THE SERPENT'S TRAIL: WILLIAM JAMES, OBJECT-ORIENTED COMPUTING, AND CRITICAL REALISM

Larry J. Crockett

Abstract. Pragmatism has played only a small role in the half-century and more of the science-and-religion dialogue, in part because pragmatism was at a low ebb in the 1950s. Even though Jamesean pragmatism in particular is experiencing a resurgence, owing partly to the work of Rorty and Putnam, it remains inconspicuous in the dialogue. Excepting artificial intelligence and artificial life, computer science also has not played a large role in the dialogue. Recent research into the foundations of object-oriented programming, however, shows this increasingly pervasive practice possesses an implicit pragmatist epistemology. Since science will have to become more computational, it will have to come to terms with both object-oriented computing and its implicit pragmatism, which in turn supports the conclusion that we have fresh warrant for recasting the science-and-religion dialogue in Jamesean pragmatist terms. Some preliminary consequences of such a recasting of the dialogue are explored.

Keywords: Darwin; epistemology; Alan Kay; logic; Alister McGrath; philosophy of computing; Hilary Putnam; Brian Cantwell Smith; software crisis; underdetermination.

Like swaddling bands in the infancy narratives of the New Testament, critical realism (CR) has swathed the science-and-religion dialogue from the inaugural issue of *Zygon*. Not only was it integral to the birthing of the modern dialogue, CR has "for decades been the 'orthodox' position" (Gregersen 2004, 77). Incorporating some of the consequential developments of twentieth-century philosophy, critical realism emphasizes a role for metaphor in both science and religion, a correspondence theory of truth, and an analogical understanding of the role of evidence in scientific and religious communities (Russell 2004, 3). Moreover, critical realism is often seen as the philosophical bridge (exemplified by the cover of *Theology and Science*) that is needed for a productive conversation between science and religion. As a result, it would seem that the place of CR in the dialogue is secure.

Just as swaddling bands were abandoned because they are too constraining, however, so there is a growing number of voices urging—and substantial new grounds for—the abandonment of critical realism as too restrictive for the dialogue. The voices include J. Wesley Robbins (1999) who argues that critical realism is based on a dated Cartesian view of human cognition, Andreas Losch (2010) who suggests realist language accentuates the differences between science and religion, and Richard Bernstein who questions the advisability of any "Janus-faced" epistemology (2010, 186). The new grounds include: first, fresh insight that science must, given the deluge of data it faces, inexorably employ computational techniques, most notably, object-oriented programming (OOP); and second, since there is a good case to be made that the epistemology of OOP is implicitly pragmatist, it follows that pragmatism will be a more productive philosophical lens with which to view science.

As a result, I will argue that we are now in a position to see why Jamesean pragmatism—captured in William James's memorable aphorism, "the trail of the human serpent is thus over everything"—is a better philosophical premise for the science-and-religion dialogue than the increasingly problematical critical realism.

Critical Realism and Robbins' Critique

In more than a half century of the S-and-R dialogue, pragmatism has been championed here and there, notably by J. Wesley Robbins' (1988; 1993; 1999) work, but has not been widely embraced. While espousing pragmatism in some of her papers, for example, Nancey Murphy (1990) explores a variety of philosophical approaches to theology in the age of science, but there is no consideration of pragmatism. John Hedley Brooke (1991) briefly discusses pragmatism, but more as a curiosity than a resource for the S-and-R dialogue. Arthur Peacocke (1993) distinguishes several views—namely, naïve realism, instrumentalism, and critical realism, but makes no reference to pragmatism. Alister McGrath (1999) devotes three pages to James the psychologist but none to pragmatism. Last, Philip Clayton's (2006) thousand-page *Oxford Handbook* says almost nothing about pragmatism, classical or modern.

The reigning champion, critical realism, maintains that we can have genuine knowledge of a mind-independent world while accommodating the litany of epistemological limitations stemming from the Enlightenment in general and David Hume and Immanuel Kant in particular. Critical realists are impressed that the world possesses characteristics and regularities that our formal and natural languages can portray with a degree of success that would be inexplicable if science consisted of useful fictions or handy tools. Specifically, CR affirms these propositions (Barbour 1966, 172): first, there is a mind-independent world that is amenable to human investigation; and second, we can discover and represent the structures of the world, even though we do so metaphorically and only partially. In particular, unobservables are amenable to inferential representation with unexpected "verisimilitude" (Polkinghorne 2005, 4)—including those referring to unobservables such as electrons in physics (they are remarkably round) or God in theology (God is remarkably gracious).

As intimated above, however, sundry undercurrents threaten the viability of critical realism. Nancey Murphy (1993) criticizes critical realism, as does Robbins (1988; 1993). Niels Gregersen provides a comprehensive assessment of critical realism before observing "[Critical realism] is virtually nonexistent in today's philosophy of science" (2004, 86). Though there are exceptions (e.g., Niiniluoto 1999), Gregersen makes a disquieting point: the S-and-R dialogue largely employs a view of science that is primarily used by social theorists and dialogue participants but not by mainstream philosophers of science. It might be objected that this point stems from semantics or trivial disciplinary differences, but I will argue it is more serious.

J. Wesley Robbins (1999) provides an incisive pragmatist critique of critical realism. Robbins argues that CR is dependent on a "generic Cartesian" view of human cognition that is both pre-Darwinian and increasingly at odds with more recent cognitive science (see Laura Reed 2008) . More specifically, Robbins underscores critical realism's commitment to *representationalism*: the human mind consists of mental representations that are computationally manipulated in order to generate better representations that more faithfully portray the external world. On CR's view, the "cognitive value" of both science

and theology is a function of how well their representations correspond to external scientific and religious realities. Robbins suggests that critical realism is so committed to representationalism, it commits the "unforgivable sin" (1999, 656) of ideologically precluding alternative approaches.

For present purposes, it is important to note a parallel between critical realism and not only classical AI but also classical, formalist computer science. "It's the architecture, not the stuff" was the classic AI shibboleth as researchers emphasized formal program and de-emphasized neurons and learning. While Robbins rightly questions the quotidian software-hardware distinction, what he should emphasize is the parallel of critical realism's distinction between formal operations and mental representations, on one hand, with classical computer science's distinction between algorithms and data structures, on the other. The latter distinction still obtains in most computer science curricula but is, as we will see, increasingly indefensible. For CR, while there is laudable recognition of the role of model and metaphor, cognition is understood to be formal operations on representations, and the distinction is both sharp and essential because representations are candidates for propositions that express the principles "governing"—and describe the entities comprising—a mind-independent world.

Moreover, the Cartesian chasm between representations and everything non-representational (and, as suggested above, between data structures and algorithms) "is the seedbed for the problem of knowledge about the external world" (Robbins 1999, 657). Since critical realism wishes to distance itself from naïve realism, representations are not directly caused by the world, but stem significantly from inference and formal manipulation. The epistemic differences between a child and a robot diminish and psychology becomes more like artificial intelligence. A "generically Cartesian" mind, notably, is unable finally to determine to what extent its representations correspond to the world because there is no representation-independent way to make the judgment.

