understanding and support of democracy. As this history and the contents of this volume make evident, like any good program, this one is still going in unforeseen directions. As with the case of gravitational waves, the pleasure in the growth of these ideas and their diffusion into realms, such as philosophy and psychology, far outside the concerns of STS, is all the greater for that initial negative reaction. My gratitude to the editors and authors of this volume, and my delight and honor at being asked to write this Foreword, is more than I can express.

Cardiff University
Cardiff, UK

Harry Collins

Note

1. "The Third Wave of Science Studies: Studies of Expertise and Experience," *Social Studies of Science* 32, no. 2 (2002): 235–296.

Acknowledgments

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Contents

Notes on Contributors

Justus Bauch is a social scientist who received his bachelor's degree in 2018 from the Humboldt-Universität zu Berlin. The main focus of his research is in the field of identity construction in urban areas. He wrote his bachelor's thesis on "The Influence of the Fascination for Football on the Identity Construction of Fans."

Andrew Berardy is a sustainability scientist and a postdoctoral scholar with the Food Systems Transformation Initiative at Arizona State University. His research evaluates all stages of the life cycle of food and assesses potential alternatives or improvements that reduce vulnerability and improve environmental performance. His previous postdoctoral work was an assessment of agricultural vulnerability in central and southern Arizona in the food-energy-water nexus in response to anticipated effects of climate change and identifying strategies for adaptation. His dissertation included the development of a new expertise assessment method.

Celia Bouali is finishing her master's in Social Sciences at Humboldt-Universität zu Berlin, where she also works as a student assistant at the Berlin Institute for Integration and Migration Research (BIM). In 2017, she won the university's Humboldt Award for her Bachelor of Arts thesis on political struggles of South European migrants in Berlin in the context of EU "migration management." Her peer-reviewed article "Facing Precarious Rights and Resisting EU 'Migration Management': South European Migrant Struggles in Berlin" was published in 2018. Her research interests focus on issues around labor, migration, and racism.

Benjamin D. Bowes is a PhD student in Civil and Environmental Engineering at the University of Virginia School of Engineering and Applied Science. His research focus is on the use of machine-learning techniques with applications in hydrology and water resources management. His areas of interests include groundwater table forecasting, flood modeling, and resilience in coastal cities.

David S. Caudill holds the Arthur M. Goldberg Family Chair in Law at Villanova University Charles Widger School of Law in Villanova, Pennsylvania. He is the author of *No Magic Wand: The Idealization of Science in Law* (with L.H. LaRue, 2006) and *Stories About Science in Law: Literary and Historical Images of Acquired Expertise* (2011), as well as numerous articles and book chapters in the fields of legal ethics, law and science, and expert evidence. He is also a senior fellow at the University of Melbourne in Australia, where he teaches Expert Evidence and Entertainment Law in alternate years. Before joining the faculty at Villanova in 2005, Caudill clerked in the U.S. Fifth Circuit Court of Appeals, practiced for seven years with Gray, Cary (San Diego) and Graves, Dougherty (Austin), and taught for 16 years at Washington and Lee University School of Law.

Harry Collins is Distinguished Research Professor and directs the Centre for the Study of Knowledge, Expertise and Science (KES) at Cardiff University, United Kingdom. He is Fellow of the British Academy and winner of the Bernal prize for social studies of science. His 25 books cover sociology of scientific knowledge, artificial intelligence, the nature of expertise, tacit knowledge, technology in sport, the Imitation Game, sociological methodology, and the relationship of science and politics. He is also interested in fringe science, the philosophy of the collectivity, and the relationship between face-to-face and remote communication.

Shannon N. Conley is Assistant Professor of Integrated Science and Technology at James Madison University, and she is the co-director of the James Madison University STS (Science, Technology, and Society) Futures Lab. Her background in political science focused on political theory, public policy, and science and technology studies. She teaches classes on STS, governance, and ethics as well as co-leading the program's junior capstone sequence. She is a member of the Socio-Technical Integration Research (STIR) project, which embeds social scientists and humanities scholars—"embedded humanists"—in laboratories to explore capacities for responsible

innovation. Much of her research has focused on the governance of biotechnology and the negotiation of expertise within different political and cultural contexts. She also works on topics related to expertise acquisition, such as T-shaped expertise and the development of interactional competence. She uses case studies to understand and develop the notion of anticipatory governance in connection with political theory.

