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Introduction: Science and Persons

George Kelly used "scientist" as a metaphor for "person" to emphasize that understanding science practice – how scientists think and what they do – enables us to understand human nature more profoundly. In turn, understanding human nature invites critical appraisal of our notions of science as an activity of persons:

> Psychologists are likely to be very much in earnest about making their discipline into a science. (Unfortunately, not many are as concerned as they might be about making science into something.) . . . But what would happen if one were to envision all human endeavor in those same terms the psychologists have found so illuminating in explaining themselves to their students? And indeed, might it not be that in doing so one would see the course of individual life, as well as human progress over the centuries, in clearer perspective? Scientists are men, and while it does not follow that men are scientists, it is quite appropriate to ask if it is not their human character that makes scientists what they are. This leads us to the question of how that human character can be better construed so as to account for scientists, and whether our construction can still explain as well the accomplishments that fall far short of what we, at this transient moment in our history, think good science is (George Kelly, unpublished manuscript quoted in Bannister & Mair, 1968, pp. 2–3).

In a similar spirit, but with differing concepts and method, this book is written with the conviction that science practice provides fertile yet undercultivated ground for psychological theorizing. The central question with which psychology historically has wrestled – how best to characterize the integration of the bodily, intentional, environmental, social, and cultural dimensions of human life in day-to-day functioning and long-range achievement – is spotlighted and amplified in the microcosm of the science laboratory. Thus the laboratory is psychologically important not merely

because it allows for isolation and control of variables, as is psychology's typical view of the laboratory's investigatory benefits. Rather, the laboratory is important because, within the culture of even a *single* laboratory, cognitive, social, affective, material, and other dimensions of human activity are richly and importantly interlaced in a "mangle of practice," as Pickering (1995) has called it.

In *Epistemic Cultures*, Knorr Cetina proposed a view of the laboratory as "an 'enhanced' environment that 'improves upon' natural orders in relation to social orders" (1999, p. 26). Sciences display "the *smear* of technical, social, symbolic dimensions of intricate expert systems" (Knorr Cetina, 1999, p. 3, emphasis added). Although the focus of science studies is on understanding science and scientific knowledge for its own sake, we are suggesting that natural science is also an especially informative locus of human activity, the inherent complexity of which offers inroads for understanding human nature and functioning more profoundly. This book reflects our view of science or rather of scient*ists* – the activities and articulations of persons working as scientists in situ – as a relatively untapped source for generating and honing ideas we categorize as "psychological." As we shall discuss, this is a new reading of the "person-as-scientist" metaphor forwarded by George Kelly in the 1950s.

In this effort we describe several specific psychological dimensions of science practice through our analysis of the accounts and activities of working scientists. The scientists we analyze are biomedical engineers collaborating within well-regarded laboratories on the campus of a major American research university.[1] Despite the long-standing demarcation of "basic" or "pure" science from applied or problem-focused professions such as engineering, the laboratories we study are innovation communities engaging in cutting-edge research that transcends and blurs any boundaries between basic and applied science. The focus of our analysis is a set of interviews with researchers possessing varying levels of expertise, from students entering laboratories for the first time to the principal investigators who have established the laboratories under study. The work here builds both on extensive analysis already undertaken and on research that is ongoing, the details of which are given in Chapter 2.[2]

Some background discussion is necessary to clarify how our analytic efforts offer a departure from traditional conceptions of the relation between

[1] Details about the scientists and the form of science practiced are provided in Chapters 2 and 3.

[2] See, for example, Nersessian (2006); Nersessian and Chandrasekharan (2009); Nersessian, Newstetter et al. (2003); and Osbeck and Nersessian (2006).

psychology and natural science. We begin by drawing a distinction between psychology as science and science as psychology and then address the problems to which our analysis is directed and the ways in which it is intended as a contribution. We offer an outline of the book as a whole at the end of this chapter.

