Campbell's Evolving Influence on Organization Science

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Introduction

Donald T. Campbell was born November 20, 1916 and he died May 6, 1996. During the 80 years of his life he took a Ph.D. from U. C. Berkeley in 1947, produced 236 publications, and received 19 honors and awards. He held 10 positions at various institutions but mostly he was at Northwestern University. After retiring in 1982 he married his second wife, Barbara Frankel, and produced the last 74 of his works.

1905 was a good year for Albert Einstein—he published his first paper on the theory of relativity and he won the Nobel Prize for another paper that year on the photoelectric effect. 1959 was a good year for Campbell—his first paper on the multitrait-multimethod idea appeared, as did his first one on epistemology. The quasi-experiment idea first appeared in 1963. These three papers (Campbell 1959, Campbell and Fiske 1959, Campbell and Stanley 1963) started the streams of research that led to most of his many honors and awards.

Before he retired in 1982, Campbell's ratio of epistemology to all other publications was 11%; after retirement it is 61%. Campbell is particularly unusual because he is a bench scientist who achieved significant recognition later in life for epistemological contributions. He published 50 bench-scientist type papers before his first "knowledge process" paper, the beginning of his writing on epistemology (Campbell 1959). Most bench scientists never turn to philosophical writing. Most would say, "I ignore all that philosophy stuff. I just try to do good science." Usually this means hypotheses are tested for possible refutation—reflecting a vague Popperian influence. Occasionally Nobel Prize winners become drawn into the philosophical fray in their later years because their more pivotal contributions are often what philosophers point to in their writings, Bohr, Mach, Schrödinger, and Einstein being typical.[1] Needless to say, philosophers never become bench scientists in their later years.

In a short introduction to Campbell's "Comment: Another Perspective on a Scholarly Career"(1981a), Brewer and Collins (1981, p. 454) say, "…this chapter provides a glimpse of the fits, starts, and blind alleys that characterize the life of a working scientist and intellectual." Campbell agrees with this, saying one page later, "It will enable me to exemplify the blind-variation-and-selective-retention (BVSR) epistemology…by illustrating with my own career the inevitable wastefulness of scientific exploration, the chancy indirectness of discovery, and the further chanciness of recognition." We leave the following quandary to the reader. Campbell's own BVSR theory suggests that the change in the ratio of epistemology to other writings results from selection—the epistemology papers are more essential to his intellectual survival. Alternatively it could be a life-cycle effect—some famous scientists are drawn toward epistemology for other reasons.

Campbell's Interests

The Brewer and Collins volume, titled *Scientific Inquiry and the Social Sciences*, was created by some of Campbell's students in honor of his retirement. It is clear from this book that Campbell's primary interests are: (1) The natural selection model of knowing, that is, evolutionary epistemology; (2) Multimethod perspectives; (3) Ontological entitivity and multilevel units of analysis; (4) A Gestalt psychological approach to pattern matching particularly relevant to cross-cultural research; (5) The contextual basis of perception, whether experiential or cultural; and (6) Methods of knowing and stimulus cue utilization. As a 7th category, we would add the significant body of Campbell's work devoted to program evaluation, out of which grew his interest in quasi-experimental design. All of these themes continued into the 1990s.

Brewer and Collins (1981, p. 7) note "…Campbell's remarkable facility in moving across levels of generality, from the abstract the to concrete." Surely nothing is more abstract than his combination of scientific realism, evolutionary epistemology, and hermeneutics. Oppositely we note his interest in the triangulation of multiple operational measures. What is unique about Campbell, the bench scientist, is his contribution to all the major epistemological themes philosophers define as the desiderata of effective science. Campbell worries about the quality and appropriate use of specific operational measures—that is measurement reliability and validity. He studies the upward and downward causality and entitivity of metaphysical concepts. He wonders whether evolutionary epistemology will tilt his science toward

[1] Mach was appointed to the first chair for philosophy at the University of Vienna and then Boltzmann held it. Bohr, Schrödinger, and Einstein carried on philosophical arguments for years over the "reality" of the entities comprising quantum theory in their debates about the "Copenhagen interpretation" (Bitbol 1996). Einstein was named (on the signature page of the Vienna Circle's first publication about logical positivism (Neurath 1929)) along with Russell and Wittgenstein as having significant impact on the development of logical positivism.

operationalism and naïve realism. His focus on experiments and quasi-experiments aims at the heart of philosophers' concerns about avoiding explanations and theories based upon what might be accidental regularities. He worries about the tension between the goal of objectivity in science and the individual interpretations of scientists and the social construction of knowledge by scientific communities. Finally, he studies the root problem of philosophy, how to know which theories are more or less truthful and how do sciences systematically move toward more truthful theories and winnow out mistakes?

While Campbell's interests and most of his contributions cover much of the broad table of social science, our particular interest, honored in this book, focuses on his seminal contribution to organization science. His interests in quasi-experiments and triangulating multiple methods have been brought to the study of organizations by the many psychologists and social psychologists taking positions in business schools and applying their disciplines to the study of firms. Even so, out of the vast sweep and number of Campbell's works, we believe that a single paper stands out as having the most pervasive influence on organization science—"Variation and selective retention in socio-cultural evolution" (Campbell 1965). Granted that triangulation and quasi-experiments could improve bench-level organization science, nevertheless, the countering of the intentions and rational decisions by the visible hand of managerial elites (Chandler 1977) with the invisible hand of emergent forces and consequent emergent behavior, processes, functions, and structure surely ranks as a major turning point in organization science.

Campbell's Influence in Organization Science

Organization science is a receptive soil to Campbell's seed. Early evolutionary tilling stems from the influence in social science of Hawley' (1950) book, *Human Ecology* and Alchian's (1950) classic paper, "Uncertainty, evolution, and economic theory." These are followed by Friedman's (1953, p. 22) use of natural selection theory to justify the idea that firms behave "…*as if* they were seeking rationally to maximize their expected returns." Then comes Winter's (1964) investigation of some differential equation models of selection processes. Other evolutionary insertions into economics come from Penrose (1952), Farrell (1979), Dunn (1971) and Hirshleifer (1977). More narrowly in organization theory, perhaps early sensitizing stems from Haire's (1959) use of the biological metaphor in his growth and development model? Possibly the idea emerges from Buckley's (1967) book on general systems theory—he mentions Campbell's evolutionary ideas and cites his 1959 paper. The most direct use is by Kaufman (1975) in his paper, "The natural history of organizations." This is followed quickly by Aldrich and Pfeffer 1976), Hannan and Freeman (1977), Aldrich (1979), Weick (1979) and McKelvey (1982).