Lara Danyel is an urban planning student at Technische Universität Berlin. In 2017, she received her first bachelor's degree in Social Sciences from Humboldt-Universität zu Berlin. Her research interests include the dynamics of identity construction and symbolic boundary drawing, qualitative fieldwork, and the academic integration of urban sociology and urban planning.

Deepanwita Dasgupta is Assistant Professor of Philosophy at the University of Texas at El Paso. Her research interests focus on the philosophy of science, especially studying science from a cognitive point of view—exploring the mental models and other embodied practices that scientists use to create new concepts. She is greatly interested in the development of science in the early twentieth-century India, and is writing a book that offers a model of science in such peripheral contexts. She is also interested in understanding the nature of the twenty-first-century science and the possible goals of its transnational scientific community.

Darrin Durant is Lecturer in Science and Technology Studies at the University of Melbourne in Australia. He has published widely on how experts and publics can and should relate to each other in democratic societies. Durant's empirical research focuses on controversies involving nuclear waste management, nuclear power, public policy about energy options, and more recently investigations of climate change policymaking and recycling practices.

Robert Evans is Professor of Sociology in the School of Social Sciences at Cardiff University in Wales. He has worked in the field of science and technology studies for over 20 years, with research projects including sustainable energy, medical genetics, and economic forecasting. In addition to the development of the Imitation Game method, he has also published a number of papers and books developing the "Third Wave of Science Studies," including *Rethinking Expertise* (2007) and *Why Democracies Need Science* (2017), both of which were co-authored with Harry Collins.

Kristina D. Fauss is a fourth-year student at the University of Virginia, finishing her degree in Civil Engineering with a minor in Global Sustainability. Her primary interest is the intersection of natural systems, society, and technology, which she has explored through research with the dMIST project and participation in collaborative design-build projects.

Rob Feick is an associate professor in the School of Planning at the University of Waterloo (Ontario, Canada). His research interests center broadly on methods for using geospatial information technology and data to support decision-making and public participation in land management and planning. His research focuses on data quality and uses of citizen science and volunteered geographic information, methods to extract place-based knowledge from geosocial data streams, and spatial multi-criteria analysis.

Erik Fisher is an associate professor in the School for the Future of Innovation in Society and in the Consortium for Science, Policy and Outcomes at Arizona State University. He studies the governance of emerging technologies from lab to legislature, focusing on policies and practices for socio-technical integration. He developed Socio-Technical Integration Research (STIR), an approach for collaboratively enhancing expert capacities to modulate science and innovation practices in light of societal considerations. To date, STIR has been applied in over 50 laboratories and other organizations around the world. Fisher serves as Editor-in-Chief of the *Journal of Responsible Innovation*.

Michael E. Gorman holds a PhD in Social Psychology (University of New Hampshire, 1981) and does research on collaboration among scientists, engineers, social scientists, and ethicists to both solve pressing problems and create new opportunities. He was an NSF program director (2011–2012). He is Full Professor of Science, Technology and Society at the University of Virginia. His most recent book is *Trading zones and interactional expertise: Creating new kinds of collaboration* (2010).

Martin Hall is a software developer with extensive experience of using and creating distributed and network software in research domains. Examples include remote instrumentation for laboratory devices and remote interactive process control. In the Imitation Game project, Hall created multi-user software using network sockets in web-browsers to monitor and control the status of each participant and enable real-time experiments in geographically distinct areas and is keen to extend use and

functionality of this technology. He is working at the University of Winchester, where his role includes data integrations for an attendance-monitoring system.

Nuriani Hamdan is a social scientist with a specialization in social inequality and urban sociology. She studied social sciences at Humboldt-Universität zu Berlin, Sciences Po Paris, and The New School for Social Research, New York. Passionate about qualitative methods as well as postcolonial theories, she aims to look beyond established categories and dichotomies. In her research, she has focused on minorities, particularly Muslim and immigrant groups in the urban context. She is interested in their identity formation, negotiation, and hybridity, especially in the face of experiences of racism and exclusion. Moreover, she is curious about their community organizing and political struggles.