PSYCHOLOGY AS SCIENCE VS. SCIENCE AS PSYCHOLOGY

As a starting point, it is important to note that "psychology as science" has functioned as something between a slogan and mandate for the academic and professional community of psychologists for more than a century and a quarter. The assumption it crystallizes is that psychological knowledge is most trustworthy and prestigious when psychologists pattern their methods of inquiry after those presumed to be the bedrock of natural science. Thus researchers and practitioners hold each other accountable to the normative framework of "scientific psychology," with controlled experimentation the beau ideal; disciplinary hierarchies follow. In turn, the mandate has sparked assorted forms of rebellion. Reactions to the methodological strictures and perceived philosophical vacuity accompanying a too rigid psychological scientism include the mid-20th-century eruption of Third Force psychologies and contemporary alternatives devoted to critical and hermeneutic psychologies. Indeed, nothing has been as polarizing to the discipline of psychology as its ideas *about* natural science, whether in relation to psychology's potential for achieving a full measure of objectivity or to the ontological status of the objects of both human and natural science. Psychologists operate within a field defined by poles representing, on the one hand, a largely unexamined emulation of science and, on the other, the marginalized position of critic. Genuine dialogue between those positioned at either end occurs most frequently around methodologies, over the appropriate combinatory applications of qualitative and quantitative research designs in relation to a specific problem (e.g., Tashakkori & Teddlie, 2002). Despite the advantages offered by mixed method designs, psychologists should not conflate the mixing of methods with meaningful conceptual integration.

Psychology needs new questions concerning its *range of possible relations to science* as a way to revitalize the inquiry. A step in this direction is to bypass or bracket the question of whether psychology can or does have proper scientific standing. One means of changing strategies is to focus psychological attention on the quite fascinating human practices that constitute science itself, thereby helping inform the persistent question about what science is in the first place. If we at least temporarily suspend the

debate over psychology and science and leave behind preconceptions about the latter, psychologists have much to mine from the everyday business of scientists in practice: their complex learning trajectories, their myriad creative efforts to achieve coherence and develop new concepts, the entanglement of their sense-making with emotional engagement and values, and the shifting, intricate identity formations negotiated in relationship with one another and with the material culture of their practice. Thus in this text we engage natural science not to borrow its methods but to bring psychological questions to its practice. The central task of our analysis is to consider what might be mined theoretically by turning the psychology-as-science mantra on its head – by imagining *science as psychology*.

Under the direction of principal investigators Nersessian and Newstetter, we have formed an evolving, interdisciplinary team of ethnographers to describe and understand the learning, reasoning, and problem-solving practices of both the novice and expert researchers in two biomedical engineering laboratories, details of which are provided in Chapter 2. We draw both from ethnographic observations and analysis of a large set of interviews conducted with research scientists in the two laboratories. The interviews concern the nature of the scientists' work, the problems they are working on, the sources and progression of their ideas, their learning and social experiences in the laboratory, transformations in their identity through their encounters with persons and objects in the laboratory, and their aspirations and plans for the future.

Here one might legitimately question why the practice of *science* should be targeted for psychological analysis rather than other forms of professional, skilled, or nonskilled practice. Part of the answer has to do with psychology's emulation of science and what this reveals about the discipline's self-representation. Psychology's natural science aspirations spring from conviction of the special standing and ultimate authority of science, a conviction that is certainly not limited to the discipline of psychology. Philosophically, it is tied to the ideal of science as a value-free or value-neutral enterprise, on which there is a vast literature with roots traceable to Bacon and Galileo (Lacey, 1999). Because of this ideal, science is enveloped in mystique that more than one author has branded *mythical*, even religious in its overtones: Kitcher (1993) speaks of the "legend" view of science, Mitroff (1974) acknowledges the "storybook" view, and Mahoney calls the scientist the "high priest of knowledge" (2004, p. 3). The reason we target science practice in particular has to do with the relation science seems to bear to our highest human ideals: what we value in ourselves and see as the farthest reaches of our intellectual power.