Organization science benefits primarily from four key Campbellian ideas about scientific inquiry: (1) Dominating is the focus on selectionist evolutionary explanations of emergent order and differential. survival. Having much less effect are the other themes: (2) Evolutionary epistemology; (3) Multimethod triangulation perspectives; and (4) Experiments and quasi-experiments. This is unfortunate. As Donaldson (1995) observes, the first theme adds to paradigm proliferation in organization science. But if the other three themes were strong in organization science, paradigm proliferation would diminish. Why? Because the scientific basis for winnowing out less truthful theories, terms, and entities would considerably improve. Coupled with the integration of those that are left into broader more compelling theories, this would result in fewer but more fruitful theories having more influence and practical impact.

McKelvey (this volume) develops the scientific realist basis of *Campbellian Realism* to show that Campbell's particular synthesis of the 2nd, 3rd, and 4th themes presents us with a strong nomic and experimentally driven objectivist epistemology that is, nevertheless, sensitive to Kuhnian (1962) historical relativism and the dynamics of changing beliefs among scientific communities. Key elements of Campbellian realism are:

1. Objectivist belief in the potential realness of measurable, detectable, and metaphysical terms.
2. Semantic relativist interpretation and social construction do not thwart an objective though fallible search for increased verisimilitude.
3. The selectionist process of knowledge development winnows out the more fallible terms, theories, and entities over time.
4. This selectionist process does not favor either metaphysical or operational terms.
5. The true/false dichotomy of truth is replaced by degrees of verisimilitude.
6. More truthful theories remain as the more fallible theories are selective winnowed out—thus, successful theories tend to be more truthlike.
7. The truthlikeness of knowledge is probable and consists of both observable and metaphysical terms.
8. Theories consist of some law-like statements having predictive elements capable of being tested experimentally.
9. Theories preferably are based on model behavior capable of being tested as to representation of real world phenomena.
10. Verisimilitude is defined in terms of the content of models.
11. A process of convergent realism exists in which increased verisimilitude reduces errors of measurement and prediction and vice versa.
12. The relation between theory and prediction and organizations and how they behave is independent of the realness of terms and entities.

If we compare psychology and organization science, we are forced to conclude that psychology much more reflects the influence of the 2nd, 3rd, and 4th of Campbell's themes while organization science shows much more of his first and ambivalence toward the other three. Campbell was a psychologist and so perhaps he had more influence on psychology than on organization science. Possibly this is a life vs. social science thing. Psychologists are placing renewed interest in the

biological basis of human behavior (Barkow, Cosmides, and Tooby 1992, Bates and Wachs 1994, Plomin 1994, Nicholson 1997, Pinker 1998) and thus, more easily falling in step with Campbellian realism. Organization science seems buffeted much more by multiparadigmaticism and the tendency in current social science to hear much more loudly from the subjectivist, relativist, postmodernist kinds of postpositivisms than from the normal science postpositivisms embedded in Campbellian realism.

Campbellian Realism

Our honoring of Campbell's life and work is surely a celebration of Campbellian realism as well. This is especially important to organization science given its multiparadigmatic disarray and the pull by elements in the field toward. postmodernism.[2] The fifteen or more different paradigms (Donaldson 1995) partly are based on different theories, but also reflect the long-time division between objectivists and subjectivists (Natanson 1963). The plurality of perspectives seems to have led to an overabundance of discourse and a paucity of explanation in organization science. Presaging, but also stimulated by Pfeffer's Presidential Address to the Academy of Management (Pfeffer, 1993), many authors have remarked on the "problem" the multiple paradigms create for organization science (Hartman 1988, Aldrich 1992, Mone and McKinley 1993, Donaldson 1995, Pfeffer 1995, Van Maanen 1995a,b, McKelvey 1997). Pfeffer's basic argument, that multiparadigmaticism is characteristic of low status sciences, still stands unrefuted:

> "without working through a set of processes or rules to resolve theoretical disputes and debates, the field of organizational studies will remain ripe for either a hostile takeover from within or from outside. In either case, much of what is distinctive, and much of the pluralism that is so valued, will be irretrievably lost" (1993:620).

Although cognizant of the potentially divisive effects of ethnocentric disciplines or subdisciplines, Campbell (1969b: 328) suggested that a "fish-scale model of omniscience represents the solution…[the] slogan is collective comprehensiveness through overlapping patterns of unique narrownesses. Each narrowness is in this analogy a 'fish scale'…Our only hope of a comprehensive social science, or other multiscience, lies in a continuous texture of narrow specialties which overlap with other narrow specialties." But this only works when each of the "scales" has scientific credibility in its own right. Based on scientific realist epistemology, in which an objective reality is accepted as the ultimate criterion variable, and the translation of Popper's (1959) notion of 'falsificationism' into incremental falsification and incremental corroboration, McKelvey (1997) argues that multiple paradigms, or more fallible scales, persist when a field has no objective means of carrying out studies leading to the incremental corroboration or refutation of key elements of the paradigms—hence paradigm proliferation. In this light, organization science is in great need of epistemological and methodological elaboration aimed at developing better methods of providing such tests. This would be unnecessary if it were avowedly Campbellian realist.

But organizational epistemology surely is not Campbellian realist. At best it is confused. At worst it is in danger of becoming an anti-science (or alternative science or parascience), as defined by Holton (1993), metascience (Fuller 1993) or nonscience (Wolpert 1992). Organization scientists continue to debate among normal science and postmodernism (positivist and relativist approaches loosely defined) (Brown 1992, Hassard 1993, Pfeffer 1993, 1997; Burrell 1996, Donaldson 1996) even though philosophers abandoned both two decades ago (Suppe 1977). Consequently those in the field who are trying to avoid anti-science have lost their traditional philosophical basis of legitimacy without having found a suitable replacement. During this period of epistemological confusion and weakness, normal science in organization science has been under attack by subjectivists, interpretists, phenomenologists, social constructionists, critical theorists, and postmodernists (see authors listed in note 2 as well as Daft and Lewin 1990), decrying positivism while arguing that organization science needs a different approach, one more relevant to social sciences—see for example Burrell and Morgan (1979); Perrow (1994); Reed, (1996).

Recently Hunt (1994) shows how incorrect are the anti-normal science scholars in their accusations against positivism. By today's understanding, organization scientists have always been much more *realist* than *postitivist* (Miner 1980; Godfrey & Hill 1995). Organization researchers practice a logic-in-use, which holds that there is "enough of an objective reality 'out there' that repeated attempts by various researchers, using a variety of generally approved methods of 'justification logic' eventually will discover the approximate truth of theories by successively eliminating errors" (McKelvey 1997: 363). Campbellian realism brings to the social sciences in general and to organization science in particular, a vision of science and method rooted in scientific realism and evolutionary epistemology—both of which show the strong influence of the noted philosophers Karl Popper (1956/1983, 1959, 1963, 1972) and Stephen Toulmin (1953, 1961, 1972). Given the abandonment of positivism by current philosophers, the misconceptions of positivist epistemology by social science postpositivists, and lack of a coherent replacement epistemology that conforms to the expectations of normal science and higher status sciences, the field of organization science is in great need of a new organizational epistemology.