Teresa Hoffmann is a social scientist studying at Humboldt-Universität zu Berlin. She has published on psychosocial influences of soccer on gender in the Palestinian territories in David Becker's book *1:0 für Rafah - Chancen und Herausforderungen psychosozialer Arbeit in Palästina* (2016). She is researching perspectives of German masculinist movements on everyday sexism against women.

Daria Kappel is a social scientist who graduated from Humboldt-Universität zu Berlin in July 2018. She has a special interest in urban studies and qualitative social research and the construction of identities.

Eric B. Kennedy is Assistant Professor of Disaster and Emergency Management in the School of Administrative Studies at York University. His research focuses on understanding and improving decision-making processes within emergency management issues, exploring how these groups handle uncertainty, complex stakeholder relationships, and ever-changing socio-environmental conditions. He works primarily on wildfire management, with secondary emphases on catastrophic flooding, aviation safety, and emergency medical services. He is also the founder and director of the Forum on Science, Policy, and Society, a Canadian not-for-profit organization dedicated to training young leaders to work at the science/policy interface.

Daniel Kubiak is a research associate in the Social Sciences Department at Humboldt-Universität zu Berlin and in his third year of a PhD entitled "Identification and 'Othering' of young East Germans." He has published

peer-reviewed articles on social scientific perspectives on East Germany, analogies of Muslims and East Germans, and the generation of post-reunification children. His co-edited volume (with Sandra Matthäus), *Der Osten: Neue sozialwissenschaftliche Perspektiven auf einen komplexen Gegenstand jenseits von Verurteilung und Verklärung*, was published in 2016.

Ida Lübben holds a master's degree in Ideology and Discourse Analysis from the University of Essex, and a bachelor's degree in Social Sciences from Humboldt-Universität zu Berlin. Her research focuses on gender and queer studies. Her recent work has featured such topics as poststructuralist concepts of the subject, heteronormativity, and feminist truth-telling practices.

Yannik Markhof is a Master of Arts student of social sciences at Humboldt-Universität zu Berlin. His research focuses on gendered collective identities and mechanisms of exclusion in Germany.

Bastian Neuhauser studied social sciences at Humboldt-Universität zu Berlin and holds an undergraduate degree with a thesis on LGBT rights in Israel. He is pursuing a graduate degree in cultural policy at Sciences Po Paris.

Hannah O'Mahoney worked on the Imitation Game project at Cardiff University for the final 18 months of its funded lifespan. She has since left the world of academia and holds the position of research officer within the third sector, working for Tenovus Cancer Care based in Cardiff. She remains an honorary research associate at Cardiff University. Her own research interests include environmentalism, volunteering, employment, and well-being.

Ann Potter is Senior Lecturer in Social Work at Manchester Metropolitan University (UK). Prior to taking up her academic role, Potter spent 19 years in social work practice in local authority children and families teams and as a Children's Guardian in the Family Court. Her teaching and research focus on the interface between social work and law, including the communication and evaluation of professional expertise in the Family Court. Potter has presented her work at international conferences and she has also been a guest lecturer at the Judicial College in England.

Colin Robertson is an associate professor in the Department of Geography and Environmental Studies at Wilfrid Laurier University. His research interests include the development and application of spatial

analysis and GIS methods, and, increasingly, their application in engaging different communities in monitoring and citizen science projects. His research examines how new geospatial data and technologies can be utilized by communities in Northern Canada to monitor and adapt to environmental change.

Philippe Ross is an associate professor in the Department of Communication, University of Ottawa (Canada). Following a long (if not particularly glamorous) career as an actor in commercials, television and film, he completed a PhD in Communications from the London School of Economics (UK). He likes to think of his research as tackling long-standing problems in media studies through an STS epistemology, and he credits Harry Collins, Rob Evans, Martin Weinel, and their Studies in Expertise and Experience (SEE) collaborators for enabling him to do so in new and exciting ways in recent years.