Last, Robbins also highlights more recent work in dynamic systems that are non-computational, which may turn out to be better explanations for psychological competence than computationally based cognitive science. Indeed, we ought to have

learned by now that from the fact we can model a phenomenon mathematically or computationally, it would not follow that the phenomenon is best explained in those terms. I once asked a mathematician colleague if the earth solves differential equations as it orbits the sun. He thought for a moment, paused, and responded, "Of course, it has to." I was reminded of Whitehead's criticism that Kant "balanced the world upon thought—oblivious to the scanty supply of thinking" ([1929] 1979, 151). Notably, Robbins argues that cognitive facility need not be representational since cognition can function adaptively without representation. As we will see, some writers in more recent computer science abandon the classical Cartesian view of cognition because it (and CR) presuppose an understanding of computation that does not scale to the level of genuine psychological competence—as the failure of classical AI suggests (Crockett 1994).

Legend, Realism, And William James

It is becoming more evident that critical realism embodies mid-20th-century sensibilities that are now in retreat. Describing a predecessor of critical realism that he nominates "Legend," Philip Kitcher writes that it "proposed to uncover the logic of confirmation, the logical structure of theories and the logic of explanation ... References to logic reverberate like drumrolls ..." (1993, 5). My claim is that critical realism is significantly dependent on Legend's outmoded views. On this view dating to the 1940s and 50s, there is a distillable logic to science as it discovers both the real constituents of the world and the causal relations obtaining between them. I am going to use the word *Legend* to include these assumptions: mind-body dualism; reason transcends biology; essences define kinds; rationality is the essence of human nature; logic epitomizes ideal reasoning; and reasoning involves manipulation of formal constituents representing the world.[1] Kitcher, a protégé of Stephen Jay Gould, urges the replacement of Legend by naturalism, a cousin of pragmatism. Both naturalism and pragmatism welcome biological and psychological contributions to understanding how science works. The grandfather of Legend, the logician Gottlieb Frege ([1884] 1980, 3), as well as the early Ludwig

Wittgenstein (1922) of the *Tractatus*, famously denied the epistemic relevance of the sciences, especially Darwinism (1922, 4.1122).

There is no more protean and therefore treacherous word in philosophical tradition than *realism*, but it may be useful to distinguish four realist movements in order to explain better the relationship of pragmatism to critical realism. The most pressing question in philosophy in the last 200 years has been that of *reference*—how do our words refer to the world? *Naive realism* imagines we are in unmediated contact with external objects, such that veridical perception yields the real objects in the world. *New realism* maintains that objects have fixed essences independently of our knowledge, thus opening a distinction between perception and world. *Critical realism* argues that we need an intermediator between mind and the world, in part, in order to account for error in perception. While Jamesean pragmatism wants to affirm the reality of the world and some of our realist intuitions, it argues that the movement from naive to critical realism opens exactly the bifurcations—indeed the dualisms—that have turned out to be epistemic dead-ends.

As a result, critical realism and pragmatism have some common ancestry but it is important to understand their different views of human cognition. Reflecting the mid-20th-century ethos in which it was born, CR emphasizes *representation* (Barbour 1966, 159) as the third term to buttress Descartes's classic dualist division of mind from world. Words and ideas represent a world that is independent of mind. Jamesean pragmatism, by contrast, offers a naturalized, Darwinian psychology by suggesting that the function of human cognition is not to *represent* the world but to *cope* adaptively with it. The referent of an idea is not the world but another experience; pragmatism *embodies* idealism and collapses Cartesian dualism into a single biopsychological experience.

Critical realism further maintains that it reflects the accumulating lessons of 20th-century philosophy of science, such as the role of models and metaphors, but I argue it reflects a mid-20th-century image of science that was progressively abandoned after 1980. Rorty's widely debated (1981) *Philosophy and the Mirror of Nature* and Kitcher's (1992) "The Naturalists Return" both reflected and contributed to the tectonic upheaval in

mainstream philosophy of science that more recent critical realism largely ignores. Naturalism maintains, in concert with pragmatism, that the results of science are much more pivotal than logic to understanding how and why science is productive. If my claim that critical realism has Legend coursing in its veins seems suspect, consider Robert Russell's second of five elements in his definition of critical realism (2004, 53):

> 2. a Hempelian hypothetico-deductive methodology embedded in a contextualist/ explanatory and historicist/competitive framework (against positivism, empiricism, and instrumentalism).

This is a mid-20th-century image of science: take a healthy portion of Carl Hempel (science as the logic of explanation), leaven with some Thomas Kuhn (historicism), sprinkle with some sociology of knowledge, and we have a first approximation of critical realism. Though his views evolved over time, no one embodied Legend more than Hempel (Kitcher 1993, 5, 142n) with his astutely articulated logicist view of scientific confirmation and explanation. Even Kuhn's (1962) historicist account evidences Legend's legacy with its appeal to *structure* and *paradigm*. This unstable admixture of logic with history generated the self-replicating epistemic epicycles of mid-20th-century philosophy of science and helps explain why the naturalists returned in force after 1980. Indeed, William James was arguably the original American naturalist and Kitcher now occupies the John Dewey chair at Columbia and reads James (Gasper 2004).

In fact, it is difficult to imagine a more significant figure in the history of ideas than William James. In a handwritten note to Charles Hartshorne, Alfred North Whitehead suggests that James "is the analogue to Plato" (Hartshorne 1972, ix) and in *Modes of Thought* observes there are "four great thinkers ... Plato, Aristotle, Leibniz and William James" (1938, 2). Hilary Putnam writes that Bertrand Russell, despite disliking James's view of truth, in lecturing at Harvard had "two heroes in his lectures—Plato and James" (1995, 6). Less happily, perhaps because of the power but also the inconsistency of his work, James is an unintentional fountainhead in the history of thought. One line of thought from James to Whitehead to Barbour culminates in critical realism; another from

James to Dewey to Rorty culminates in a quasi-relativistic neo-pragmatism. Thus, James's writings issued in exactly the kind of bifurcation he strove to avoid.

James was deeply influenced by Darwin even though—perhaps because—he did original research with Louis Agassiz, the principal opponent of Darwin in America. Foreshadowing his development of pragmatism, James became convinced Agassiz's elaborate theory of divine creation of biological types added nothing useful to biological research (Croce 1995). Even James's approach to Legend's beloved logic is Darwinian. James holds that necessary truths originate in the brain rather than in external structures such as Plato's eternal forms (1890, 664; see also [1876] 1978, 7-22). Necessary truths are analogous to instincts and, therefore, evolve in the interplay of chance with natural selection. James's view of truth and true beliefs is doubly Darwinian: truth is defined in terms of survival value, and true beliefs—effectively cognitive species—emerge and perish over time.

Though Legend largely came after James, we can see in Jamesean pragmatism a way round the failures of Legend and, derivatively, the vulnerabilities of CR. But it means engaging James's contentious claim that we deem a proposition true if it works satisfactorily, that the meaning of a proposition is equivalent to the practical consequences of embracing it. Arguing against the "stagnant property" view, James famously—for some, notoriously—writes that "truth happens to an idea ... [ideas are] made true by events" (1907, 201). The *pragmatic maxim*, which dates to C. S. Peirce (1878), presses us further by claiming that a complete enumeration of a concept's experiential implications exhausts its meaning. Pragmatists hope to mitigate the unproductive metaphysical speculation, ideological conflict, and epistemic aporias that historically characterized so much reflection on both science and religion.