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[2] For evidence of the "pull", see recent books by Reed and Hughes (1992), Hassard and Parker (1993), Chia (1996), Clegg, Hardy, and Nord (1996) Burrell (1997), Bentz and Shapiro (1998), Hassard and Holliday (1998), and McKinlay and Starkey (1998).

Buried within Campbell's 2nd theme of evolutionary epistemology is the concern about coevolutionary change and the conflation of upward (reductionist) and downward (contextualist) causation (explanation). Traditional organization theory, since the time of Max Weber, has generally studied organizations with little attention paid to the coevolutionary competitive context of organizational niches—that is, contextual causation. Not until the seminal paper on population ecology by Hannan and Freeman in 1977, was niche theory introduced to organization science. Since then various authors have developed organizational population ecology, . which has focused mainly on organizational foundings and failures and population regulation (for a recent review, see Baum, 1996).

What is missing is a development of coevolutionary effects among firms in niches. Some progress is made recently in the volume edited by Baum and Singh (1994). Parallel to the development of population ecology, organization science has seen the rise of competitive strategy, dominated until a few years ago by industrial organization economists and game theorists (Porter, 1980; Besanko, Dranove, and Shanley 1996). Economists study the competitive context of firms, but frequently treat firms as "black boxes," ignoring the extension of their analytical approaches inside firms—game theory (Rasmusen 1994), agency theory (Besanko, Dranove, and Shanley, Ch. 16), and transaction cost economics (Williamson 1975, Groenewegen 1996) being exceptions (see also Barney and Ouchi 1986 for an overview of organizational economics). Thus, reductionist explanations starting from within firms have suffered. Consequently, as it stands in the late 1990s, organization science needs further development of theory and research that brings the competitive perspectives of economics and strategic management inside organizations, while not letting go of the rich understanding of organizational functioning gained by organization theorists. The emerging stream of research on the microdynamics of interfirm rivalry, though which firms (re)define their market positions and interrelationships (e.g., Chen and MacMillan 1992, Miller and Chen 1994, Baum and Korn 1996, Chen 1996, Baum and Korn 1998, Korn and Baum 1998) reinforces other recent work on asymmetric competitive dynamics (e.g., Baum and Singh 1994a, b, Baum and Mezias 1992, Baum 1995, Podolny, Stuart and Hannan 1996, Barnett 1997), which, taken together, appear to hold real promise as a basis for realizing a general coevolutionary approach to competitive interfirm dynamics.

The 2nd theme contains additional scientific dynamics—a stretching of analysis in two directions. One stretch moves toward increasingly micro and macro levels of, respectively, reductionist and contextualist explanation. The second moves from assumptions of uniform underlying phenomena—particles, molecules, or microstates—such as the rational actor assumption in economics (Hogarth and Reder 1987) to the stochastic assumption, say, that each actor has stochastically idiosyncratic perceptions and behaviors. Over the 100 years from the discovery of Brownian motion in 1828, to Boltzmann's statistical mechanics of 1870, to the acceptance of the implications of quantum and relativity theories circa 1930, physicists shift from the uniformity to the stochastic assumption. Over the past 100 years biologists also shift from the notion of uniform genetic processes to a view recognizing that the stochastic elements characterizing the basic processes of cell replication are at the root of adaptive evolution (Williams 1966, Maynard Smith 1975, Dawkins 1976, Kauffman 1993, Eldredge 1995). The emergence of complexity theory in many sciences also gives witness to this shift (Nicolis and Prigogine 1989, Cramer 1993, Kaye 1993, Cowan, Pines, and Meltzer 1994, Belew and Mitchell 1996, Arthur, Durlauf and Lane, 1997). The shift in these disciplines did not come easily. For one thing it takes a century. Boltzmann commits suicide from feelings that his work is not recognized. It takes the circuitous route from Gibbs (1902), who "popularized" Boltzmann in English in the U. S., via Fisher in England, to finally and slowly impact the Germans. Fisher (1930) and Wright (1931) are also instrumental in fostering the shift in biology with their stochastic modeling of genetic improvements on adaptive landscapes.

The organization science life cycle is a couple centuries behind other sciences like physics, biology, and economics. Consequently organization scientists are only just now coming to terms with the essential idiosyncrasy of their microstate phenomena. Assumptions and observations of idiosyncratic phenomena are endemic to the work of ethnomethodologists, interpretists, radical humanists, and postmodernists (Burrell and Morgan, 1979; Lincoln, 1985; Reed and Hughes, 1992; Cannella and Paetzold, 1994; Alvesson and Deetz, 1996, Chia 1996). To date the two assumptions of uniformity and stochasticity in organization science are at the heart of the paradigm debate—uniformity assumptions of the normal science aspects of the field vs. the idiosyncratic assumptions of the relativists (Perrow 1994). McKelvey (1997) observes that the assumptions promulgated by the social science postpositivists (Lincoln 1985, Chia 1996) are remarkably similar to underlying assumptions held by other disciplines, as demonstrated by Schwartz and Ogilvy (1979). The fact is that the microstate assumptions of the physical and life sciences have evolved such that they are now similar to microstate assumptions held by relativists, postmodernists, and complexity theorists.

The scientific realist roots that McKelvey (this volume) highlights as essential to fully understanding Campbellian realism clearly put (preferably formalized) models at the center of science. In this, scientific realists (Bhaskar 1975/1997, de Regt 1994, Aronson, Harré, and Way 1994) are joined by those espousing the semantic conception of theories (Beth 1961, Suppes 1962, Suppe 1977, 1989, van Fraassen 1980, Lloyd 1988, Thompson 1989). Campbell was so broadly familiar with both the biological and

scientific realist literatures that it is inconceivable to us that he was not aware of scientists' acceptance of the changing microstate assumptions and the recognition of the centrality of models. There is even evidence of this. In Campbell (1994) he cites an earlier work (Campbell 1983) that cites Haldane's 1932 book, *Causes of Evolution*. Haldane, along with Fisher, is an early contributor to mathematical modeling in genetics. In the 1994 paper Campbell also cites Williams (1966), one of the strongest advocates of the role of genetic mutations in fostering evolutionary changes in species. Admittedly, 1994 is late in Campbell's career. Though the 1983 cite of Haldane is much earlier, still, it is just after he retired. Excepting these citations we find little if any evidence in his work that Campbell addressed these issues directly in his epistemology or methodological writings, strange as this might seem.

The most obvious telltale would be evidence that Campbell was familiar with agent-based adaptive learning models. These are computational modeling methods that draw specifically on idiosyncratic microstate assumptions and have been used heavily by the "up-ward causation" theorists in biology (Fisher 1930, Maynard Smith 1975, Kauffman 1993). Examples of these modeling approaches are: *spin-glass* (Mézard, Parisi, and Virasoro, 1987, Fischer and Hartz 1993, Kauffman 1993), *simulated annealing* (Arts and Korst, 1989), *cellular automata* (Weisbuch, 1993, Kauffman 1993), and *neural network* (Freeman and Skapura, 1992) models, *genetic algorithms* (Holland 1975, Mitchell, 1996). We give mostly recent references, but in biology they have been in the literature in computational form for over two decades. These are so-called "particle" or "nearest neighbor" models, in which very simple minded "agents" adopt a neighboring agent's attributes to reduce energy or gain fitness. Prerequisite to the use of these models is the need to view organizational process level behavior as coevolving discrete random events in a multilevel micro- and macro-coevolutionary context.

