JOHN DEWEY'S LOGIC OF SCIENCE

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In recent years, pragmatism in general and John Dewey in particular have been of increasing interest to philosophers of science. Dewey's work provides an interesting alternative package of views to those which derive from the logical empiricists and their critics, on problems of both traditional and more recent vintage. Dewey's work ought to be of special interest to recent philosophers of science committed to the program of analyzing "science in practice." The core of Dewey's philosophy of science is his theory of inquiry—what he called "logic." There is a major lacuna in the literature on this point, however: no contemporary philosophers of science have engaged with Dewey's logical theory, and scholars of Dewey's logic have rarely made connections with philosophy of science. This article aims to fill this gap, to correct some significant errors in the interpretation of key ideas in Dewey's logical theory, and to show how Dewey's logic provides resources for a philosophy of science.

1. Introduction

In recent years, pragmatism in general and John Dewey in particular have been of increasing interest to philosophers of science.[1] Dewey has interesting

1. For a few examples, see Giere (1999), Godfrey-Smith (2002, 2010), Richardson (2002, 2003), Howard (2003), Mirowski (2004), Douglas (2005, 2009), Reisch (2005), Fine (2007), M. B. Brown (2009), and M. J. Brown (2009a, 2009b, 2010).

and often compelling views on a variety of topics of interest to contemporary philosophers of science, including the social dimensions of science and the role of values in science and of science in policy, fallibilism, foundationalism, realism, and constructivism. Dewey's work ought to be of special interest to recent philosophers of science committed to the program of analyzing "science in practice," as the core of Dewey's philosophy of science is his "logic" or "theory of inquiry," which is one of the few examples of a carefully articulated "logic of practice." Unfortunately, there has been no in-depth analysis of Dewey's logical theory by contemporary philosophers of science interested in Dewey. Conversely, scholars of Dewey's logic have rarely emphasized the connections to philosophy of science.[2]

On this basis, one may doubt whether one can say that Dewey had a philosophy of science at all. He did not devote any of his major works to the nature of science; Why not say that he is an epistemologist, logician, or social philosopher with some relevance to philosophers of science? I think we can say something stronger; indeed, I believe that the reason Dewey fails to devote a volume to the topic is because philosophy of science is so central to all of his work as to be pervasive.

Dewey began his career as not only a philosopher but also a practicing scientist with an interest in methodology. He played a role in founding one of the early experimental psychology laboratories in the United States at the University of Michigan (along with James Hayden Tufts; Martin 2002, 87) and at the University of Chicago (along with James Rowland Angell; 140). He was the president of the American Psychological Association in 1899 (6 years before his presidency in the American Philosophical Association), and his early papers in psychology were highly influential.[3] He also founded the Laboratory School at the University of Chicago, probably the first empirical pedagogy laboratory. *Schools of To-morrow*, coauthored with his daughter Evelyn Dewey, includes both theoretical chapters on the philosophy of education and empirical studies of experimental schools across the country. Dewey's occupation with method—in science, psychology,

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2. Bhattacharya (1975), Sleeper (1986), and Shook (2003) are notable exceptions. Pihlström (2008) is an exemplar of the conventional approach to Dewey's philosophy of science by way of *Experience and Nature* (*LW* 1) and *The Quest for Certainty* (*LW* 4). Unless otherwise noted, references to John Dewey are parenthetical citations to the critical edition by Boydston (1969–91), published as *The Early Works, 1882–1898* (*EW*), *The Middle Works, 1899–1924* (*MW*), and *The Later Works, 1925–1953* (*LW*). Citations are made with these designations followed by volume and page number.