James just as famously observes that the history of ideas is "to a great extent that of a certain clash of human temperaments," between the "tough-minded" and the "tender-minded" (1907, 12). The tough-minded are disposed to the analytical, while the tender-minded find the world more subtle and the sources of ideas more diffuse. The tender-minded tend to be idealistic, sanguine, and religious, while the tough-minded are

typically materialistic, resigned, and irreverent. The tender-minded celebrate free will as integral to human self-understanding while the tough-minded are skeptical and reconciled to fate. Thus, many of the lines of the purported classic "warfare" between science and religion are set. We can see also that the tough-minded appear in Legend and in the formalist computer science that the tender-minded artisans of OOP, notably, strive to subvert.

Belief is more important than theory since "there is no eternally standing system of extra-subjective verity to which our judgments ... are obliged to conform" ([1904] 1987, 1139). We construct our beliefs—keep in mind Peirce's Pragmatist Maxim, "Consider what effects ... we conceive the object of our conception to have" (1878, 293)—in light of whether they help solve the problems we face. James's "radical empiricism" excises extraneous concepts, controversies, and metaphysical questions that fail the radical empiricist test, namely, do they make a difference as we work to solve problems we find compelling? As we will see, just as the object-oriented programmer dismisses as computationally meaningless the trepidation there is a mind-independent, external reality that is beyond simulation, so James has little patience for the raft of metaphysical and epistemological questions that generate interminable debate, but do not augment our problem-solving efforts. These questions take us away from our experience—and what ideas best express the relations inherent in our experience.

For James, theory is never adequate to its task but we make progress, both individually and corporately, by coaxing our beliefs to become more effective over time. They become more effective not because they become more coherent or because they more accurately represent an extra-conscious reality, but because they become more adequate to the task. Truth resides not in abstract propositions but emerges in the stream of consciousness, specifically in goal-enabling perception. It is in perception that idea and object are indissolubly fused, which Jamesean pragmatism proposes as a way to avoid the epistemic quagmires (e.g., the failures of both confirmationism and falsificationism and the problematical representationalism ingredient in Legend more generally) so

characteristic of the 20th century. Indeed, truth is more like vibrant good health than bloodless Boolean logic.

Audaciously, James maintains that we have a right to believe, even if the evidence by itself is inadequate. James's seminal *Principles of Psychology* thematically anticipated *Pragmatism*—the human subject is a "fighter for ends" ([1871] 1905, 141) who sculpts experience according to personal interests and chooses belief despite the fact that evidence and logic alone are insufficient to confirm beliefs. James intuitively understood what we now call underdetermination—that theories are underdetermined by evidence alone—and provided a psychological solution: we will accept those theories "which appeal most urgently to our aesthetic, emotional and active needs" (1890, 312). Since pragmatism holds abstract theory at arm's length, it strives to "avoid the grip of theory" (Goodman, 2002, 18).

James is the psychological tour guide to the irreducibly variable phenomena that appear in our experience, and he was loathe to subsume them precipitously under abstract, theoretical structure. Long plagued by a variety of physical ailments, for example, James concluded that our infirmities are pertinent to the philosophical dilemmas that present themselves. From the *Principles of Psychology* to *Pragmatism* to *A Pluralistic Universe*, James writes that the "personal point of view" (Goodman, 2002, 48) stands equally with the scientific point of view.

Pragmatism offers a "mediating way of thinking" (1907, 40) since theories are partly the expression of human temperament and passion. Philosophers imagine philosophical disputes to be only a contention of ideas, but James the psychologist insists they are also a clash of temperaments which give rise to the ideas. Pragmatism "unstiffens" (1907, 53) rigid theories so that it might help find middle ground between contending perspectives. James the philosopher is always James the psychologist who is always James the physiologist, impressed by the body as a necessary condition for knowledge. One of James's chief virtues is that he never forgets that a scientist, philosopher or believer is still a person and being a person is inextricably bound up with

every scientific, philosophical and religious belief. For James, the route to truth is both academic and personal.

Expressed anachronistically, for James there is no single principle, no single essence, that describes any human activity since there are only Wittgensteinian family resemblances. Names obscure local diversity with an essentialist illusion—in computer science terms, they are like an object array containing different data types. James therefore abandons classical philosophical searches for incisive definitions and unambiguous starting points and resists typical Western metaphysical searches for unsullied rationality mirroring transcendent structure. He espouses an epistemological, "happy-go-lucky" (1907, 259) anarchism that resists rationalist characterizations and reductions of the irreducibly ambiguous and messy. *The Varieties of Religious Experience* ostensibly explores religious experience but it is also an exercise in Jamesean epistemology. James anticipates the agile programmer who looks askance at formal proofs and software programming as engineering.

We should see in James an unusual openness to fresh experience unencumbered by tradition. His radical empiricism entails the claim that it is "fatal to lose connexion with the open air of human nature, and to think in terms of shop-tradition only" (1920, 17). He writes that reason is inexorably passionate—"the knower is an actor" who "registers the truth he helps to create" ([1876] 1978, 21). James typically (he is not consistent) criticizes correspondence views brandishing the purported "fit" of theories with the intrinsic nature of reality by saying they add nothing to practice which funds adaptive belief and action. The definition of belief as "that upon which a man is prepared to act," attributed to Alexander Bain by Peirce (1934, 7), succinctly captures Jamesean epistemology. Since there is never exact repetition in human streams of consciousness, signally, all belief is unavoidably biological wagering.

Wittgenstein, Induction, And Dismantling Classical Reason

Russell Goodman (2002) chronicles the deep and often unappreciated influence of James on Ludwig Wittgenstein. So enduring was the impression left by *The Varieties of*

Religious Experience ([1902] 1920) that it contributed to the later Wittgenstein's abandonment of Legend. Under the influence of James, Wittgenstein rejects the Platonic notion that the rules of language are part of a metaphysical domain and independent of human beings. For Wittgenstein, our practice is the ground and practice needs no additional foundation. Wittgenstein relished the James of *The Varieties of Religious Experience* precisely because James examined lots of cases and did not rush to theoretical subsumption of those cases under theory.

Notably, both Wittgenstein and James are "in the business of resisting the seeming necessities of bad theories" (Goodman 2002, 85). Goodman chronicles the parallels between James and Wittgenstein and their common migration from emphasizing explanation to emphasizing description. After his idiosyncratic expression of Legend in his *Tractatus* (1922), the later Wittgenstein pushed analytic philosophy in a semi-Jamesean direction. Wittgenstein would second James's dismissal of rationalist philosophers, "To say that phenomena inhere in a substance is at bottom only to record one's protest against the notion that the bare existence of the phenomena is the total truth" ([1871] 1905, 346).

Both writers reject the idea that analysis shows there is an underlying deep structure to language. Wittgenstein thinks this is bad philosophy, James that it is bad psychology. Both attempt to keep the ordinary and common away from the "falsifying clutches" (Goodman 2002, 147) of theories. There is nothing more fundamental than conventional language and workaday consciousness. James writes that it is "far too little recognized how entirely the intellect is built up of practical interests" (1890, 313). Instead of emphasizing philosophic or scientific theory, James and Wittgenstein take "stream of thought" and "language games" as the real. As a result, Goodman lays out a convincing case that the later Wittgenstein, significantly under the influence of James, made a decisive and influential break with Legend.