Volume Themes and Contributions

Our short history of Campbell's influence across the seven broad topic categories and the four narrower themes relevant to organization science suggests that by the time in his life that he had fleshed out the essential features of Campbellian realism he no longer had the time to elaborate on all of its implications. And because he was a psychologist there is no reason to expect that he would have more specifically developed the implications of his brand of scientific realism and selectionist evolutionary epistemology as they might pertain to organization science. Our volume is titled *Variations in Organization Science: In Honor of Donald T. Campbell* because we wish to give current organization scientists opportunities to honor his many contributions by producing "variations" that stem from the 236 papers that he did write, the additional implications of Campbellian realism he did not elaborate, and further applications of his perspective to organization science. One key strength of Campbellian realism is that it very much reflects what might be called "normal science" in psychology and organization science. The "bench science" type chapters in this volume all measure up reasonably well in terms of the tenets summarized by McKelvey. The chapters are not particularly self-conscious about this and there is certainly room for improvement. They are not as far along in terms of nomic necessity and law-like statements as Campbell's realism calls for. Nor are models as central as Campbellian realism calls for in some of the chapters, though some are model-centered papers.

Blind Variation, Selection, and Retention. This heading—Campbell's favorite phrase—covers five chapters that variously tease out further implications of BVSR processes *inside* firms. Organization science has progressed from the early applications of BVSR in population ecology studies to greater emphasis on intrafirm BVSR processes, as indicated by the decreasing number of population-level studies, going from Carroll (1988), to Singh (1990), to Baum and Singh (1994), to this volume. Now, with both population and intrafirm level studies, organization science sets up the debate that Eldredge (1995) points to in biology. Earlier in the natural selection theory life-cycle, emphasis was on ecological forces affecting speciation. Later, as genetics developed, along with more powerful microscopes, lab techniques, and modeling approaches, the intrabody microstate origins of adaptive change became strong elements of modern biology. The chapters in this section suggest a similar process is beginning in the study of firms—with the potential for a similar debate.

- Aldrich and Kenworthy couple Campbell's BVSR model with his writings on creativity, experimentation, playfulness, clique selfishness, and altruism to create two *Campbellian antinomies*, or apparent contradictions, that help explain why most organizational foundings are simple reproductions of existing forms rather than innovative creations.
- Miner, Raghavan and Haunschild challenge contemporary organization theorists' taken for granted assumption (reinforced by Campbell's BVSR framework) that interorganizational imitation produces homogeneity. Their review of models from a variety of fields reveals that imitation can indeed produce convergence to a single routine, but it can also produce stable mixes of routines and oscillatory patterns of routines over time.
- Rao and Singh build on Campbell's idea that new mutations represent failed forms to explore how new organizational forms are built *with* the ruins of existing organizational forms rather than *on* the ruins of old organizational forms. Their chapter chronicles and clearly typifies the *variety in variation* in organizational populations.
- Romanelli critiques the ubiquitous practice of interorganizational copying by exploring the possibility raised by Campbell that a substantial cost to variety and innovation may arise from an overemphasis on copying. By seducing a belief in prescience (i.e., ability to know outcomes in advance), copying limits organizations' experimentation with their own variations and fundamentally and detrimentally reducing the ability of an organization to advance.
- Miller explores how BVSR processes and whole-part competition *within* organizations are engendered by success. Perceived success, shapes managerial attributions and attitudes, and transforms corporate cultures, structures and information processing behavior, which, in turn, push strategies toward extreme conservatism or boldness, toward simplicity and inertia, and toward insularity.

Multilevel Coevolution. Though we usually talk in terms of "evolutionary theory," as Kauffman says, "the true and stunning success of biology reflects the fact that organisms do not merely evolve, they *coevolve* both with other organisms and with a changing abiotic environment" (1993, p. 237; his italics). Roughgarden's (1976) initial definition and application of coevolution has been extended from the ecological level analyses of populations to coevolution at all levels. Thus, Kauffman applies it at the chromosome, gene, cell, and organ levels of analysis, in addition to the species/population level. Kauffman's book is the epitome of modern biological analysis: multilevel *and* coevolutionary. Campbell's interest in the levels of analysis problem—and implications for causal analysis—is obvious (Campbell 1974, 1981b, 1990, 1994). But, he does not appear to have pursued multilevel *coevolutionary* analysis. Coevolutionary analysis in firms began with several chapters in the Baum and Singh (1994) book (chapters by Baum and Singh; Rosenkopf and Tushman; Van de Ven and Garud). The first two of these chapters follow Roughgarden's population ecology application, whereas the Van de Ven and Garud chapter shows coevolution at two levels—technical and institutional. Three, along with two new additions, continue their coevolutionary perspective in this volume: coevolution of organizational parts and wholes and competitive contexts. This is a significant step forward in evolutionary applications in organizations and obviously a conflation of Campbell's multilevel and evolutionary perspectives.

- Baum elaborates Campbell's rationale for expecting individuals and face-to-face groups to undermine the efficacy of organizational selection. He formalizes several aspects of whole-part competition in organizations using Kauffman's (1993) *NK*[*C*] model of coupled fitness landscapes, and derives some novel approaches to the problem of shared control in organizations that focus on *tuning* the structure of coevolution within them.

- Anderson draws on the idea that BVSR occurs through a *nested hierarch*y, which Campbell helped to popularize, to examine how the range of variation in the population of venture capital funds shapes and constrains variation in firms that receive venture capital funding.

- Ingram and Roberts empirically examine the idea that organizational components may experience evolution independently of entire organizations. Their dynamic analysis of new drug introductions in the U.S. pharmaceutical industry robustly supports their model in which firms are conceived as bundles of routines that comprise productive capabilities, which are, in turn, associated with specific product offerings.

- Rosenkopf and Nerkar advance theories of technological evolution by conceptualizing technology as hierarchies of systems, products and components and by applying Campbell's evolutionary concepts to these hierarchies. Their case study of the optical disc industry illuminates *cross-level* phenomena of downward causation and whole-part coevolutionary competition and *within-level* phenomena of interdependent components and products.

- Van de Ven and Grazman explore how new organizational forms emerge and evolve in a lineage by the crossing and joining existing organizational units, resources and competencies. They ground their framework, in which organizations evolve as entities nested within evolving systems at higher and lower levels by constructing 150-year genealogies of management, strategy, structure and institutional arrangements of health care delivery organizations in Minneapolis-St. Paul.