Bafta Sarbo is a graduate student at the Department for Social Sciences at Humboldt-Universität zu Berlin. She is working on a materialist understanding of racism and the relationship between race and class from a Marxist perspective.

Theresa Schilhab is an associate professor at Aarhus University, Denmark. She holds an MSc in Neurobiology, an MA in Philosophy, a PhD in Philosophy of Science and a senior doctorate in Educational Neuroscience (Dr. paed.). Her research interests embrace the effect of direct experiences on conceptualization and "linguification" processes in a neurobiological and evolutionary perspective. The research corroborating her senior doctorate degree was published as *Derived Embodiment in Abstract Language* (2017), and addresses what defines human learning from the neurobiological, embodied approach given that interactional expertise exists. She manages the Nordea-funded project Natural Technology about children learning with technology in nature.

Laura Schlagheck is a social scientist interested in the discursive formation of national collectives and the consequential production of the *other*. She has, among other things, written on the constitution of the male Muslim *other* through processes of racialization, and gender attribution. She is working on the operating principle and function of antisemitism in German society.

Henrik Schultze is a research associate at the Department of Urban and Regional Studies. He is working in the Collaborative Research Centre 1265 "Re-Figuration of Spaces," Subproject "The World Down My Street: Resources and Networks Used by City Dwellers" funded by the *Deutsche Forschungs gemeinschaft* (German Research Foundation). He completed his PhD on "The role of place within constructions of social and spatial belonging" in 2017 and has published some ideas of this work in edited volumes.

Thomas Seager is an associate professor in the School of Sustainable Engineering and the Built Environment at Arizona State University in Tempe Arizona. Seager leads research teams working at the boundaries of engineering and social science to understand innovation for resilient infrastructure systems, the life-cycle environmental consequences of emerging energy technologies, novel approaches to teamwork and communication in socio-technical integrative settings (including serious play) to teach creativity, and systems thinking in engineering education.

Philip Seitz studied social sciences at Humboldt-Universität zu Berlin and graduated with his bachelor's degree in 2017. The main focus of his research is urban sociology and identity construction. He wrote in his bachelor's thesis about the influence of Berlin-associated narratives on the perception and evaluation of social inequality of young people in Berlin.

Leon Spiegelberg is a social scientist and actor. He graduated with his bachelor's degree in 2016 from the Humboldt-Universität zu Berlin. He wrote his bachelor's thesis on "Psychoanalysis as a capitalistic phenomenon and capitalism's schizophrenic potential." He is studying acting at the Ernst Busch Academy of Dramatic Arts in Berlin and will graduate in 2020.

Martin Weinel is a German sociologist and researcher at the Cardiff School of Social Sciences at Cardiff University. In collaboration with others, most notably Harry Collins, Rob Evans, and Nicky Priaulx, he has written on aspects of expertise, science policy, interdisciplinarity, science communication, and the Imitation Game. He is working on two EU-funded projects exploring the use of new technologies in industrial settings.

Aylin Yavaş is working at ufuq.de, an NGO in Berlin, and is studying social sciences at Humboldt-Universität zu Berlin. Her research interests are postcolonial and Islamic feminisms, as well as intersectionality and anti-Muslim racism.

Zihao Zhang is a PhD candidate in the Constructed Environment at the University of Virginia, School of Architecture. His research offers a critical analysis of the entanglement of technology and nature as well as material agency in the cybernetic environment. Rooted in the discipline of landscape architecture, his research explores concepts from cybernetics such as self-organization, feedback, self-reflexivity, coupling, and so on, in contemporary landscape theories and practices, offering a new understanding of how cybernetics is relevant in today's data-driven paradigm.

Rosa Zylka received her bachelor's degree in Social Sciences at the Humboldt-Universität zu Berlin in May 2018. In her bachelor's thesis, she researched "Gender-Based Street Harassment in Berlin" by interviewing women on the streets in Berlin. Her research interest is focused on qualitative fieldwork. In October 2018, Zylka started studying the Master's Program "Sociocultural Studies" at the Europa-Universität Viadrina in Frankfurt (Oder) and intends to research street harassment from further points of view.