The problem of induction has bedeviled empiricism and any kind of representational epistemology since Hume. Of course, Hume wrote after Descartes but before Darwin; Jamesean pragmatism suggests there is no *logical* solution to the problem

of induction but takes a Darwinian approach that, characteristically, sidesteps the problem. We can accept inductive practices not because there is a solution to the problem of induction in classical Legend terms but because inductive practice is the enabling crucible of naturally selected beliefs; we are more successful if we frame our beliefs in light of repeated experience. Induction remains just as logically invalid, but the pragmatist shrugs and suggests that this classical 20th-century limitative result is neither surprising nor worthy of the handwringing it has generated.

The proclivity to construct theories understandably beckons, but implicit within realism generally is the formalist conviction that, at least in principle, there must be some vantage point, some place outside of history, in which problems and solutions can be surveyed, modeled, and assessed at an atemporal glance; indeed, since Legend's laudable goal is economy of explanation, its temptations are perennial. Ideally, according to Legend, all locality, all particularity are subsumable under formalist notions such as laws of nature. Jamesean pragmatism responds by underscoring how problematical the concept of a law of nature is,[2] and takes the local, the particular, and the specific as the real. No theory is rich enough to capture such variegated experience because theories are the wrong instrumentality—they assume the moist manifold of our lived experience is reducible to the desiccated outlines of theoretical abstraction. This is evident in the opening lecture of James's *Pragmatism*, where he discusses the philosophy professor's Legendary vision:

> The world of concrete personal experiences to which the street belongs is multitudinous beyond imagination, tangled, muddy, painful and perplexed. The world to which your philosophy-professor introduces you is simple, clean and noble. The contradictions of real life are absent from it. Its architecture is classic. Principles of reason trace its outlines, logical necessities cement its parts. Purity and dignity are what it most expresses. It is a kind of marble temple shining on a hill. (1907, 21-22)

We are face-to-face here with Legend and the formalist tradition in computer science. The formalist tradition (and sundry realisms related to it) imagines that our experiences in the

"tangled, muddy" world must be instances of larger, more conceptually tractable ideas. Muddy instances can be explained by the pristinely transcendent—explained by *covering laws* purportedly subsuming the tangled and the transient—and such concepts represent the real. Legend's task is the Gnostic task, as Rorty expresses it, of "replacing appearance with reality" (2007, 104). By contrast, James's goal, as Frank Lentricchia puts it, is the "dismantling of the classic project of reason" (1988, 113). Just as object-oriented programming aspires to replace algorithmically manipulated variables with objects that have purposes and problem-solving abilities, so pragmatism seeks to replace the "will to theory" with the "will to believe" so that our beliefs, as we repeatedly revise them in the face of our experience, enable us to act decisively and successfully in the world.

McGrath's Defense of Critical Realism and Clifford's Principle

In a tough-minded, widely-read defense of critical realism, Alister McGrath argues "The basic impulse of the scientific method lies in an engagement with the real world ... It is the natural world which determines how we should investigate it, and how we are to make sense of it. ... In the end, the final verdict lies with nature itself" (McGrath 2002, 121-122). Language, models, and perception assuredly play a role—hence *critical*—but it is the world that finally determines what we learn about it—hence *realism*. On its face, all this seems sensible and balanced. But notice McGrath's uncritical use of the phrase, "the scientific method." Does the definite article mean there is just one? Is science productively characterized in terms of Legend's vaunted *method*? Does the epistemically vexed phrase "real world" possess Jamesean cash value?

McGrath understandably wants a deeper science than what Owen Barfield calls "dashboard knowledge" (1988, 56) and appeals to the fact that most scientists are realists. This is uncontroversial sociology but, alas, there is little entailment from sociological fact to epistemic moral. Should we be impressed that "major environmental agencies ... adopt a realist approach" (2002, 128)? McGrath invokes (2002, 33) Karl Popper, one of Legend's venerated defenders, but Peter Godfrey-Smith points out that "Popper's theory of science has been criticized a great deal by philosophers over the years ... [and] I don't

see any way for Popper to escape their force" (2003, 57). Allow me to highlight in particular McGrath's appeal to Hilary Putnam (2002, 124). In fact, Putnam's long career has been an illuminating—sometimes erratic—exercise in stepping ever closer to Jamesean pragmatism. Decisively, Putnam argues that language, mind, and historical context so shape our perception of the world that "Realism is an impossible attempt to view the world from Nowhere" (1990, 28).

Additionally, McGrath invokes (2002, 126) Wilfrid Sellars, but McGrath pays insufficient due to Sellars's critique of the "Myth of the Given" ([1956] 1997, 33), which subverts McGrath's comment that "the final verdict lies with nature itself" (2002, 122). Scientific language is irreducibly normative and our senses grasp no prenormative facts. Critical realism is inexorably Janus-faced and my read is that Rorty's charismatic historicism induces McGrath's default to a tougher-minded realism more typical of new realism, as explained above, than critical realism. The correspondence tenet grounding McGrath's realism (2002, 19) is key to seeing why it is Legend in updated guise—the broad sweep of the work of Quine, Wittgenstein, and Donald Davidson, as detailed by Bernstein, undermines "our confidence in any of the traditional correspondence theories" (2010, 149). Moreover, Sellars's comment, "science is the measure of all things, of what there is that it is, and of what there is not that it is not" (1963, 173), is surely not a helpful premise for the S-and-R dialogue. Furthermore, as Putnam's long-running debate with Rorty illustrates, the major alternative to critical realism is not antirealism or Rorty's historicism that McGrath spends six pages rebutting (2002, 5-11), but the classical pragmatism of James whose work warrants a meager two paragraphs (2002, 196-197).

McGrath passes quickly over Ronald Giere's (1999) challenge to whether science needs the problematical (finally theological) notion of law of nature. It is a significant boost to the realist cause if we can discover laws of nature that are mind-independent. To his credit, McGrath takes up the problem of underdetermination—namely, a theory entails its evidence but evidence never entails a theory, on pain of committing the fallacy of affirming the consequent: T—> O, O, therefore T, where O is an observational

consequence of theory T. In fact, however, it is a half-hour exercise in propositional logic to show why both *confirmationism* and Popper's *falsificationism*—two ways to define putative scientific *method*—fail logically as models of science. McGrath appeals to historical and sociological considerations to resist underdetermination and argues that it falls just as heavily upon antirealism as realism, without entertaining the pragmatist suggestion that we may not need to engage the desultory realist-antirealist debate in the first place. In fact, I take underdetermination to be a straightforward consequence of conceiving of science in Legend terms and that there is no purely analytical solution.

More generally, however, in his two chapters developing and defending critical realism, McGrath reenacts much of the forlorn history of Legend. I believe McGrath attempts to do what cannot be done for the reasons James supplies: when we imagine that philosophic arguments for metaphysical or epistemic positions are sufficient conditions for reaching beliefs about such matters, we ignore the personal considerations that constitute necessary conditions for such belief. John Henry Newman was right; it is the "whole man that moves" since logic is but the "paper trail" ([1864] 1994, 158). Judgments that involve the whole person—such as which epistemology we adopt or which religion we embrace—cannot be decided by logic and argument alone. McGrath therefore commits the formalist fallacy of imagining that evidence, logic and argument can resolve both scientific and epistemic questions and rebuts the neo-pragmatism of writers such as Rorty rather than the subtler views of James.