3. In 1943, Dewey's "The Reflex-Arc Concept in Psychology" was voted the most important paper in the first 50 years of *Psychological Review* (Langfeld 1943, 154, table 3, col. 1; cited by Hickman 2004, 157).

and philosophy—appears in some of his very earliest papers (e.g., "Kant and Philosophic Method" [1884, *EW* 1], "Psychology as Philosophic Method" [1886, *EW* 1], "The Science and Method of Psychology" in *Psychology* [1887, *EW* 2], "Galton's Statistical Methods" [1889, *EW* 3]), and the concern with scientific method continues throughout his career.[4]

Beginning with his move to Columbia University in 1904, Dewey ceased his firsthand involvement in empirical science and focused more fully on philosophical work.[5] Still, in his later years, Dewey kept up with developments in science from a distance. His daughter Jane Dewey became a physicist and physical chemist with a PhD from MIT. She trained with Bohr and Heisenberg and became a pioneer in quantum optics (Stroud 2004). Jane's influence on her father can be seen in his occasional references to the work of quantum physicists like Heisenberg and Dirac in his later works (esp. *The Quest for Certainty* [*LW* 4], *Logic* [*LW* 12:178]), and "Time and Individuality" [*LW* 14]. Dewey was also fond of the popular science writer Lancelot Hogben, whom he refers to several times in the *Logic* and elsewhere. These influences on his later work may be what led Ernest Nagel to write, "The great William Harvey is reported to have said of Francis Bacon that he wrote about science like a Lord Chancellor. Of Dewey it can be said with equal justice that he writes about natural science like a philosopher, whose understanding of it, however informed, is derived from *second-hand sources*" (1950, 247, emphasis added; cited by Howard [2003, 59]). As we have seen, this claim is at least somewhat specious, given Dewey's 22-year career as at least a part-time empirical scientist. True, Nagel in the quotation above refers to "natural science" while Dewey practiced the human and social sciences, but Nagel himself has argued (as would Dewey) that there is no essential difference between the types of science, apart from the difference in subject matter (see the comparisons of natural and social science in Nagel [1961]).

Although Dewey may not be thought of as a philosopher of science by philosophers today, this was a central feature of how his contemporaries understood him, as Mirowski (2004) has argued: "Our contemporaries may not generally regard John Dewey as a philosopher of science in good standing, but nevertheless, that was perhaps the most important facet of his reputation

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4. The phrase "scientific method" appears in 35 of 37 volumes of his *Collected Works* (Boydston 1969–91) and 268 times in the three volumes of his correspondence.

5. This may seem a relatively early stage in Dewey's career, given that he had yet to write many of his most famous works, but in fact he was 45 years old, having already completed the first 2 decades of his professional career. If we count his graduate work at Johns Hopkins with G. Stanley Hall, we can say that Dewey worked as an empirical scientist for 22 years. This cannot help but have had a profound effect on his work for the rest of his career.

in the first three decades of the 20th century" (290). Dewey's "philosophy of science" or "theory of science" was referred to by a variety of philosophers, including Reichenbach (1939), Hook (1950), Nagel (1950, 1961, 129), and Morgenbesser (1977, xi). He was a participant in the early volumes of the journal *Philosophy of Science* (Dewey 1934) and the *International Encyclopedia of Unified Science*.[6] Dewey's *Logic: The Theory of Inquiry* and *Essays in Experimental Logic* were reviewed in *Philosophy of Science* (Nathanson 1939; Geiger 1955), and logical empiricist Felix Kaufmann treated Dewey's *Logic* as primarily a theory of science (1959).

The goal of this essay is to recover some of the key aspects of Dewey's mature logical theory as contributions to philosophy of science. The recovery is threefold: some of Dewey's central ideas are, to current readers at least, rather obscure. Some of them have been badly misunderstood by commentators on Dewey, historical and contemporary. And last, their relevance as contributions to philosophy of science must sometimes be explained.