Process Level Analysis and Modeling. As mentioned earlier, though Campbell (1994) writes of multilevel evolutionary processes, and shows some minimal awareness of the use of microstate modeling in biology, in all of his writing he never quite gets to coevolutionary microstate analysis at the basic process levels of socio-cultural systems or firms. We think this is a life-cycle thing. By the time Campbell evidences appreciation of this kind of analysis he was at retirement age—well past the time when most scientists turn their energies to the nitty-gritty of their discipline—cell counts and gene sequence analyses in biology, item analysis and experimental treatment protocols in psychology, and for both sciences, empirical research, number crunching, and mathematical and computational modeling. Campbell was 31 at the time he received his Ph.D. degree and started as an assistant professor at Ohio State University. His research at the time involves such bench-scientist things as: indirect assessment, effect of ordinal position of responses, social distance scales, operational delineation, galvanic skin response, bias estimates, trait judgments, and response sets. Very definitely the nitty-gritty of psychology at the time. Suppose Campbell is 31—his age at the time of his original Ph.D.—and starting as an assistant professor in 1998? And suppose he was to focus more specifically on firms? What kinds of research would he do? We imagine it would look much like the chapters in this section.

- Madsen, Mosakowski and Zaheer develop a multilevel model of intrafirm BVSR processes that produces firms' dynamic capabilities and heterogeneity. Their empirical analysis of the Foreign Exchange Trading Industry from 1973 to 1993 reproduces the model, showing how prior performance and experience influence the current stock of change capabilities, which, in turn, shape future performance and behavior.

- Pentland adopts a process-oriented approach and empirically grounds a method for characterizing organizations as structured patterns of action to enable organizations to be modelled as *networks of action* that transform inputs and create value rather than networks of individuals, groups, sub-units, or divisions.

- Lomi and Larsen use cellular automata models to represent the recombinant processes hierarchical social systems use to reproduce themselves. Their modeling is designed to illustrate how *levels* are connected without imposing any *a priori* aggregation rules to explore evolution unfolding at different levels of action in organizational systems.

- McKelvey adapts Kauffman's (1993) use of Boolean networks and *NK* models to model intra- and interfirm coevolutionary adaptive strategic processes in 'Portarian' coevolutionary pockets.

Epistemology and Methodology. Campbell writes about these two topics often and well, dating back to 1959. Though our "ratio analysis" shows his epistemological work to be mostly a late career activity, his interest in multimethod triangulation and quasi-experiments dominates his mid career attention. Thus, his methodological ideas have matured into stability by the time of his retirement whereas the epistemological writing starts slowly but keeps growing throughout his life. Quite possibly Campbell's long time interest in bench-science measurement and experiments keeps objectivism at the forefront as he searches for an improved epistemology. Starting in 1959, his early epistemology focuses on BVSR

and the evolution of knowledge. Then, in 1969 we see the first evidence of his "*corrigible, hypothetical, realism*." Attention to cultural relativism emerges in 1972, with multilevel analysis beginning in 1974. His move into semantic relativism and hermeneutics shows up by 1986 (models of language) and 1991 (coherence theory and hermeneutics). As noted earlier, Campbellian realism includes scientific realism, selectionist epistemology, and hermeneutics. Over the years Campbell slowly evolves toward an objective epistemology that also attends to the concerns of interpretists and social constructionists and to the dynamics of how sciences change over time.

- Evans traces Campbell's influence on methodologies in organization science by exploring the influence of two well-known bodies of work—construct validity and quasi experimentation—and one less familiar set of ideas: the analysis of case studies.
- Hendrickx keys in on Campbell's eventual addition of hermeneutics to his development of selectionist evolutionary epistemology. Using Campbell's (1994) essay on individual versus group selection, she shows that a hermeneutic reading of the text indicates that Campbell's fundamental concern centers *not* on whether "groups are real" but rather on whether his use of BVSR necessarily imnplies the selection and retention of selfish individuals at the expense of sociocultural (group) solidarity and altruism.
- McKelvey's examination of Campbell's intense interests in scientific realism and evolutionary epistemology reveals a basis—*Campbellian realism*—for an objective organization science that denies neither the epistemological dynamics of historical relativists nor the sociology of knowledge developed by interpretists and social constructionists, and demonstrates that the current 'paradigm war' between organizational positivists and relativists is philosophically uninformed and dysfunctional.

Looking to the Future

Given the growing rapprochement of organization theory and competitive strategy, especially as indicated by the development of the "resource-based" or "competence-based" views of strategy, which focus on idiosyncratic resources internal to firms (Teece 1984, Rumelt 1987, Barney 1991, Reevis-Connor 1991, Lado and Wilson 1994, Pfeffer 1994, Heene and Sanchez 1996, Porter 1996), there is a growing recognition that organization science needs further development of theories that deal specifically with the rapprochement. Specifically, what are needed are theories that deal with both micro- and macrocoevolutionary multilevel applications of the effects of competitive context (contextualism) and microstates (reductionism). Some starts have been made in this direction in Baum and Singh (1994), and in recent papers by Levinthal (1997), Rivkin (1997), and McKelvey (1998), among others, on the microdynamics of interfirm rivalry and asymmetric competitive dynamics (noted above), as well as new work in this volume. But these are only bare beginnings. More theoretical and methodological "variations" are clearly called for if organization science is to improve its standing as a science and contribute more meaningfully to the competitive positioning, managing, and designing of organizations. Some new variations appear as chapters in this book.

There are four facets to our future vision. **One** goal is to foster the development of an explicit organizational epistemology that is up-to-date in terms of recent developments in the philosophy of science and is relevant in that it specifically focuses on the epistemological peculiarities of organization science. A **second** goal is to stimulate the development of methods that will be more successful in the incremental refutation or corroboration of key elements of the conflicting paradigms in organization science. A **third** goal focuses on fostering the development of micro-and macrocoevolutionary approaches and multilevel applications of selectionist competitive context perspectives. Our **fourth** goal is to speed up the rapprochement of organization theory and competitive strategy by encouraging authors to try to be as innovative and far reaching in their ideas as a young Don Campbell might be if he were starting his career in the mid-1990s. Besides celebrating Campbell's many contributions, we hope this volume will stimulate organization scientists to offer various new extensions to the Campbellian themes, thereby speaking directly to the needs of the field, perhaps as we have characterized them. Our view of the field suggests that this is indeed a timely and worthwhile goal.

References

Alchian, A. A. (1950), "Uncertainty, Evolution and Economic Theory," *Journal of Political Economy*, 58, 211─222.

Aldrich, H. (1979), *Organizations and Environments,* Englewood Cliffs, NJ: Prentice Hall.

Aldrich, H. (1992), "Incommensurable Paradigms? Vital signs from three perspectives," in M. Reed and M. Hughes (Eds.), *Rethinking Organization: New Directions in Organization Theory and Analysis*, London: SAGE (17–45).

Aldrich, H. E. and J. Pfeffer (1976), "Environments of Organizations," *Annual Review of Sociology*, 2, 79─105.