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CHAPTER 1

Introduction

David S. Caudill, Shannon N. Conley, Michael E. Gorman, and Martin Weinel

1.1 The Third Wave of Science Studies

Just over 35 years ago, Harry Collins, discussing the "new" sociology of scientific knowledge, expressed his disappointment that although "the field has only begun to fulfil its potential, disagreements are now taking up more space than substantive contributions" (Collins 1983, 265). Indeed, the effort "to explain the content of scientific knowledge as far as possible in social terms" invited disagreement, as did "explanations of the outcomes of [scientific controversies] … by reference to wider social and political

D. S. Caudill (✉)
Villanova University, Villanova, PA, USA
e-mail: caudill@law.villanova.edu

S. N. Conley
James Madison University, Harrisonburg, VA, USA
e-mail: conleysn@jmu.edu

M. E. Gorman
University of Virginia, Charlottesville, VA, USA
e-mail: meg3c@virginia.edu

M. Weinel
Cardiff University, Cardiff, UK
e-mail: WeinelM@Cardiff.ac.uk

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factors" (272, 275). While the social *aspects* of science are hardly in doubt (there are scientific *communities*, experimental *conventions*, identifiable *cultural* values—e.g., honesty—and so forth), the sociology of scientific knowledge (hereinafter, "SSK") was a challenge to traditional notions that the *content* of science should *not* be affected by society and, consequently, that scientific controversies should be settled by Nature. Reflecting that ideal, the mid-twentieth-century sociology of science associated with Robert K. Merton, now called the "first wave" of science studies, assumed that "sociological accounting had to stop at the door of scientific method and scientific knowledge" (Shapin 1995, 294–295). SSK, having opened that door, is often now referred to as the "second wave" of science studies; it is variously characterized as (1) breaking down the distinction between science and society; (2) highlighting the constitutive, and not merely influential, role of "the social" in the production of scientific knowledge (Shapin 1995, 294–295); and (3) developing a less idealized view of science and scientists—the scientific enterprise is part of, and not above, culture.

A feature of the latter ("second wave") development—the argument for a more modest view of science—was the proposal that ordinary citizens could and should play a role in scientific decision-making—for example, an *elite* scientist helping a community suffering from an environmental crisis may not know as much about the problem (and workable solutions) as a local farmer (Wynne 1989). It is this phenomenon—this proposal to increase citizen participation in science—which in large part inspired the so-called Third Wave of science studies—indeed, the Third Wave was a reaction *against* a broad notion of "citizen scientists":

> Though science studies has [shown] that the basis of technical decision-making can and should be widened beyond the core of certified experts, it has failed to [answer the question:] "How far should participation in technical decision-making extend?" In other words, science studies has shown that there is more to scientific and technical expertise than is encompassed in the work of formally accredited scientists and technologists, but it has not told us how much more. (Collins and Evans 2002, 237)

This reaction is relevant in numerous contemporary debates, including concerns about a "post-truth" era, populism, and, for example, anti-vaccine movements. And it is of particular relevance to the ongoing criticism of forensic science in legal settings, as the Third Wave project is in part focused on who should participate in scientific decision-making, which becomes a question of who is a credible trial expert (see Chap. 2 in

this volume). More broadly, who is a credible expert in policy settings that require scientific input (see Chaps. 3 and 4 in this volume)? Briefly, in Third Wave terminology, experts include (1) those who are trained and credentialed in the consensus science of the relevant field, *as well as* (2) those who have sufficient experience (even without formal training) in the field to interact productively with trained experts and thereby contribute to the task at hand. While an "ordinary" citizen has no business influencing scientific decisions, an experienced farmer (and therefore not an "ordinary" citizen, with respect to farming) without scientific training can help a trained scientist (with no farming experience) understand and solve a problem.

1.2 Focusing on Expertise and Experience

The usual marker of expertise is a credential, perhaps a certificate indicating a proficiency of some type; but to the extent that many types of expertise are not associated with an external credentialing entity, credentials cannot serve as the standard for expertise.