2.   A Note on Sources

The key text for my analysis is Dewey's *Logic: The Theory of Inquiry* (1938, *LW* 12). In choosing additional texts, I follow the advice given in the opening words of Dewey's preface:

> This book is a development of ideas regarding the nature of logical theory that were first presented, some forty years ago, in *Studies in Logical Theory* [1903]; that were somewhat expanded in *Essays in Experimental Logic* [1916] and were briefly summarized with special reference to education in *How We Think* [1910; revised 1933]. While *basic ideas remain the same*, there has naturally been considerable modification during the intervening years. While connection with the *problematic* is unchanged, express identification of *reflective thought* with *objective inquiry* makes possible, I think, a mode of statement less open to misapprehension than were the previous ones. (*Logic*; *LW* 12:3, emphasis added)

I make use of these texts where they help throw light on the ideas of the *Logic*, with care in showing the significant differences in those works. Here *How We Think* (rev. ed., 1933) turns out to be a particularly useful text. I take Dewey

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6. Charles Morris regarded the collaboration between Dewey and Neurath in the project to be of upmost importance (Reisch 2005, 84).

at his word that earlier discussions of "reflective thought" should be reinterpreted as or identified with "objective inquiry," which gives us the opportunity to use a few other key sources. There are also a few essays specifically on topics of logic, written just before or around the time Dewey was composing the *Logic* (esp. "Qualitative Thought" [1930, *LW* 5] and "Context and Thought" [1931, *LW* 5]), as well as some written in response to criticisms of the *Logic* that will occasionally be referred to.

3. Science, Common Sense, and Epistemology

One further reason why contemporary readers of Dewey are much less likely than those in his own time to read him as primarily a philosopher of science is that Dewey repeatedly emphasized the continuity of scientific with other forms of inquiry under the general heading of "logic." The natural tendency for contemporary readers, after having dismissed his idiosyncratic use of the term "logic" as Carnap would have us do (see sec. 4), is thus to read Dewey as writing on epistemology in general rather than philosophy of science in particular. But it is important in understanding Dewey to recognize that it is the continuity between scientific and other kinds of inquiry that he stressed, not the continuity of philosophy of science and epistemology. As others have discussed (Hickman 1998, 2007), for most of his career Dewey vehemently opposed what he called the "industry of epistemology" (*EW* 5:7; *MW* 10:23), and this distinction is crucial to understanding Dewey's theory of inquiry as a contribution to philosophy of science.

Dewey's view was that modern science was continuous with, and to some degree an outgrowth and refinement of, practical or "commonsense" inquiry as practiced for millennia. Modern science was, however, a radical break from ancient forms of theoretical knowledge. It is the forms and issues of the latter, he thought, that philosophical theories of knowledge had been based on, and so he eschewed the entire field of epistemology and even in later works the term "knowledge" and worked instead in "logic," which he conceived of as the theory of inquiry.[7]

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7. It is not entirely clear why he was not similarly pessimistic about the field of logic, given a similar origin in Aristotle's theory of scientific method. One hypothesis is that Bacon's *Novum Organum* pointed the way for the reconstruction of logic, whereas he could see no way to do the same for epistemology. In *The Quest for Certainty*, Dewey contrasted the "'epistemological' problem of knowledge in the general terms of relation of subject and object" with "the logical problem of the methods by which inquiry shall attain understanding" (*LW* 4:97–98). It would appear that once you eliminated all of the confusion and false starts that Dewey saw in epistemology, all that would remain would fall either under empirical psychology or under logic in Dewey's sense.

After summarizing a variety of differences between the Greek (esp. Aristotelian) conception of knowledge and modern science—including the new importance of measurement and the changed focus from the unchanging to change, from essences to relations—Dewey writes, "it is not too much to say that what Greek science and logic rejected are now the head corner-stone of science" (*Logic*; *LW* 12:96). This is in stark contrast with the relationship between modern science and practical knowledge—the knowledge of artisans and technicians: "Genuine scientific knowledge revived when inquiry adopted as part of its own procedure and for its own purpose the previously disregarded instrumentalities and procedures of productive workers. This adoption is the radical characteristic of the experimental method of science" (*LW* 12:99). While modern science is more systematic and precise, according to Dewey practical inquiry has always borne the basic features of modern science.