Alvesson, M. and S. Deetz (1996), "Critical Theory and Postmodernism Approaches to Organizational Studies," in S. R. Clegg, C. Hardy and W. R. Nord (Eds.), *Handbook of Organization Studies*, Thousand Oaks, CA: SAGE, 191–217.

Aronson, J. L., R. Harré and E. C. Way (1994), *Realism Rescued*, London, Duckworth.

Arthur, W. B., S. N. Durlauf and D. A. Lane (Eds.) (1997), *The Economy as an Evolving Complex System*, Proceedings Vol. XXVII, Reading, MA: Addison-Wesley.

Arts, E. and J. Korst (1989), *Simulated Annealing and Boltzmann Machines*, New York: Wiley.

Barkow, J. H., L Cosmides and J. Tooby (1992), *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, Oxford, UK: Oxford University Press.

Barney, J. B. (1991), "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, 17, 99–120.

Barney, J. B. and W. G. Ouchi (Eds.) (1986), *Organizational Economics*, San Francisco, CA: Jossey-Bass.

Bates, J. E. and T.D. Wachs (Eds.) (1994), *Temperament: Individual Differences at the Interface of Biology and Behavior*, Washington, DC: American Psychological Association.

Baum, J. A. C. (1996), "Organizational Ecology," in S. R. Clegg, C. Hardy and W. R. Nord (Eds.), *Handbook of Organization Studies*, Thousand Oaks, CA: SAGE, 77–114,

Baum, J. A. C. and J. V. Singh (Eds.) (1994), *Evolutionary Dynamics of Organizations,* New York: Oxford University Press.

Belew, R. K. and M. Mitchell (Eds.) (1996), *Adaptive Individuals in Evolving Populations*, Proceedings Vol. XXVI, Reading, MA: Addison-Wesley.

Bentz, V. M., and J. J. Shapiro (1998), *Mindful Inquiry in Social Research*, Thousand Oaks, CA: SAGE.

Besanko, D., D. Dranove and M. Shanley (1996), *The Economics of Stgrategy*, New York: Wiley.

Beth, E. (1961), "Semantics of Physical Theories," in H. Freudenthal (Ed.), *The Concept and the Role of the Model in Mathematics and Natural and Social Sciences*, Dordrecht, The Netherlands: Reidel, 48–51.

Bhaskar, R. (1975), *A Realist Theory of Science*, London: Leeds Books [2nd ed. published by Verso (London) 1997].

Bitbol, M. (1996), *Schrödinger's Philosophy of Quantum Mechanics*, Dordrecht, The Netherlands: Kluwer.

Brewer, M. B. and B. E. Collins (Eds.) (1981), *Scientific Inquiry and the Social Sciences*, San Francisco, CA: Jossey-Bass.

Brewer, Marilynn B. and Barry E. Collins (Eds.) (1981), *Scientific Inquiry and the Social Sciences*, San Francisco: Jossey-Bass.

Brown, C. (1992), "Organization Studies and Scientific Authority," in M. Reed and M. Hughes (Eds.) (1992), *Rethinking Organization: New Directions in Organization Theory and Analysis*, London: SAGE, 67—84.

Buckley, W. (1967), *Sociology and Modern Systems Theory*, Englewood Cliffs, NJ: Prentice-Hall.

Burrell, G. (1996), "Normal Science, Paradigms, Metaphors, Discourses and Genealogies of Analysis," in S. R. Clegg, C. Hardy and W. R. Nord (Eds.), *Handbook of Organization Studies*, Thousand Oaks, CA: SAGE, 642–658.

Burrell, G. (1997), *Pandemonium: Towards a Retro-Organization Theory*, Thousand Oaks, CA: SAGE.

Burrell, G. and G. Morgan (1979), *Sociological Paradigms and Organizational Analysis*, London: Heinemann.

Campbell, D. T. (1959), "Methodological Suggestions From a Comparative Psychology of Knowledge Processes," *Inquiry*, 2, 152—182.

Campbell, D. T. (1965), "Variation and Selective Retention in Socio-Cultural Evolution," in H. R. Barringer, G. I Blanksten, and R. W. Mack (Eds.), *Social Change in Developing Areas: A Reinterpretation of Evolutionary Theory*, Cambridge, MA: Schenkman, 19—48.

Campbell, D. T. (1969a), "A Phenomenology of the Other One: Corrigible, Hypothetical and Critical," in T. Mischel (Ed.), *Human Action: Conceptual and Empirical Issues*, New York: Academic Press, 41—69.

Campbell, D. T. (1969b), "Ethnocentrism of Disciplines and the Fish-Scale Model of Omniscience," in M. Sherif and C. W. Sherif (Eds.), *Interdisciplinary Relationships in the Social Sciences*, Chicago, IL: Aldine, pp. 328—348.

Campbell, D. T. (1972), "Herskovits, Cultural Relativism, and Metascience," in M. J. Herskovits, *Cultural Relativism*, New York: Random House, pp. v—xxiii.

Campbell, D. T. (1974), "'Downward Causation' in Hierarchically Organized Biological Systems," in F. J. Ayala and T. Dobzhansky (Eds.), *Studies in the Philosophy of Biology*, London: Macmillan, 179—186.

Campbell, D. T. (1981a), "Comment: Another Perspective on a Scholarly Career," in M. B. Brewer and B. E. Collins (Eds.), *Scientific Inquiry and the Social Sciences*, San Francisco, CA: Jossey-Bass, pp. 454—486.

Campbell, D. T. (1981b), "Levels of Organization, Selection, and Information Storage in Biological and Social Evolution," *The Behavioral and Brain Sciences*, 4, 236—237.

Campbell, D. T. (1983), "The Two Distinct Routes Beyond Kin Selection to Ultra-Sociality: Implications for the Humanities and Social Sciences," in D. L. Bridgeman (Ed.), *The Nature of Prosocial Development: Interdisciplinary Theories and Strategies*, New York: Academic Press, pp. 11—41.

Campbell, D. T. (1986), "Science's Social System of Validity-Enhancing Collective Belief Change and the Problems of the Social Sciences," in D. W. Fiske and R. A. Shweder (Eds.), *Metatheory in Social Science: Pluralisms and Subjectivities*, Chicago, IL: University of Chicago Press, 108—135.

Campbell, D. T. (1990), "Levels of Organization, Downward Causation, and the Selection-Theory Approach to Evolutionary Epistemology," in G. Greenberg and E. Tobach (Eds.), *Theories of the Evolution of Knowing*, (the T. C. Schneirla Conference Series, Vol. 4), Hillsdale, NJ: Erlbaum, 1—17.

Campbell, D. T. (1991), "Coherentist Empiricism, Hermeneutics, and the Commensurability of Paradigms," *International Journal of Educational Research*, 15, 587—597.

Campbell, D. T. (1994), "How Individual and Face-to-Face-Group Selection Undermine Firm Selection in Organizational Evolution," in J. A. C. Baum and J. V. Singh (Eds.), *Evolutionary Dynamics of Organizations*, New York: Oxford University Press, 23—38.