> A criterion that does seem to set the boundary in a better place is experience in a [technical] domain. [Without] experience at judging the products of a technical domain, there is no specialist expertise. (Collins and Evans 2007, 67–68)

In 2007, Harry Collins and Robert Evans published *Rethinking Expertise*, an attempt to invent a sociology not of science but of expertise. The authors even constructed a taxonomy of expertise, beginning with *ubiquitous expertises* that everybody has in order to live in society—"a huge body of tacit knowledge"—and then moving to *specialist expertises*, the three lower levels of which "are better described as levels of [ubiquitous tacit] knowledge"—(1) "beer-mat knowledge",[1] (2) popular understanding of science, and (3) primary source knowledge (e.g., literature and the internet) (Collins and Evans 2007, 13–14). The higher levels of specialist expertise (or "specialist tacit knowledge"), requiring more than ubiquitous expertise, are, for example, most relevant to science that is appropriated in legal and policy settings: *contributory* expertise, "which is what you need to do an activity with competence", and *interactional* expertise, "which is the ability to master the language of the specialist domain in the absence of professional competence" (Collins and Evans

2007, 14). The latter category, "a new concept" and the focus of much of *Rethinking Expertise*, is important because it captures the genuine expertise of a non-scientist (i.e., without formal training or credentials) who, through experience in a scientific community, knows what he or she is talking about when there is a scientific controversy (Collins and Evans 2007, 14).

Finishing out the taxonomy, there are five *meta*-expertises, including (1) ubiquitous discrimination (evaluating, e.g., "the experts' demeanor [or] the internal consistency of their remarks"); (2) local discrimination, both of which involve judges who are not experts but who make judgments about experts; (3) technical connoisseurship (the expertise of an art critic who is not an artist); (4) downward discrimination, when a specialist judges a lesser expert; and (5) referred expertise, when an expert moves to a new domain and applies his or her expertise from an earlier domain (Collins and Evans 2007, 15). The primary focus of this book is on the two highest levels of specialist expertises: contributory and interactional expertises, but readers will find other categories of expertise (in the taxonomy summarized above) discussed in various chapters of this volume.

In distinguishing these two higher levels of specialized expertise, Collins and Evans (2007) note that the "first three categories of expertise, beermat knowledge, public understanding, and primary source knowledge, might be said hardly to enter the category of specialist expertise at all", since they do not require mastery of a domain and basically involve

> reading rather than immersion in the specialist culture. "Enculturation" is the only way to master an expertise which is deeply laden with tacit knowledge because it is only through common practice with others that the rules that cannot be written down can come to be understood. (24)

Much of the catalyzing work on interactional expertise, enculturation, and immersion can be attributed to Collins' own self-study on the topic as he immersed himself in an expert community comprised of gravitational wave physicists (Collins 2017). During this decade-plus-long immersion, Collins, a sociologist and outsider to the specialist community of scientists, slowly learned the language of gravitational wave physics and spent time with members of the community in both formal and informal spaces (Collins 2017, 313). He gained both formalized and tacit knowledge through this experience, and was able to pick up on slight linguistic nuances in expert conversation, and importantly came to understand and

even make inside jokes. Although he could not "do" the science in the sense of being a contributory expert, he could fluently engage with the expert community, even going so far as to pass a Turing-test-like experiment in which he managed to convince an expert judge that he was an actual gravitational wave physicist, and not the "pretender" or outsider (Davies 2006).

After defining expertise as immersion in a specialist "culture", Collins and Evans *divide* those with expertise between contributory and interactional experts.[2] As to contributory experts, which is the conventionally recognized type of expert, they begin as novices and advance through the stages of advanced beginner, competence, proficiency, and finally, expertise (Collins and Evans 2007, 24–27). Interactional experts, a new category proposed by Collins and Evans (2007), do not go through the stages required to become an expert; instead, by immersion in an expertise community, they learn enough of the expert's language to carry on intelligent, thoughtful conversations about (1) the nature of the community, (2) the key programs and players, and (3) cutting-edge issues—they can even tell the sorts of jokes that would only seem funny to (or even be understood by) an expert in the field.