The difference between science and commonsense inquiry is a matter of (*a*) different subject matters or kinds of problems to be solved (*LW* 12:71), (*b*) the degree of distance from immediate need, and (*c*) the degree of precision, control, and systematicity. The first two differences are closely connected: Dewey speaks of the "world" of common sense as "the environment in which human beings are *directly* involved" (*LW* 12:66).[8] The subject matters of commonsense inquiries are thus "problems of the use and enjoyments of the objects, activities and products … of the world in which individuals live" (*LW* 12:66). By contrast, scientific inquiry lacks "*direct* involvement of human beings in the *immediate* environment" (*LW* 12:67) and is relatively distant from immediate needs and wants.

Scientific knowledge is concerned with "attainment of knowledge … for its own sake," that is, "attaining confirmed facts, 'laws' and theories" (*LW* 12:66–67). A major difference is that common sense focuses on qualitative subject matter while science characterizes its subject matter in nonqualitative (chiefly quantitative) terms. Another is that the materials of science become distant and removed from situations of direct human involvement: scientific conceptions, methods, and tools are judged not on their application but on "their systematic relations of coherence and consistency with one another" (*LW* 12:71). These conceptions, methods, and techniques themselves become the immediate subject matter of scientific inquiry; the problems of science are set by inadequacies that arise in them and the difficulties of expanding and refining them.

The distinction between common sense and science is a distinction both of degree and of functional interrelation. That there is no sharp or final

8. Dewey places "world" in scare quotes.

distinction should be clear from the way that Dewey emphasizes "*direct in-volvement*" in the "*immediate* environment" in his characterization of commonsense inquiry, whereas science is "increasingly remote from … situations of use and enjoyment" (*LW* 12:77), referring at one point to the goal of commonsense inquiry as "*pretty* direct existential application" (*LW* 12:71, my emphasis). Nonetheless, the activities of science arise in and return to those situations of use and enjoyment that constitute the commonsense "world," and it is losing sight of that fact that undermined ancient science and modern philosophy, which in its worst form constituted the link between superstition, religious practice, and class hierarchies in ancient cultures (*LW* 12:78).

The connection between science and common sense is twofold: "(1) Scientific subject-matter and procedures grow out of the direct problems and methods of common sense, of practical uses and enjoyments, and (2) react into the latter in a way that enormously refines, expands and liberates the contents and the agencies at the disposal of common sense" (*LW* 12:71–72). As commonsense inquiries develop more technical approaches, more precise tools and concepts, greater stores of information, and more sustained and systematic investigation, they developed into scientific inquiry:

> Gradually and by processes that are more or less tortuous and originally unplanned, definite technical processes and instrumentalities are formed and transmitted. Information about things, their properties and behaviors, is amassed, independently of any particular immediate application. It becomes increasingly remote from the situations of use and enjoyment in which it originated. There is then a background of materials and operations available for the development of what we term science, although there is still no sharp dividing line between common sense and science. For purposes of illustration, it may be supposed that primitive astronomy and primitive methods of keeping track of time (closely connected with astronomical observations) grew out of the practical necessities of groups with herds in care of animals with respect to mating and reproduction, and of agricultural groups with reference to sowing, tilling and reaping. Observation of the change of position of constellations and stars, of the relation of the length of daylight to the sun's place in relation to the constellations along the line of the equinox provided the required information. Instrumental devices were developed in order that the observations might be made; definite techniques for using the instruments followed. (*LW* 12:77)

The features of precision, control, and systematicity that characterize modern science mean that it is the primary template for logic, which investigates the

forms of successful inquiry. Scientific inquiries include some of the paradigm cases of successful inquiry according to Dewey, although it has no exclusive claim on the matter. Understanding Dewey's philosophy of science requires understanding both his general theory of logic as well as the special features of scientific inquiry.