Campbell, D. T. and D. W. Fiske (1959), "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," *Psychological Bulletin*, 56, 81—105.

Campbell, D. T. and J. C. Stanley (1963), "Experimental and Quasi-Experimental Designs for Research on Teaching," in N. L. Gage (Ed.), *Handbook of Research on Teaching*, Chicago, IL: Rand McNally, pp. 171—246.

Cannella, A. A. and R. L. Paetzold (1994), "Pfeffer's Barriers to the Advance of Organization Science: A Rejoinder," *Academy of Management Review*, 19, 331–341.

Carroll, G. R. (Ed.) (1988), *Ecological Models of Organizations*, Cambridge, MA: Ballinger.

Chandler, A. D., Jr. (1977), *The Visible Hand*. Cambridge, MA: Belknap/Harvard University Press.

Chia, R. (1996), *Organizational Analysis as Deconstructive Practice*, Berlin, Germany: Walter de Gruyter.

Clegg, S. R., C. Hardy and W. R. Nord (Eds.), *Handbook of Organization Studies*, Thousand Oaks, CA: SAGE.

Cowan, G. A., Pines and D. Meltzer (Eds.) (1994), *Complexity: Metaphors, Models, and Reality*, Proceedings Vol. XIX, Reading, MA: Addison-Wesley.

Cramer, F. (1993), *Chaos and Order: The Complex Structure of Living Things* (trans. D. L. Loewus), New York: VCH.

Daft, R. L. and A. Y. Lewin (1990), "Can Organization Studies Begin to Break Out of the Normal Science Straightjacket? An Editorial Essay," *Organization Science*, 1, 1–9.

Dawkins, R. (1976), *The Selfish Gene*, New York: Oxford University Press.

De Regt, C. D. G. (1994), *Representing the World by Scientific Theories: The Case for Scientific Realism*, Tilburg, The Netherlands: Tilburg University Press.

Donaldson, L. (1995), *American Anti-Management Theories of Organization*, Cambridge, UK: Cambridge University Press.

Donaldson, L. (1996), *For Positivist Organization Theory*, Thousand Oaks, CA: SAGE.

Dunn, E. S. (1971), *Economic and Social Development*, Baltimore, MD: Johns Hopkins Press.

Eldredge, N. (1995), *Reinventing Darwin*, New York: Wiley.

Farrell, M. J. (1970), "Some Elementary Selection Processes in Economics," *Review of Economic Studies*, 37, 305─319.

Fischer, K. H. and J. A. Hertz (1993), *Spin Glasses*, New York: Cambridge University Press.

Fisher, R. A. (1930), *The Genetical Theory of Natural Selection,* Oxford: Oxford University Press.

Freeman, J. A. and D. M. Skapura (1992), *Neural Networks: Algorithms, Applications, and Programming Techniques*, Reading, MA: Addison-Wesley.

Friedman, M. (1953), *Essays in Positive Economics,* Chicago: University of Chicago Press.

Fuller, S. (1993), *Philosophy of Science and its Discontents* (2nd ed.), New York: Guilford.

Gibbs, J. W. (1902), *Elementary Principles in Statistical Mechanics*, New Haven, CT: Yale University Press.

Godfrey, P. C. and C. W. L. Hill (1995), "The Problem of Unobservables in Strategic Management Research," *Strategic Management Journal*, 16, 519–533.

Groenewegen, J. (Ed.) (1996), *Transaction Cost Economics*, Boston, MA: Kluwer.

Haire, M. (1959), "Biological Models and Empirical Histories of the Growth of Organizations," in M. Haire (Ed.), *Modern Organization Theory*, New York: Wiley, pp. 272─306.

Haldane, J. B. S. (1932), *The Causes of Evolution*, New York: Harper.

Hannan, M. T. and J. Freeman (1977), "The Population Ecology of Organizations," *American Journal of Sociology*, 83, 929–984.

Hartman, E. (1988), *Conceptual Foundations of Organization Theory*, Cambridge, MA: Ballinger.

Hassard J. and R. Holliday (1998), *Organization Representation: Work and Organizations in Popular Culture*, Thousand Oaks, CA: SAGE.

Hassard, J. (1993), "Postmodernism and Organizational Analysis: An Overview," in J. Hassard and M. Parker (Eds.), *Postmodernism and Organizations*, Thousand Oaks, CA: SAGE, pp. 1─23..

Hassard, J. and M. Parker (Eds.) (1993), *Postmodernism and Organizations*, Thousand Oaks, CA: SAGE.

Hawley, A. (1950), *Human Ecology*, New York: Ronald Press.

Heene, A. and R. Sanchez (Eds.) (1996), *Competence-Based Strategic Management*, New York: Wiley.

Hirshleifer, J. (1977), "Economics from a Biological Viewpoint," *Journal of Law and Economics*, 20, 1─52.

Hogarth, R. M. and M. W. Reder (Eds.) (1987), *Rational Choice: The Contrast Between Economics and Psychology*, Chicago: University of Chicago Press.

Holland, J. H. (1975), *Adaptation in Natural and Artificial Systems*, Ann Arbor, MI: University of Michigan Press [2nd edition, MIT Press, 1992).

Holton, G. (1993), *Science and Anti-Science*, Cambridge, MA: Harvard University Press.

Hunt, S. D. (1994), "On the Rhetoric of Qualitative Methods: Toward Historically Informed Argumentation in Management Inquiry," *Journal of Management Inquiry*, 23, 221–234.

Kauffman, S. A. (1993), *The Origins of Order: Self-Organization and Selection in Evolution,* New York: Oxford University Press.

Kaufman, H. (1975), "The natural history of organizations," *Administration and Society*, 7, 131─149.

Kaye, B. (1993), *Chaos & Complexity*, New York: VCH.

Kuhn, T. S. (1962), *The Structure of Scientific Revolutions*, Chicago, IL: University of Chicago Press.

Lado, A. A. and M. C. Wilson (1994), "Human Resource Systems and Sustained Competitive Advantage: A Competency-Based Perspective," *Academy of Management Review*, 19, 699–727.

Levinthal, D. A. (1997), "Adaptation on Rugged Landscapes," *Management Science*, 43, 934–950.

Lincoln, Y. S. (Ed.) (1985), *Organizational Theory and Inquiry*, Newbury Park, CA: SAGE.

Lloyd, E. A. (1988), *The Structure and Confirmation of Evolutionary Theory*, Princeton, NJ: Princeton University Press.

Maynard Smith, J. (1975), *The Theory of Evolution* (3rd ed.), Harmondsworth, UK: Penguin.

McKelvey, B. (1982), *Organizational Systematics: Taxonomy, Evolution and Classification,* Berkeley, CA: University of California Press.

McKelvey, B. (1997), "Quasi-natural Organization Science," *Organization Science*, 8, 351─380.

McKelvey, B. (1998), "Complexity vs. Selection Among Coevolutionary Microstates in Firms: Complexity Effects on Strategic Organizing," *Comportamento Organizacional E Gestão*, 4, 17─59.