There have indeed been prominent psychological efforts to embrace scientific thinking as prototypical of human rationality, and rationality as the quintessential human attribute. Among the arguments that Greg Feist's (2006a) pioneering *Psychology of Science and the Origins of the Creative Mind* offered as a rationale for a new subdiscipline organized around psychological dimensions of science is that science and scientific thinking constitute "prototypes of human thought and understanding" (p. 3). Note, however, that there are two quite divergent connotations of "prototype": one implying an idealized form of something, the other a typical representative of a class. As we shall discuss in our final chapter, two quite varied accounts of scientific thinking correspond to these two connotations. In turn, the different accounts of scientific cognition give rise to two different representations (depictions/perspectives) of scientists and by extension the human characteristics that scientists represent.

There have been scores of efforts to cast doubt on the possibility of a value-free enterprise of any kind and of a value-free science specifically, even if these efforts have yet to have an impact on the business as usual of psychology practice. Our aim in this work is not to dismantle the rational core or privileged position of science – far from it. Yet if our analysis of one particular context of scientific practice might provide some insight into how people "do" rationality in research laboratories – that is, in the settings upheld as demanding the purest of rational practices – we might be better poised to offer some comment on the nature of rational operations more generally. Note also that our intent is not to reinvent the wheel crafted by the extensive body of literature in philosophy of science, cognitive science, and related disciplines that demonstrates the embodied, embedded nature of rational functioning. Rather, we aim to clarify how some of the rich insights of recent science studies might have relevance to the psychological community and its questions and, at the same time, supplement existing lines of theorizing with our own analysis of a particular research culture.

Problems Targeted

We organize our analysis of interview content and observational data to address two related and overlapping problems relevant to the study of science and the discipline of psychology. The first is what we identify here as the *integration problem*: the challenge of characterizing adequately the fluid entanglements of cultural, cognitive, affective, and other dimensions as they coordinate in all forms of human activity and particularly in those for which targeted problem solving is a principal aim (see Nersessian, 2005). As Lave

noted, the very notion of "problem solving" historically invites frameworks (and, until recently, methods) that exclude social, cultural, and emotional considerations: "Today, for example, it is likely to be assumed that if an ongoing activity consists of problem solving – 'individual, rational, cognitive' – it is not necessary to address the possibilities that it is culturally and socially structured, primarily expressive of feelings, or part of socially contextualized experience in ways that require theorizing, empirical description, or analysis" (1988, p. 7).

The second problem we target is the unsatisfactory status of contemporary general psychology, which instead of serving as a foundation for subdisciplines through its questions and analytic strategies has devolved into a grab-bag of specialized lines of research. We call this the *problem of grab-bag general psychology*.[3] Our assessment is a commentary on the status with which general questions about human functioning and integrated efforts to address them tend to get taken up by the academic community, outside of the discipline of psychology but more egregiously within it. Instead of upholding general psychology as the axis of the most thorny and intriguing challenges for the discipline of psychology, the convention in psychology departments is to limit it to an introductory-status course, one eagerly farmed out to graduate students for the purposes of cutting their teaching teeth. Students are left with the impression that psychology is a collection of research findings conveniently parsed into traditional categories around which academic careers have been organized. Indeed this is not an inaccurate assessment of the state of the field. Yet general psychology as a *theoretical pursuit* can be much more and deserves to be so. It is among our goals to contribute to its revitalization.

To summarize, central to the analysis and the organizational scheme employed for its presentation here are two related claims:

1. Our study of scientists offers an opportunity to present carefully *integrated* accounts of cultural, cognitive, and affective human dimensions of human activity. We thus align our efforts with those of theorists both recent (Papadopoulos, 2008) and historical (Vygotsky, 1978) who argue that we cannot understand volitional, cognitive, and emotional phenomena as isolated systems but rather must examine their concrete and everyday realization in human action and community.

[3] Note that the naming of this problem is not intended as a criticism of the *Review of General Psychology* (the APA Division 1 journal), which explicitly endorses the importance of cross-cutting research in its editorial aims.