4. Logic and Science

Dewey, like the logical positivists and other contemporaries, often discussed philosophy of science in terms of 'logic'. As I have already suggested, the central text for understanding Dewey's philosophy of science is *Logic: The Theory of Inquiry*. The connection drawn there between science and logic is a strong one: "The net conclusion of both the critical and constructive portions of the foregoing discussion is that the phrase 'logic *and* scientific method' has no valid meaning when 'and' is taken to mean an external relation between the two terms. For scientific method both constitutes and discloses the nature of logical forms" (*LW* 12:388). This link between logic and science saddles Dewey with two complementary problems: (1) those sympathetic to or influenced by the logical positivists are likely to see Dewey's "logic" as no logic at all, and (2) post-Kuhnian philosophers are likely to see the focus on logic as quaint and outmoded.

The first approach is exemplified by Carnap's reaction to Dewey's *Logic*. Carnap dismisses Dewey's *Logic* as not really logic at all but instead the "art of thinking." It "cannot be criticized as psychologism," which is inconsistently subjectivistic (discussing logical problems in objectivist mode while treating the nature of logic as subjective). Dewey's *Logic* is "consistently subjectivistic," and thus "there is merely a terminological difference in the use of the term 'logic.'" Carnap believes Dewey has been misled to think he is doing logic because "many logicians … have erroneously characterized this field as the art of thinking. … Dewey, who actually works on the art of thinking, that is, the theory and technology of procedures for overcoming problematic situations [was thus led] to choose the title 'Logic'" (Carnap 1962, 40). Putting aside the apparent condescending tone of these remarks, how much justice is there in Carnap's evaluation of Dewey's logic?

In fairness to Carnap, his discussion of Dewey follows a long argument that psychologism is a contradiction between objectivistic practice and subjectivistic theory (1962, 39–40), and so Dewey comes out looking better, in terms of consistency, than the psychologistic logicians like Boole. Dewey just is not doing logic, but there is nothing wrong with that. Carnap, however, has to explain away "a few sections which seem somewhat out of place" on

topics of "logic in our sense" (40). Although it is beyond the scope of this article to demonstrate the point, Carnap's historical argument is problematic; his reading of Dewey is flawed. This is a distortion of the history, meant to legitimate what had been in fact a highly revisionary development in logical theory over the past half century by the likes of Frege, Russell, and Carnap himself. Dewey's views are in fact more continuous with the tradition of logic from Aristotle through Kant to Mill and modern logic, for better or worse, than the antipsychologistic school in modern logic that became orthodox for much of the twentieth century—what Dewey called "formalistic logic." Dewey's logic is still a type of logical theory: it is general, normative, and concerned with the relation of form and content and the nature of various types of inference. He states up front that the entire goal of the *Logic* is to explain the familiar subject matter of logic in ways both Aristotelian and modern logicians would recognize. Indeed, Dewey addressed key questions in philosophy of logic—such as the origins and justification of logical forms.[9] It is not the point of this article to settle disputes in philosophy of logic, however; it is enough to show that the charge in 1 that Dewey is not even doing logic can be answered.

If this argument is successful, we run the risk in point 2 that Dewey's philosophy of science will seem to be a historical relic of little contemporary interest since the close connection of discussions in logical theory and philosophy of science now seems a quaint and mistaken conceit of mid-twentieth-century analytic philosophy.[10] Ever since Kuhn, it has become harder and harder to insist that science can be analyzed primarily by the use of formal logic.[11] The imposition of formal logical methods in the reconstruction of the practice of science is now seen by many as a poor tool for the job, perhaps even to have hindered the progress of philosophy of science (Kitcher 2011, 35; see also Kuhn 1962/1996; Feyerabend 1975; Kitcher 1993). We now travel a hard road of trying to analyze scientific practice, the social dimensions of science, the role of values of science, and all the rest by different means. Looking to Dewey's writings on logic for inspiration in philosophy of science may thus appear to be dangerous recidivism.

9. Whether we like his answers today is of course another thing, but it is worth pointing out that the logical positivists are not on much better footing in this respect.

10. While many philosophers of science still hold this attitude, it is clearly becoming an untenable one, as readers of this journal well know. As the recent renaissance of work uncovering the depth and nuance in the views of the logical positivists has shown, the views of philosophers of science who relied on the close connection between logic and science are anything but quaint and outmoded. In the rest of this section, I respond to those who hold this problematic attitude.