According to Collins and Evans, "mastery of any language, naturally occurring or specialist, requires enculturation within a linguistic community" (Collins and Evans 2007, 30). Interactional expertise therefore can be acquired only by immersion in a language community. Collins' work therefore challenges both (1) the view that *full* immersion in a domain is necessary to master a language and (2) the view that mastering a domain's language requires *only* "the acquisition of propositional knowledge—a set of formal rules and facts gained through reading and instruction" (Collins and Evans 2007, 29).

> The idea of interactional expertise implies that complete fluency in the language of a specialist domain can be acquired in the *absence* of full-blown physical immersion …, [and] the level of fluency … that can be attained by … an interactional expert is indistinguishable from that [of] a full-blown contributory expert. (Collins and Evans 2007, 30–31)

The significance of this analysis is that an expert in a scientific field, for example, need not be a scientist who "contributes" to that field—examples offered by Collins and Evans (2007) include "activists," seemingly mere members of the public, who actually *know* enough to interact suc-

cessfully (i.e., they "possess interactive ability") with scientists (32). More importantly, the interactional expert is often one who communicates to the general public, such as a sociologist of science who publishes a study of a scientific domain, or a science journalist who reports on a scientific controversy (Collins and Evans 2007, 31–32).

Collins and Evans (2007) even raise the question whether an interactional expert could be admitted as an expert witness in courts of law, since (in their view) "interactional expertise is just as good in forums that work through the medium of language as contributory expertise" (42). The example offered by Collins and Evans (2007) is Simon Cole, in his role as an expert in criminal prosecutions involving fingerprint evidence—although he has studied the profession, he has been attacked on cross-examination (as a junk scientist) because he is not (and has no experience as) a fingerprint examiner:

> What we would like to bring about is the establishment of a discourse that would enable Cole … under cross-examination [to respond] with a confident: "I do not have contributory expertise in the matter of fingerprint identification but I do have interactional expertise in the domain…. (72)

Of course, the category of contributory experts in science is not limited to the core set of trained scientists, because Collins and Evans (2007) talk of the possibility of specialist *contributory* "experts without formal qualifications," who have "no paper qualifications" (49).[3] Cole, however, had neither formal training nor experience as a fingerprint examiner, so his expertise was interactional. Given that Collins and Evans believe that an interactional expert (unlike a mere member of the public) has the legitimacy to participate in scientific decision-making, it is not surprising that they believe an interactional expert should be able to testify as an expert witness.

The final piece of this focus on expertise is the problem of pseudoscience, but Third Wave theory does not really distinguish between the status of expertise *as expertise* (1) in fields such as witchcraft or astrology (experts in those practices do exist), on the one hand, and (2) in what we might call "efficacious" expertise (associated with successful scientists), on the other. Collins and Evans (2007) do, however, address the problem of allowing extrinsic influences to distort the results of tests, studies, or experiments—here they can only rely on the protection of consensus where it exists, such that when genuine scientists propose a new theory based on new findings:

> [T]he scientists pushing forward in the new direction have the intention to change as little as possible consistent with their new theories and findings. They do not want to overthrow the scientific method, nor the greater body of scientific findings, nor the major social institutions of science, nor the existing data of science. (130)

Science as we know involves "the elimination of personal bias" and the preservation of "continuity between a new approach and the main body of science" (Collins and Evans 2007, 130, 132).

1.3 Imitation Games

The Imitation Game, inspired by Alan Turing's (1950) proposals to test the intelligence of computers, is a new social science research method that seeks to "measure" interactional expertise qualitatively and quantitatively. The fact that interactional expertise—the ability to talk fluently about a practice without necessarily being able to perform the practice—is one of the central concepts of the Third Wave program, turns the Imitation Games method into a central element of this research program.

Unlike the concept of expertise that underpins the Third Wave approach, which is a recent development within Science & Technology Studies (Collins and Evans 2002, 2007), the idea of the imitation game as a "method" to systematically explore expertise can be traced back to Alan Turing's attempt to devise a test that was able to resolve the question whether "machines can think" (Turing 1950, 433). Turing himself drew upon a much older parlor version of the imitation game, the principles of which he succinctly explained as follows:

> It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A". (Turing 1950, 433)

To achieve the aim of the game, the interrogator—referred to as Judge in the context of Imitation Game research—is allowed to put testing questions, one at a time, to the two respondents who answer according to their roles in the game. The respondent of the same sex as the interrogator—

the Non-Pretender—answers naturally, while the respondent of the different sex—the Pretender—has to answer the question as if she or he shares the same sex with the interrogator.