In fact, there is a deeper criticism of Jamesean pragmatism, however, that warrants attention. Gerald Myers (1986) carefully dissects James's views on what is amenable to psychological investigation, what philosophy must treat, and whether, in fact, our beliefs can be justified philosophically. Myers highlights James's claim, "That theory will be most generally believed which, besides offering us objects able to account satisfactorily for our sensible experience, also offers those which are most interesting, those which appeal most urgently to our aesthetic, emotional and active needs" (1890, 312). Myers' criticism is that James blurs "belief and a sense of reality" (1986, 280), that he sometimes collapses a critical distinction, that he fails to rise above what Leon Wieseltier

calls the "swim of subjectivity" to the "more obligating authority of reason" (2010, 44). Myers' point is that psychological explanation, no matter how perceptive, should be distinguished from the question of what is philosophically justifiable.

Clifford's Principle, namely, "It is wrong, everywhere and for anyone, to believe anything upon insufficient evidence" (1879, 183), deeply shaped both Legend and critical realism. James believed from his psychological studies that we form our beliefs in the way he described even though he was "plainly nervous" (Myers 1986, 450) about Clifford's Principle; indeed, his move from psychology to philosophy suggests he understood some of the philosophical limits of psychological explanation. These limits may explain why successors to classical pragmatism—logical positivism and Legend, more generally—thought they had to justify the putative representations in our heads of the external world with philosophical and logical analysis. *Justified true belief* was Legend's epistemic holy trinity. Legend's subsequent failure paved the way for the return of pragmatism, but Myers reminds us that psychology is not philosophy and we might pine for a deeper analytical justification of Jamesean pragmatism. As I will argue next, the development of object-oriented programming (OOP), as well as Brian Cantwell Smith's philosophical explorations of computing, provides analytically significant support for Jamesean pragmatism from disciplines outside psychology.

Werewolves, Objects, and Smith's Varieties of Computation

In his celebrated *Mythical Man-Month*, Frederick Brooks characterizes the software world as a conflict between "werewolves" (1995, 178) and "silver bullets" (1995, 179). He argues there are no silver bullets with which to slay the werewolves of the ongoing software crisis which dates to the 1970s. The word "werewolves" startled many who imagined that computer science, as a formal discipline, would be immune from the epistemic werewolves that were conspicuously stalking Legend; few software engineers deigned to read either Immanuel Kant or James. Indeed, the nascent pragmatism of W. V. O. Quine's seminal "Two Dogmas of Empiricism" (1951), which would do more than any other paper to subvert Legend, appeared irrelevant to computer science. Godfrey-

Smith has observed that this paper is "sometimes regarded as the most important of all twentieth-century philosophy" (2003, 31). Richardson submits that "Quine's arguments moved analytic philosophy toward naturalism ... and pragmatism" (2002, S36).

As a result, we have a parallel set of developments: the software crisis and the rise of OOP in computing, on one hand, and the decline of Legend in philosophy and the return of both naturalism and pragmatism, on the other. It is my claim that the software crisis and Legend's decline represent failures for the formalist program while the rise of OOP and the return of pragmatism and naturalism represent major philosophical shifts that call into question the continuing viability of critical realism.

I take it as uncontroversial that conventional computer science has few obvious implications for the S-and-R dialogue. AI still warrants comment, or perhaps artificial life, but it seems to be conventional wisdom that there are few conspicuous implications of programming, networking or computability for the dialogue—never mind something as presumably parochial and technical as OOP. My goal in this part of the paper is to trace the rise and distill the implications of a purported silver bullet, namely, object-oriented programming. I will amplify the arguments of a few notable voices in the movement that OOP is not simply a programming technique but, in fact, embodies an implicit philosophical conception at odds with the Legend-inspired mainstream, imperative programming. Once we recognize that OOP is significantly pragmatist in its implicit epistemology and historical origins, we can see how it is not only related to pragmatism but unexpectedly augments the case for pragmatism as the best premise for the science-and-religion dialogue.

Object-oriented programming is generally not well known. Yet a brief anecdote illustrates how OOP was there at the outset of the most momentous developments in modern computing. PBS' "The Triumph of the Nerds" (Cringely 1996) portrays the 1979 visit of a 24-year-old Steve Jobs to Xerox's Palo Alto Research Center. Jobs noticed three developments in particular and comments, "within you know ten minutes it was obvious to me that all computers would work like this some day." The most important was the graphical user interface, which led to the Macintosh; the second was the networking of a

number of small computers, which accelerated development of the Internet; and the third was object-oriented programming. We easily recognize today the revolutionary import of the graphical user interface and the Internet, but the significance of object-oriented programming is less conspicuous. What is OOP? Traditional or *imperative* programming attempted to distill the logic of a program on the assumption it must answer the question, "What needs to be *done*?" By contrast, OOP asks the question, "What are the things or *objects* needed in this program?" A traditional, imperative program is a logical *recipe*—do this, then this, then that, and so on, until the task is done. An OOP program consists of creating the requisite objects with the right capabilities which can exchange messages until the job is done.

Central in the imperative, formalist view of computing are classical notions of effective computability, predictability and provability. If imperative programming sounds like Legend-inspired programming, that is because it is. The dramatic advances in symbolic logic around the turn of the twentieth century, most notably the work of Russell and Whitehead (remember Whitehead's role in the history of Barbour's critical realism), influenced both philosophy of science and computer science. Pioneers Alan Turing and John von Neumann reinforced this formalist interpretation of computing, with the apex of formalist aspiration being the artificial intelligence of the 1950s and 1960s. Imperative programming reached its fullest expression in the command-line interface of Unix and the programming language C; good programmers knew they needed to think like a computer. My first AI programming efforts were done in Prolog, "*Pro*gramming in *Log*ic." Parenthetically, it is no accident of history that AI and Hempel's work in the logic of scientific confirmation enjoyed their greatest prestige in the period of time pragmatism had virtually disappeared.

This traditional approach works acceptably well for smaller, better defined tasks. But imperative programming does not scale well—as we attempt more ambitious tasks, imperative programming gets hamstrung in its own logical knots and our ability to understand such programs erodes badly. The software crisis mentioned at the outset of this section dates in large measure to the failure of imperative programming to scale well.

OOP argues that this failure stems from the moribund imperative emphasis on tools, methodology and theory. Instead, OOP emphasizes the importance of talented, imaginative people who have the judgment to know when tools, methodologies and theories are useful—and when they are not. OOP replaces the logical, recipe approach of traditional imperative programming with a focus on objects and the competencies they need in order to solve problems. Programmers are encouraged to think like creative people instead of computers and to ask the question, "What objects are needed for this task?" just as an astute politician would ask, "Who are our best diplomats to assign to this international problem?" An *object* can be a car, a person, or a scroll bar in a graphical user interface. In a move that would not surprise William James, OOP emphasizes the irreducibility of multiple perspectives, the limited utility of theoretical abstraction, and the pivotal role of interpretation. Computer simulation more broadly has helped us to see how important emergence and probabilistic explanations are in scientific practice, reinforcing the nineteenth century's Darwinian undermining of classical concepts of provability and determinism. Recent work in *neural* networks, *genetic* algorithms and *cellular* automata underscores how biology has replaced symbolic logic as the central source of ideas in computer science. Indeed, perhaps the central concept in OOP is *inheritance*. Objects can adapt to new environments—OOP unapologetically employs Darwinian ideas—without having to be rewritten. In a word, biology infuses OOP.