2. Thus the study of science *as practiced* has the potential to inform questions concerning human functioning and experience more broadly, that is, to inform the project of a general psychology.

We begin with a brief review of how we intend this text to address both the *integration problem* and the *problem of grab-bag general psychology* and then present the outline of the book as a whole and the content of its chapters. Our hope is that the analysis offered here will not only serve as a contribution to science studies, specifically to the burgeoning field of psychology of science, but more directly as a contribution to a freshly envisioned general psychology.

SCIENCE STUDIES AND THE PSYCHOLOGY OF SCIENCE: THE INTEGRATION PROBLEM

An infrequently recognized source of the conflict surrounding the question of psychology's scientific status is that although "science" does not lend itself to facile definition or understanding, psychologists have attempted to impose plainness on it by equating science with a rigidly codified method (equated with "The Scientific Method"). Thus the question of whether psychology is a science, or what kind of psychology is scientific and what is not, is addressed by reference to what is methodologically sanctioned. But scholarly views of science are quite complex. Academic dividing lines are at least chalked around the question of how science is to be understood, both within and between disciplines devoted to the study of science. At one end are accounts emphasizing a set of core similarities and an essential inner logic common to all forms of science, which form a foundation of enduring rational structures to which the norms of particular sciences ultimately appeal (e.g., Carnap, 1935; Hempel, 1952). More recent emphasis has been placed on the grounding of these structures in the sound operations of mechanisms detailed by cognitive science – this is the focus of cognitive studies of science.[4] At the other end, rational and cognitive descriptions of science have long faced competition from accounts of science as a fundamentally social and even political system – from the argument that the logic of science itself reflects deeply ingrained human habits and negotiated rules to the assertion that there are broad institutional and economic

[4] For example, Carruthers, Stich, and Siegal (2002 [edited volume]); De Mey (1982); Giere (1988, 1992); Gooding (1985); Gorman et al. (2005); Klahr (2000); Nersessian (1984, 2008); and Tweney, Doherty, and Mynatt (1981).

forces that inflect the forms of representation that influence how methodology is understood and our material reality is interpreted. Such forces may even be seen as determining the questions to be asked and the explanations proffered.[5]

Rational–Social Divides

That, historically, socio cultural and rational-cognitive accounts of science have been at epistemological loggerheads is obvious in the use of the term "science wars" to describe their relationships. Writing in the early 1980s and characterizing 20th-century trends, Marc De Mey remarked on the fragmentation of science studies resulting from the competing interests of philosophy and social sciences:

> Philosophy of science claims a special position because of the special nature it attributes to scientific knowledge as superior knowledge, this special nature being essential for justifying its existence as a separate discipline. Sciences of science such as the psychology and sociology of science, on the contrary, appear to consist of the application of empirical disciplines not developed with science as their primary object of study, and their products, though sometimes very penetrating and highly interesting, seem unrelated to each other and leave us with a picture of the science of science as a rather fragmented endeavor (De Mey, 1982, p. xv).

The picture of something rather fragmented remains when surveying the development of science studies since the time of De Mey's writing. A kind of grafting of cognitive and neuroscience research onto the rational reconstructions provided by philosophy of science has occurred over the past three decades. Although controlled and naturalistic observation have added immeasurably to philosophical accounts of model use, analogy, visualization, and metaphor in scientific reasoning, theory formation, hypothesis testing, and discovery, the vast majority of cognitive studies of science have proceeded in relative isolation from social and cultural studies of science, robust and internationally poised as they also may be. More recently, Helen Longino (2002) and Nancy Nersessian (2005) separately have pointed to the implicit acceptance of a rational-social dichotomy in philosophy of science and science studies, prodded by critical reactions to the reactionary establishment view of science as a rational, rule-bound, progressive enterprise

[5] For example, see Feyerabend (1975); Latour and Woolgar (1986); Levins and Lewontin (1985); and Pickering (1984).