11. The present-day inheritors of this tradition are the Bayesians, who still hold that science is profitably analyzed, not according to the formal apparatus of the predicate calculus but rather according to that of the probability calculus.

Dewey differs from his contemporaries by denying that logic is imposed on science from the outside. Logic just is, for Dewey, a theory of inquiry. While philosophers like Russell and Carnap believed that logic was to be developed on its own and then used as a tool to deal with problems in philosophy, Dewey believed that there was a more complex relationship between reason and practice. In the case of science, Dewey had to fight the "well recognized distinction between methodology and logic, the former being an application of the latter" (*Logic*; *LW* 12:12). This common assumption of logic's independent status from any of its uses, and that scientific method (or philosophy of science in general) is simply applied logic, is precisely the untenable stance we have come to reject. That Dewey also rejected it is clear, but he did not take this to mean that logic is thus unrelated to philosophy of science: "But it may be noted that the assertion *in advance* of a fixed difference between logic and the methodology of scientific and practical inquiry begs the fundamental question at issue. The fact that most of the extant treatises upon methodology have been written upon the assumption of a fixed difference between the two does not prove that the difference exists. ... In any case, the *a priori* assumption of a dualism between logic and methodology can only be prejudicial to unbiased examination both of methods of inquiry and logical subject-matter" (*LW* 12:13). What logical empiricists (and their present-day heirs) and their critics may be taken to share is the assumption that logic and methodology are distinct from one another, and where they differ is on the question of whether methodology is an application of logic or whether logic is largely irrelevant for methodology.

Scientific method is not simply the application of logic, on a Deweyan view, and neither is it irrelevant to logic. Rather, logic and scientific method exist in a dialectical relationship; they mutually inform one another. At base, Dewey's theory is as follows: "all logical forms (with their characteristic properties) arise within the operation of inquiry and are concerned with control of inquiry so that it may yield warranted assertions" (*LW* 12:11).

Dewey agrees with the formalists: "Inquiry in order to reach valid conclusions must itself satisfy logical requirements." What he denies is the "easy inference from this fact to the idea that the logical requirements are imposed upon methods of inquiry from without" (*LW* 12:13). Rather, the logical requirements on inquiry come from within inquiry itself because inquiry is a self-corrective process (see Colapietro 2002; Seigfried 2002).

The way that Dewey connects logic and science is by treating logic as the theory of inquiry. Inquiry gives logical theory a natural, experiential subject matter—our practices of inquiring, questioning, judgment, or problem solving. These practices also admit of retrospective judgments of success

and failure that give logic a normative bite, without having it imposed from without a priori: "These formal conceptions arise out of the ordinary transactions; they are not imposed upon them from on high or from any external and a priori source. But when they are formed they are also formative; they regulate the proper conduct of the activities out of which they develop" (*LW* 12:106). Dewey suggest we can see logic, whether Aristotelian, modern, or Deweyan, formal or informal, deductive or inductive, as an attempt to clarify and codify the most general normative constraints that we have discovered as a result of our inquiries, successful and unsuccessful. Of course, Dewey believes that his own approach has a better shot at successfully specifying those constraints than does Aristotelian or formal logic, but the point is that we ought to interpret all logical systems as attempts to do so. The history and practice of science are particularly rich data for this pursuit. Likewise, Dewey's logical theory—formulated specifically with this goal in mind—provides ripe material for those who want philosophical tools with which to study the actual practice of science.