But how is OOP related to science more generally? James Ladyman and Don Ross argue "that a point is rapidly coming, ... at which most of our science will necessarily be done by our artefacts ... [which] will need to manipulate object-oriented frameworks ..." (2007, 300). Their signal claim is that science will inexorably be done computationally, and that *computational* will mean *object-oriented*. Paul Humphreys (2004) argues that science is inexorably becoming more computational; the data flood upon us (see Hey, *et al*, 2009) means science will be a ship navigating an otherwise overwhelming sea of 1s and 0s. Humphreys hints at the fact that computation will therefore increasingly be object-oriented. Chris Anderson (2008) goes too far in suggesting we are effectively watching Google's applied mathematics replace

epistemology, but there is a remarkable shift toward a less theoretical, more pragmatic, more network-based, computationalization of how we solve problems.

In fact, the current, widespread movement to OOP constitutes one form of the unification of science that is otherwise what Peter Galison calls "a chaotic assemblage of disciplines and activities" (1996, 119). As we saw earlier, James's *Varieties of Religious Experience* ([1902] 1920) emphasized the irreducible particularity of religious experience; Galison's book might be entitled *The Varieties of Scientific Experience*. In fact, Galison argues that what unites the disparate practices of science is not specific method, not common laws or a presumed ontology, but sundry "trading zones" (1996, 153) that provide a place for scientific subcultures to meet. Scientists enter such zones with disparate views and purposes, but nearly inadvertently the conversations and interactions stabilize belief and enable divergent practices to converge. Cast in Jamesean terms, their practice of science generates a pragmatic unity that abstract characterizations will either miss or misconstrue.

Driven by unparalleled demands dating to World War II, ad hoc Monte Carlo statistical simulations, as Galison tells it, progressively replaced classical differential and integral equations putatively corresponding to "Platonic metaphysics hidden behind appearances" (1996, 145). Researchers found they could solve more problems more quickly by casting problems statistically and computationally, using whatever shorthand descriptions and local problem-solving dialects that proved useful. Indeed, Galison draws the startling moral that "this is the hardest-line pragmatic view possible" (1996, 149): simulation competes with classical formal approaches to see which one works better, not which one better represents the world. Ismo Koponen argues that science is less a matter of "finding the fundamental truths of nature" than it is "finding reliable knowledge, which can be used to cope with nature" (2004, 10). Add these claims to Ladyman and Ross's argument that our artifactual science will "manipulate object-oriented frameworks" (2007, 300), and we have a multiply reinforced, pragmatist conclusion that science in the future will be OOP-mediated science whose ad hoc simulations will be less concerned to mirror putative physical mechanisms than to solve problems.

The parallel between the centrality of continuous run-time in OOP and James's contentious claim that truth emerges over time is striking. In pure OOP, there are only objects exchanging messages. Formalist computer scientists, by contrast, imagine program *derivation* means program and proof develop concurrently and could be done, in principle, on a blackboard; run-time behavior ought to be anticlimactic. OOP programming is event-oriented, network-centric computing in which run-time is continuous and unpredictably chaotic. OOP message exchanging is analogous epistemically to James's famed "stream of consciousness." Simulation in a networked, OOP run-time environment such as a graphical user interface, emerges diachronically, and is never complete, just as truth in Jamesean pragmatism emerges over time, and is never finalized. As a result, James's contentious claim receives unexpected OOP warrant.

Objects, importantly, are simulations rather than representations. An object does not attempt to represent, *Tractatus*-style, some *state of affairs* in the world. Instead, it simulates a specific *individual* with a set of skills, ready to converse. Representations are passive pointers, objects are active individuals with idiosyncratic histories. As West observes, objects are "*evocative* rather than representational" (2004, 302). Simulations are neither true nor false; they are either helpful or unhelpful, adaptive or non-adaptive, given what we wish to do. James would want to know their "cash value." Formalists in traditional programming want formalized design specifications; they are the Louis Agassiz creationists of the programming world so that fixed types *explain* individuals. OOP-using *agile* programmers are programmatic Darwinians who reject formal specifications in favor of the incremental evolution of projects that cannot be explained at the outset because object individuals have real histories. The epistemology of object-oriented simulation, therefore, is fully Darwinian and its psychology fully Jamesean.

Just as James's psychological investigations shaped pragmatism, so Jean Piaget's work with young children informed OOP. As a child individuates what is initially a sensory continuum, Piaget (1969, 10) noticed, the child assumes an object-oriented approach. At first, an infant might accidentally nudge a rattle but notices it makes a compelling sound. The behavior is reinforced and the child learns to distinguish rattles

from bottles. Rattles have states (silent, noisy) and methods (shaking, sliding, dropping) and rattles are distinguishable from bottles. An infant progressively carves up the world into objects that endure, have noticeable properties, and desirable or undesirable behaviors. In a word, Piaget tells us that objects are irreducible. OOP's link to Piaget is through Alan Kay, who helped develop the graphical-user interface. In 1968, Kay learned of Seymour Papert's (1993) adaptation of Piaget's genetic epistemology. Papert's LOGO project was "derived from the thinking of John Dewey" (Rheingold 2000, 243). Since Dewey was influenced by James and was a prominent pragmatist, it is clear now that pragmatism was a significant factor in the rise of OOP. In fact, Papert's first-graders programmed by sending messages to an "object-to-think-with" (Papert 1993, 23). Children led the way and, arguably, can help us see past the Enlightenment's epistemic aporias. Kay writes that the computer is more a constructor of artifactual worlds than a describer of real worlds and that the computer is the first "metamedium" (1984, 9).

Bertrand Meyer (2000) spells out the pragmatist principle inherent in OOP. Just as the pragmatist eschews ideology and, to some extent, metaphysics, for OOP an object's data and implementation are excluded from view. The formalist, begrudging acceptance of OOP imagines this to be but a frugal engineering practice. Meyer argues that, while "The tradition of information modeling usually assumes an 'external reality' that predates any program using it; for the object-oriented developer, such a notion is meaningless as the reality does not exist independently of what you want to do with it" (2000, vi). The value of an object does not depend on whether it mirrors reality, as it is in itself, but depends on what capabilities it has, given the problems we wish to solve. Putnam observes that we "don't know what we are talking about when we talk about 'things in themselves'" (1987, 36). OOP would concur because any attempt to represent the Kantian *thing-in-itself* has no utility and lots of disutility in solving problems; the explicit OOP goal is to obscure the object thing-in-itself. On Kantian epistemology, of course, the thing-in-itself is out of reach, but classical programming was largely innocent of Kant's insight and thus made the pre-Kantian mistake of imagining the programmer has and should have access to all detail and all data; this access is what OOP forecloses.

The OOP proponent interprets the world in terms of the unpredictable, the biological and the emergent rather than the mechanically deterministic and formally analyzable. OOP ends the unhelpful dualism between data structures and algorithms, and folds both into a virtual agent who experiences the object world as an exchange of messages with other objects. West (2004, 67) observes that the data structure/algorithm distinction constitutes a rigid dualism that vitiates computer science history. Consonant with pragmatist intuitions, Kay comments, "For the first time I thought of the whole as the entire computer and wondered why anyone would want to divide it up into weaker things called data structures and algorithms" (West 2004, 43). Analogously, Jamesean pragmatism ends an unhelpful dualism between representations (data structures) in the brain and the world as it evolves (algorithms) and argues that our views originate in indivisible streams of consciousness, generated and corrected by continuing experience and conversation.