The famous Turing test adapts the parlor game by shifting the focus of the game from gender toward "human intelligence," and by replacing one of the human respondents with a machine. For the purpose of the modern sociological Imitation Game (we capitalize when referring to the sociological variant, and not the parlor game), we replace Turing's machine with a human, which means we can involve members of different social groups or categories, and we shift our interest from "thinking" to "expertise." The same principles of the imitation game—dialogical interaction and the physical separation of players which affords a narrow focus on linguistic ability—which according to Turing makes it ideal for the purpose of testing a machine's ability to think, turn it also into an ideal method to explore expertise in general and interactional expertise in particular.

> The question and answer method seems to be suitable for introducing almost any one of the fields of human endeavor that we wish to include. We do not wish to penalise the machine for its inability to shine in beauty competitions, nor to penalise a man for losing in a race against an aeroplane. The conditions of our game make these disabilities irrelevant. The "witnesses" can brag, if they consider it advisable, as much as they please about their charms, strength or heroism, but the interrogator cannot demand practical demonstrations. (Turing 1950, 435)

First, the dialogical nature of the interaction enables the exploration of any topic. Over the last several years, Imitation Games have been played on topics such as gravitational wave physics (Giles 2006), gender (Evans et al. 2019), visual impairment, perfect pitch, color perception (Collins et al. 2006), sexuality, religiosity (Collins et al. 2017), national and regional identities (e.g., Kubiak and Weinel 2016; Collins et al. and Kubiak, Chaps. 7 and 9 in this volume), sub-cultural identities (Ross and Bauch et al., Chaps. 8 and 10 in this volume; Segersven et al., unpublished manuscript), and chronic illnesses (Wehrens 2015; Evans and Crocker 2013). Second, the disconnect between the linguistic ability to describe a practice, and the physical ability to demonstrate, which the imitation game supports through the physical separation and electronic communication, makes it an ideal method to explore interactional expertise. The very point

of interactional expertise is the ability to talk about a domain without being able to perform the practice that is the subject of the conversation.

The Imitation Game contributes in two principal ways—one intended and anticipated, the other surprising—to the Third Wave program. First, the Imitation Game has been specifically and intentionally used as an ingenious quasi-experimental method to test the interactional expertise concept (see Chaps. 7, 8, 9, and 10 of this volume). By the time Collins and Evans proposed the Third Wave program in 2002, Collins had already played Imitation Games since the 1990s. It did not take Collins and Evans long to recognize the potential of the Imitation Game to test empirically whether interactional expertise exists or not. Between 2004 and 2008, a series of small-scale proof-of-concept Imitation Games was played that lend credence to the idea of interactional expertise. Second, and often surprisingly, playing Imitation Games for the purpose of testing the interactional expertise concept has generated new empirical data and material that contributes to the further theorizing of the Third Wave, and opened up new and different uses for the Imitation Game. With regard to the latter, Imitation Games have been used as a "can opener" (or ice breaker) for subsequent focus groups (Wehrens 2015, 2016), or as a potential training tool for medical staff dealing with chronic patients (Evans and Crocker 2013). With regard to the former, a shift of focus from the performance of the Pretender to the Non-Pretender, who belongs to the same social category or group as the Judge, has spurred new research into the nature of social groups (Arminen et al. 2019).

1.4 Interactional Expertise and the Problem of Incommensurability

If two fields are incommensurable from a Kuhnian perspective (Kuhn 1970), how could someone from one field gain interactional expertise in another? Peter Galison's solution is trading zones (Galison 2010), which he developed from a case study of the development of radar. Multiple apparently incommensurable expertises had to be combined to reach a solution—the experts and the military organizations they were serving had to develop a trading zone, where they could exchange ideas and solutions without any party having to understand the other's paradigm. Consider also the development of a new expertise like biochemistry, the name of which shows that it emerged out of the collaboration between