5. Situationism

Dewey's philosophy of science includes a sophisticated and somewhat peculiar form of contextualism, or "situationism." His situationism, and the technical notion of a "situation," is one of the most misunderstood and underanalyzed elements of his theory of inquiry. According to Dewey, inquiry always takes place in, is immediately concerned with, and is guided by a situation—as I show in section 6, a situation is crucial to the very definition of inquiry. Understanding what a situation is, then, is a crucial precondition for understanding his theory of inquiry. Dewey's situationism really does two orthogonal things: it provides a middle path between atomism and holism, and it replaces universalism with a form of contextualism. It is thus bizarre that Russell (1939, 139–40) confuses Dewey's situationism as a form of Hegelian holism in which each situation and thus each inquiry must include the entire universe (discussed in Burke 1994, 32). Russell could apparently see no middle ground between atomism and universal holism.[12] Dewey's goal was precisely the opposite, to avoid "atomistic particularism" and the "analytic fallacy" on the one hand and "unlimited extension or universalization" on the other, by way of "contextual situations" that preserve that "connection and continuity" present in the

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12. Tom Burke sympathetically reconstructs Russell's criticism as one about whether Dewey can limit the size of situations and thus keep situationism from collapsing into runaway holism—more about this below.

experienced world while providing "limiting conditions" for any generalization ("Context and Thought"; *LW* 6:7–8).

Dewey begins by telling us what a situation is not: it "is *not* a single object or event or set of objects and events" (*LW* 12:72), either physical or mental. A situation is not an objective, perspective-free spatiotemporal region. Neither is it a subjective theater of appearances. It is a "contextual whole" that forms the background of experiences and judgments about objects and events. Dewey rejects the idea that experience contains isolated particulars: "In actual experience, there is never any such isolated singular object or event; *an* object or event is always a special part, phase, or aspect, of an environing experienced world—a situation" (*LW* 12:72). This suggestive but elusive phrase—"an environing experienced world"—is central to understanding what Dewey means by "situation." A situation is environing in that it involves an environment, in a Gibsonian sense to be explored below. It is experienced in that it is pervaded by a quality felt by the agent or agents in the situation—indeed, experience for Dewey just is a particular kind of interaction between organisms and environments. A situation is a "world" not in the sense of The World but rather in the sense of having a particular sort of wholeness, unity, and comprehensiveness— as when we talk about "the world of baseball" or "the world of the modern-day engineer" or "the post-9/11 world."

Dewey goes on to say that situations have a complex structure: they include a focus, foreground, background, and horizon. They include both discretely discriminated objects and the background on which discriminations take place. Nevertheless, a situation is experienced as a whole: "A situation is a whole in virtue of its immediately pervasive quality" (*LW* 12:73). A situation is experienced but is not a subjective state; situations include real objects, events, agents, their relations, the background on which all of those things appear, and a qualitative, experienced, or experienceable qualitative unity.

The exact idea is obscure and frequently misunderstood. As mentioned above, Burke (1994) argues persuasively that Russell did not understand Dewey's idea of a situation and that this is one of the reasons that he so badly misinterpreted and misevaluated Dewey's logic as a whole. Even many sympathetic interpreters of Dewey say little to elucidate the concept of a "situation," at best repeating unanalyzed phrases like a "contextual whole," an "environing experienced world," and a "pervasive qualitative whole."[13] Burke is an

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13. Levi, e.g., unhelpfully tells us that "a situation is a state or episode of a system consisting of an organism in its environment" that can fall into "some sort of disequilbrium" and be put back into equilibrium by inquiry (2010, 85).

important exception, as he tries to give a careful account of situations in at least two major places. Unfortunately, both attempts involve serious although different mistakes.

Burke (1994) describes situations as follows: "Situations, occurring in the ongoing activities of some organism/environment system, are instances of episodes (or 'fields') of disequilibrium, instability, imbalance, disintegrations, disturbance, dysfunction, breakdown, etc." (22–23). This is an unacceptable interpretation of Dewey's situationism for several reasons. But most important, Burke wrongly identifies situations with what Dewey calls "indeterminate situations" and "problematic situations." The latter are crucial to understanding Dewey's theory of inquiry, but they do not exhaust the category of situations simpliciter. That this is the case can be seen by looking at the uses of "situation" in the chapters of the *Logic* under the heading of "Introduction: The Matrix of Inquiry" (pt. 1, chaps. 1–5). The first significant discussion of "situations" has to do not with inquiry but with language and meaning. Dewey argues that meanings are connected with specific situations and situated actions, whether they be immediately present or "remote and contingent" (*LW* 12:55). Indeed, attempts to use language "isolated from any such situation" would be "wholly indeterminate in reference; it was no part of *communication*, by which alone acts get significance and accompanying words" (*LW* 12:59). Unless, implausibly, language is only meaningful in conditions of "disequilibrium, instability, … dysfunction, breakdown, etc.," Burke's account of situations will not do. Furthermore, elsewhere in his book, Burke mentions "determinate situations," which are a crucial part of Dewey's theory but strictly nonsense on Burke's definition.