Just as formalists such as Hobbes and—in a qualified way—Descartes extended the mechanical metaphor to people, formalist programming imagines that our understanding of computing should reflect some kind of formalist notion such as a Turing machine. In a "tender-minded" Jamesean move, OOP reverses this subsumption of the human under the mechanical and insists that we interpret objects as, effectively, little people with specific competencies and abilities. In a word, OOP heartily embraces the anthropomorphizing Legend triumphantly discarded. Moreover, the much vaunted formalist analyses and principles of top-down programming are discarded as unhelpful in developing "agile" programs; Edsger Dijkstra's (1975) enthusiasm for concurrent development of program and proof, for example, is no more helpful to programming than symbolic logic (Godfrey-Smith 2003, 7) is for Legend's view of scientific confirmation. All of Legend's unsolved epistemic problems remain in formalist modeling of the world. The external world comes first, the program tries to model the world, and the worry for traditional programming is what is left out from the real world in the modeling.

The OO Maxim, in one bold stroke, obviates this worry. In terms strikingly parallel to philosophical pragmatism, objects are exhaustively defined by what they can do and

"reality" is exhausted by our inventory of objects. An "object" in OOP, therefore, has a richer epistemological connotation than what we might otherwise assume. For an OO programmer, the idea of an external reality beyond the roster of objects, as we saw above, is programmatically meaningless. There is only one ontology, the smallest set of objects necessary to solve the problems that we want solved. Reminiscent of James's conception of pure experience as aboriginal,[3] there is only one epistemology, namely, the lineaments of object-based, message-exchanging problem solving. The epistemic corollary is that we can only know what we can use; what we know of an object is exhaustively defined by how it can be used and, indeed, what its purposes are. In fact, the realist notion of an external world independent from what can be embodied in objects is not deemed untrue but is programmatically abandoned. As a result, OOP is philosophically pragmatist.

Realists of various stripes might shrug off the object-oriented movement as an aberration; after all, if scientific ideas are Darwinian species, as Jamesean pragmatism maintains, this computational species may turn out to be maladaptive as well. While it dominates current computer programming and is a major stream of computer science research, so the objection would go, formalist thinking is far from defeated. Theory of computation classes remain in standard curricula. Turing-theoretic ideas are still taught and mathematical proofs of program correctness may still prove defensible.

In rebuttal, allow me to appeal to the work of Brian Cantwell Smith. No one has done more acute work analyzing the significance of computing and its relation to objects. His current research, the "Age of Significance," is a work in progress, appropriately posted to the Web for comments. Smith writes, in terms reminiscent of James, that no one characterization will do justice to this "computation in the wild" (2010, 14) because it is an "eruptive body of practices" no formalist account can capture. Computation is an unstable, alchemical mix of the intentional with mechanical; the formalist approach analyzes at best only the mechanical. The referent of *computation* evolves, unpredictably and contingently, under the influence of networked human intentionality. Objects exchange information across the system under no centralized control; not only is a formal characterization of such a chaotic system impossible, more importantly, it is gratuitous.

The organism evolves and has no formally describable Agassizian essence. In lots of ways computation is the progeny of the most optimistic interpretation of the reach of human understanding; Smith performs the Jamesean service of reigning human presumption about the reach of our understanding.

In the "logicist" view, computing has an abstract essence, amenable to theoretical description, regardless of the specific way computing develops. The formalist conception of *effective computability* (e.g., truth tables are an effective method for identifying validity), for instance, lies at the heart of symbolic logic and computers can be viewed as logic machines. But are truth tables pertinent to understanding Facebook's data stream? Smith argues that "We will never have a theory of computing because *there is nothing there to have a theory of*. Or rather, to put it more accurately: it will be a major conclusion of this investigation that neither computers, nor computing, nor computation, nor anything close by, are ultimately the sort of phenomenon that will sustain an intellectually satisfying, trenchant, powerful theoretical account" (2010, 38). Tellingly, Smith writes that our failure to identify a theory of computing, since logicists suppose the theory of computing limns the lineaments of mechanism, entails "the end of three hundred years of materialist natural science: science as a form of knowing restricted to the study of matter, materials, and mechanism" (2010, 40). Computing involves ineliminable intentionality while traditional computational theory is merely about mechanism.

The last 20 years of computer science has witnessed a profound evolution—the new emphasis is on "contextually-located, embodied and embedded forms of both practice and theory" (Smith 2010, 8). Smith's exploration of real-world computational practice is a pragmatist refutation of what historically has been taken as purely a conceptual, logical domain, what James described above as a "marble temple shining on a hill" (1907, 22). In fact, Smith is becoming the William James of the philosophy of computing. The conventional programmer is fading from view in this new object world, replaced by the artisan who assembles the optimal roster of objects, given some set of goals. In terms reminiscent of Galison's characterizations, we'll invoke the objects we need to solve the

problems we face and simulate the worlds we desire, leaving the procedural details to an object-infused "cloud," a computational heavenly host with effectively limitless bandwidth. This is computing as theatre, even as liturgical drama, since it will assist and energize the work of the people. OOP turns computer-mediated conversation into a hub of problem solving and creativity; I cannot imagine a more promising venue for dialogue. While it is possible that this computational heavenly host could become a new Tower of Babel, I believe a fulsome doctrine of the Spirit is grounds for optimism.

A final observation highlights the difference in temperament between conventional natural science and OOP computer science as I have detailed it, and I will express it theologically. A realist natural scientist wants to ask the question, "What can we know about the world as it is?" An OOP computer scientist wants to ask the question, "What kind of world can we invent and what can we do with it?" The realist scientist wants to portray and understand physical reality. An OOP computer scientist wants to create the reality we inhabit. From the OOP perspective, a physical scientist is researching the operating system—important, but more like a Genesis preamble to the larger human saga. Cast theologically, OOP proponents want to ask, "What new world can we create and finally fulfill our calling to be created, literally, in the image of God?" As a result, it should be no surprise that OOP, with its implicit pragmatism, wants to ask different questions than traditional, realist natural science and wants to highlight the robust role of human creativity. An S-and-R dialogue inspired by a pragmatist, computationally infused science, for example, will provide the dialogue with fresh ways to explore and extend classical panentheistic themes, such as God as the animating Spirit rousing human inventiveness.

Critical Realism, Pragmatism, And The Dialogue

Nancey Murphy dismisses both the coherence and the relevance of critical realism. She writes that it is either an unhelpful truism or an "outrageous claim" (1990, 198) about human-independent knowledge. But even if the philosophical problems could be solved, "one is left with two ... complementary pictures of reality ... a version of the two worlds

approach" (1990, 198). We're still left attempting to determine how representations of the world are more or less correct when we cannot do direct comparisons.

Critical realism is still a species of realism—even if tempered by qualifications—and it imagines that our academic constructs are ultimately representations embedded in formal theories. If our representations are representations of entities that we are convinced are largely or wholly mind-independent, then critical realism issues in an ontology in which scientific "discoveries" populate the realm of the real, both in the academy and in the popular imagination. It is not the specific theories of science that bring any variant of realism into conflict with religion; it is the realist disposition to imagine that successful scientific theories asymptotically catalogue the real. Realist science will populate its theories with entities "governed" by laws of nature—there will be no room for a run-time Creator—and religion will inexorably be shunted aside from academic discourse. Truth be told, that is largely the history of the academy in the West for the last 400 years.