driven by the highest cognitive achievements. The fallout is that science tends to be interpreted as *either* a cognitively *or* a socially powered phenomenon, and accounts of science typically are rational-cognitive *or* social accounts (i.e., the categories of rational and social are sharply distinguished). Yet the tendency to dichotomize social and cognitive accounts of science invited by the academic divide is both conceptually problematic and at odds with the complexities of science underscored by historians and ethnographers of science.[6]

Integrative Efforts

Several key lines of integrative effort serve as important counters to the trend of disengagement of social and cognitive accounts. The entire project of cognitive anthropology is a ready example,[7] as is ethnomethodology as the study of reasoning in situated contexts of practical activity.[8] In large part borrowing from these frameworks, cognitive scientists increasingly have been investigating reasoning and problem solving in naturalized settings in which the local features of the context, including social roles and cultural artifacts, are theorized as essential to the cognitive tasks at hand. In the case of extended mind theory, those local features are considered part of the cognitive process itself.[9]

Since the 1970s, feminist scholars have undertaken many efforts to articulate more integrated formulations of science. Often derived from the experience of practicing scientists or stemming from questions concerning the nature of objectivity, such accounts forcefully argue for less individualistic notions of knowledge generation, a better understanding of the role of affect in relation to knowledge, and a keener appreciation for the role of community and intersubjective relationships in generating knowledge and criteria for judgment.[10] Although often stereotyped as purely interested in the social dimension (qua gender), such accounts frequently attempt to construct a

[6] Nersessian (2005), who has engaged in extensive historical and ethnographic study of several sciences, has forthrightly declared the divide artificial: "Producing scientific knowledge requires the kind of sophisticated cognition that only rich social, cultural, and material environments can enable" (p. 18). She has devoted her recent research efforts to developing ways to bypass or dissolve the traditional dividing lines to theorize culture and cognition as aspects of the same infinitely complex system (Nersessian, 2005, 2006).
[7] For example, see history by D'Andrade (1995) and Shore (1996).
[8] For example, see Garfinkel (1967); Hutchins (1995a, 1995b); Lave (1998); and Lynch (1993).
[9] See Clancey (1997); Clark (2003); Suchman (2007); and Wilson (2004).
[10] See Haraway (1991); Longino (2002); and Nelson (1990).

broader conception of scientific cognition through questions such as "What sort of person is the scientist?"

Omissions and Oversights

Yet vitally important things continue to fall out of cognitive and social accounts, even accounts that manage to cross the traditional social and cultural divide. Three omissions are especially noteworthy:

1. The material grounding of science practice – not only the neural and other bodily processes of scientists but also constraints imposed by the nature of the objects and artifacts to which their practices are directed – remains challenging to incorporate smoothly with accounts of linguistic, social, and normative dimensions of practice.[11] Thus some recent contributions to cognitive science construe culture, material, and social environments as aspects of a single system of processes (e.g., Hutchins, 1995b; Nersessian, 2005, 2006). Collectively these have been called "environmentalist" approaches in cognitive science (e.g., Nersessian, 2005; Rowlands, 1999).
2. Neither thoroughgoing social, cognitive, or even blended social and cognitive accounts are easily able to account for the contribution of the *particularity* of the scientist, that "something else" of embodied and storied living persons that for want of better options we resort to conventional psychological categories such as affect, motivation, personality, and subjectivity, but that appear to be an indispensable feature of at least science in process. That is, science is shot through with what is irreducibly a matter of personal *style* and, in addition to *norms*, science includes a heavy dose of *value*, and more provocatively, "*desire*." The contribution of this additional dimension – this "something else," this particularity – to the practices and processes that constitute science is more or less ignored in the mainstream of science studies, at least outside of biographical analyses of scientists.
3. The influence of the subjective or personal dimension is acknowledged principally as a source of error or complication. The "personal equation" in astronomy, for example, referred to individual differences in reported stellar transit times among astronomers using the same instrument, which muddled the effort to provide precise estimations of distance (see Duncombe, 1945). Simon Schaffer has referred

[11] See Daston and Galison (2007); Galison (1997); Maquet (1993); and Pickering (1995).