McKinlay, A. and K. Starkey (1998), *Foucault, Management, and Organization Theory*, Thousand Oaks, CA: SAGE.

Mezard, M., G. Parisi and M. A. Vivasoro (1987), *Spin Glass Theory and Beyond*, Singapore: World Scientific.

Miner, J. B. (1980), *Theories of Organizational Behavior*, Hinsdale, IL: Dryden.

Mitchell, M. (1996), *An Introduction to Genetic Algorithms*, Cambridge, MA: MIT Press.

Mone, M. A. and W. McKinley (1993), "The Uniqueness Value and Its Consequences for Organization Studies," *Journal of Management Inquiry*, 2, 284–296.

Natanson, M. (Ed.) (1963), *Philosophy of the Social Sciences*, New York: Random House.

Neurath, O. with R. Carnap and H. Hahn, Wissenschaftliche Weltauffassung, Der Wiener Kreis, Wien, Artur Wolf, 1929. [A pamphlet reprinted and translated in M. Neurath and R. S. Cohen (Eds.), *Empiricism and Sociology*, Dordrecht, The Netherlands: Reidel, 1973, pp. 301─318.]

Nicholson, N. (1997), "Evolutionary Psychology: Toward a New View of Human Nature and Organizational Society," *Human Relations*, 50, 1063─1078.

Nicolis, G. and I. Prigogine (1989), *Exploring Complexity: An Introduction*, New York: Freeman.

Penrose, E. T. (1952), "Biological Analogies in the Theory of the Firm," *American Economic Review*, 42, 804─819.

Perrow, C. (1994), "Pfeffer Slips," *Academy of Management Review*, 19, 191–194.

Pfeffer, J. (1993), "Barriers to the Advancement of Organizational Science: Paradigm Development as a Dependent Variable," *Academy of Management Review*, 18, 599–620.

Pfeffer, J. (1994), *Competitive Advantage Through People*, Boston, MA: Harvard Business School Press.

Pfeffer, J. (1995), "Mortality, Reproducibility, and the Persistence of Styles of Theory," *Organization Science*, 6, 681–686.

Pfeffer, J. (1997), *New Directions for Organization Theory: Problems and Prospects*, New York: Oxford University Press.

Pinker, S. (1997), *How the Mind Works*, New York: Norton.

Plomin, R. (1994), *Genetics and Experience: The Interplay between Nature and Nurture*, Thousand Oaks, CA: SAGE.

Popper, K. R. (1956/1983), *Realism and the Aim of Science*, (From the *Postscript to The Logic of Scientific Discovery*, edited by W. W. Bartley III), Totowa, NJ: Rowman and Littlefield.

Popper, K. R. (1959), *The Logic of Scientific Discovery*, New York: Harper and Row (German version, 1935).

Popper, K. R. (1963), *Conjectures and Refutations*, London: Routledge & Kegan Paul.

Popper, K. R. (1972), *Objective Knowledge: An Evolutionary Approach*, Oxford: Oxford University Press.

Porter, M. E. (1980), *Competitive Strategy,* New York: Free Press.

Porter, M. E. (1996), "What Is Strategy?" *Harvard Business Review*, Nov.-Dec., 61–78.

Rasmusen, E. (1994), *Games and Information* (2nd ed.), Cambridge, MA: Basil Blackwell.

Reed, M. (1996), "Organizational Theorizing: A Historically Contested Terrain," in S. R. Clegg, C. Hardy and W. R. Nord (Eds.), *Handbook of Organization Studies*, Thousand Oaks, CA: SAGE, 31–56.

Reed, M. and M. Hughes (Eds.) (1992), *Rethinking Organization: New Directions in Organization Theory and Analysis*, London: SAGE.

Reevis-Conner, K. (1991), "A Historical Comparison of Resource-Based Theory and Five Schools of Thought Within Industrial Organizational Economics: Do We Have a New Theory of the Firm?" *Journal of Management*, 17, 121–154.

Rivkin, J. (1997), "Imitation of Complex Strategies," presented at Academy of Management, Boston, MA.

Roughgarden, J. (1976), "Resource Partitioning Among Competing Species—A Coevolutionary Approach," *Theoretical Populations Biology*, 9, 388─424.

Rumelt, R. P. (1987), "Theory, Strategy, and Entrepreneurship," in D. J. Teece (Ed.), *The Competitive Challenge,* Cambridge, MA: Ballinger, 137–158.

Schwartz, P. and J. Ogilvy (1979), "The Emergent Paradigm: Changing Patterns of Thought and Belief," Analytic Report 7, Values and Lifestyle Program, Menlo Park, CA: SRI International.

Singh, J. V. (Ed.) (1990), *Organizational Evolution*, Menlo Park, CA: SAGE.

Suppe, F. (1977), *The Structure of Scientific Theories* (2nd ed.), Urbana, IL: University of Illinois Press.

Suppe, F. (1989), *The Semantic Conception of Theories & Scientific Realism*, Urbana-Champaign, IL: University of Illinois Press.

Suppes, P. (1962), "Models of Data," in E. Nagel, P. Suppes, and A. Tarski, (Eds.), *Logic, Methodology, and Philosophy of Science: Proceedings of the 1960 International Congress*, Stanford, CA: Stanford University Press, 252─261.

Teece, D. J. (1984), "Economic Analysis and Strategic Management," *California Management Review*, 26, 87–110.

Thompson, P. (1989), *The Structure of Biological Theories*, Albany, NY: State University of New York Press.

Toulmin, S. (1953), *The Philosophy of Science: An Introduction*, London: Hutchinson.

Toulmin, S. (1961), *Foresight and Understanding*, London: Hutchinson.

Toulmin, S. (1972), *Human Understanding*, Vol. I, Princeton, NJ: Princeton University Press.

Van Fraassen, B. C. (1980), *The Scientific Image*, Oxford, UK: Clarendon.

Van Maanen, J. (1995a), "Style As Theory," *Organization Science*, 6, 133–143.

Van Maanen, J. (1995b), "Fear and Loathing in Organization Studies," *Organization Science*, 6, 687–692.

Weick, K. E. (1979), *The Social Psychology of Organizing* (2nd ed.), Reading, MA: Addison-Wesley.

Weisbuch, G. (1993), *Complex Systems Dynamics: An Introduction to Automata Networks*, Reading, MA: Addison-Wesley.

Williams, G. C. (1966), *Adaptation and Natural Selection: A Critique of Some Current Evolutionary Thought*, Princeton, NJ: Princeton University Press.

Williamson, O. E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press.

Winter, W. G. (1964), "Economic 'Natural Selection' and the Theory of the Firm," *Yale Economic Essays*, 4, 225─272.

Wolpert, L. (1992), *The Unnatural Nature of Science*, Cambridge, MA: Harvard University Press.

Wright, S. (1931), "Evolution in Mendelian Populations," *Genetics*, 16, 97–159.