While there are unquestionably realist expressions in James's writings, which explain why he appears in the geneology of critical realism, on mature pragmatist grounds we can abandon realism of any stripe as one term of an unhelpful realist-antirealist dualism. When we employ language shaped by that venerable dispute, we divert important resources away from more productive conversations and into unproductive epistemic quagmires. Instead, we should understand our experience as a comprehensive whole, which we approach with our sundry constructs, gotten from disparate and dubious places, as James recognizes. The test, therefore, for any human construct is not whether it corresponds to the real, which, owing to underdetermination, is not possible to know in any case. The test is whether it enables us to solve more problems and construct more compelling worlds. We have only our experience—our Jamesean stream of consciousness—and what follows in our experience when we employ one construct in preference to another. It is time to retire Legend fully to the history of ideas.

Even if we are satisfied that pragmatism has returned in full force in philosophy, and even if we are convinced that pragmatism turns out to be the implicit epistemology of

object-oriented programming that is destined to infuse standard scientific practice, I want to consider one further objection to pragmatism. Namely, while the classical pragmatists such as James and Peirce were sympathetic to religion, more recent pragmatists such as Richard Rorty (2007) and Joseph Margolis (2002) are less sympathetic. Even more emphatically, since pragmatism collapses the realist distinction between our experience and the world as it exists in itself (even as created by God), does it not follow that any dialogue between science and religion will be superfluous or—worse—jejune? Moreover, can Christian theology adapt to the pragmatist claim that finally there are no essences, but only historically conditioned transiencies? James's close attention to the particular, the unique, and the unrepeatable counts against precipitously emphasizing the logical in theology or the theoretical in science; the worry is that the embrace of pragmatism for the dialogue would blunt the power and pith of each activity, leaving only the inanities of eviscerated science and religion.

I take this objection seriously. However, we need to sidestep Rorty's unapologetic distortion of James, whose insight is that the grist for our most productive conversations originates in the unfettered variety of human experiences and vocabularies. James wants to apply the same test to religious claims that is applied to scientific claims, and therein lies an exceptional lesson for the dialogue. No friend of the materialism that adulterates Darwin's cautious writings into a truculent Darwinism, James welcomes religious and theological claims, provided that "they have value for concrete life" (1907, 73). If we determine that they do, as with other constructs, we will deem them to be "true, for pragmatism, in the sense of being good for so much" (1907, 73). It is the case that James resists sanctioning such claims by appeal to religious authority, either mitred or textual, but he would just as readily oppose deference to scientific authority. That means we are obliged to test our religious ideas against experience but also the raft of other beliefs—including science—that turn out to be "good for definite, assignable reasons" (1907, 76). Belief for the Jamesean pragmatist, therefore, constitutes a Quinean web (Quine and J. S. Ullian 1978) that is good to believe in concert (James 1907, 73), that holds together

sensibly, in light of our experience and conversation. As a result, James's pragmatist trading zone is inherently dialogical.

Pragmatism notably holds out the promise of mitigating the conflicts of the many religions that humanity has embraced. Pragmatism in theology tempers the presumption of the theologian who imagines the mind of God is readily amenable to theological representation; therefore, pragmatism intentionally subverts the dogmatically doctrinal as notably unhelpful to community conversations. Pragmatism in natural science means our concepts are more akin to Darwinian species that have no essentialist definition but are frankly recognized as conceptual species whose pertinence to the problems we wish to solve will have a profound history. Pragmatism should reign in the dialogically inhibiting presumption of both positivist science and dogmatic religion that are the source of much of the historic tension. In general terms, therefore, pragmatism offers the prospect of a robust dialogue that should stimulate both our understanding and our civility.

There need be no attempt at "reconcilation" between science and religion—where that means finding a deeper theoretical interpretation that represents a more fundamental reality. James, ever impressed by particularity, took them to be specific human activities. Critical realism is still engaged in a *Tractatus*-style, Legend-inspired search for common essences. If *bridge* means subsuming distinctive local differences under theoretical abstraction, James would build none. If *bridge* means facilitating robust conversation ranging across the endless variety of human scientific and religious experience, James would be first with hammer and saw. Human practice includes science and religion; there need be no essence common to them any more than there is an essence common to all natural science or all of computing. While he recognized the ineffable in our rich variety of experience that neither science nor religion can fully articulate, James saw nothing conceptual behind (or above) science and religion that is more basic in terms of which they can be explained. Moreover, since explanations fail before the phenomena are fully explained, both in science and religion, all our explorations will have to live in the epistemic dynamic between description and explanation. That dynamic will provide abundant basis for extended, productive dialogue.

In light of these considerations, I believe we are at the point where pragmatism should now succeed critical realism as the philosophical premise that we employ in the science-and-religion dialogue.

Conclusion

I agree that, attitudinally, most academics are and all of us should be critical realists. We live in a post-Kantian, post-quantum-mechanical, post-Gödel world. Idealism and naive realism appear increasingly implausible at this juncture, and the creative tension between our critical and realist intuitions can be a useful heuristic. Moreover, realism is not simply erroneous—I grant pragmatism can be characterized as a variant species of realism and that *realism* points to aspects of our experience we ignore at our peril. The insuperable problems arise when we attempt to develop a *theory* of critical realism. I have attempted to argue in this paper that theoretical critical realism's affinities with Legend destine it to Legend's fate and, moreover, that there is a more productive way to approach philosophy of science and the science-and-religion dialogue, namely, pragmatism.

Given my case for the inexorability of a pragmatist OOP, we can metaphorically view religion and science as message-exchanging objects. It is time to conceptualize the dialogue as a pragmatist "trading zone" in which disparate dialects work to solve common problems. No dialect is in a position to triumph as the universal language since no object has a universal perspective. Neither science nor religion can claim to directly represent the truth —that's not what objects do—since what it would mean to represent correctly the world is neither knowable nor computable. James's enduring insight is that all our work in science and religion is never fully adequate to the many mansions of our experience. Instead, each practice is faced with constructing solutions to the problems that command its specific attention and exchanging messages in the trading zone that characterize how our experience changes in light of each activity.

James beguilingly wrote that "The trail of the human serpent is thus over everything" (1907, 64) in portraying the pragmatist claim that human need and intention shape all human activity. That the trail of the human serpent is over religion was made a

commonplace by the European Enlightenment. But scientists and philosophers have often believed the trail is not significantly over the natural sciences; if this is the case, then a conversation-limiting, sharp science-and-religion cleavage is exposed. And it has usually been supposed that the trail is necessarily irrelevant to the formal sciences, including computer science. I have argued that pragmatism implicitly informs object-oriented programming epistemically and that a computationally dependent natural science in the future will have no choice but to use objects and OOP. If this is correct, it means that the trail marks of James's serpent—though perhaps not as initially conspicuous—deeply characterize the empirical and formal sciences as well as religion, as James insisted more than 100 years ago. That the Jamesean trail is "thus over everything" means it is now fitting to recast the science-and-religion dialogue in pragmatist terms.

NOTES

[1] This list is adapted from Lakoff and Johnson (1999, 470-471).

[2] John Earman (2002, 123) claims the notion of a law of nature is "vague and slippery." Ronald Giere (1999) argues that science does *not* need the concept.

[3] I owe the aptness of the word 'aboriginal' to an anonymous referee.

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