Burke (2000) seems to recognize that an alternative account of situations is necessary, but the newer account is at least as badly mistaken. In this paper, Burke argues that Dewey's logic is continuous with the Cartesian project of "securing solid ground in epistemology" by "bridg[ing] or otherwise transcend[ing] … the distinction between 'appearance' and 'reality'" (96). What accomplishes this is the "qualitative wholeness of individual experiences," which Burke elides with Dewey's concept of "situations." The function of situations is thus to provide the appearance/reality bridge: "The quality (quale?) which pervades 'an experience' [or a situation] is a reality which is at the same time an immediate appearance" (97). So the function of a situation is accordingly to provide an epistemological foundation or quasi foundation.[14]

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14. It is a "quasi foundation" since "we still do not and cannot have a fixed source of certainty nor a sure mark of truth or knowledge on the basis of which all that we know may now be encyclopaedically formulated" (Burke 2000, 97).

On this basis, Burke provides the following account of situation: "In this regard, we are committed to the claim that an *experience*—with a beginning, a direction, potentiality, extending out of and into the world, and so forth—is typically more than what or how it 'appears' to be on the surface; but a *situation*, while potentially complex, is just that 'surface' of an experience. A situation is exactly as it appears to be, wherever one may be within the unfolding of the experience which the situation uniquely presents to the agent" (2000, 109). So a "situation" is the surface appearance of the things in one's experience (not the surfaces themselves, which can obviously lead to perceptual illusions, but the relational properties of the surface appearances, which cannot). Again, Burke's interpretation is radically mistaken. Whatever the merits of thinking of the situation as playing a quasi-foundational role in Dewey's epistemology (the analogy is helpful in some ways and misleading in others), situations clearly cannot be the surface appearances of immediate experience. Burke mistakes the part for the whole—situations clearly have a pervasive qualitative character that is immediately felt (*LW* 12:73), but that is not all that they are.

That this is so can be seen in Dewey's attempts to clarify the concept of a "situation" in an exchange with Albert Balz:

> "Situation" stands for something inclusive of a large number of diverse elements existing across wide areas of space and long periods of time, but which, nevertheless, have their own unity. This discussion which we are here and now carrying on is precisely part of a situation. Your letter to me and what I am writing in response are evidently parts of that to which I have given the name "situation"; while these items are conspicuous features of the situation they are far from being the only or even the chief ones. In each case there is prolonged prior study: into this study have entered teachers, books, articles, and all the contacts which have shaped the views that now find themselves in disagreement with each other. (*LW* 16:281–82)

Dewey says here that a situation includes the actual objects (teachers, books) and not merely their surface appearances. The things in a particular situation are a unity in virtue of the agents and their practices at the center of the situation. What is immediately apparent, according to Dewey, is the qualitative character of this unity; as we will see below, this includes (but is not limited to) situations that are doubtful, confused, and indeterminate.

Consider another example: a biologist in the lab is engaged in an experiment. Near at hand are the lab bench, a rat—recently euthanized—several chemical compounds, scalpel, pipette, and slides. The focus of the situation

is the preparation of slides to observe the anatomical effects of a process be-gun weeks earlier in which some rats were given an experimental treatment, and others were not. Those events are part of this situation; so too are the rest of the rats currently living in their cages in another part of the lab. The microscope that our biologist will soon use to observe these slides and record images is also a part of the situation; certain characteristics of that tool govern the specific way the current activity is undertaken. More distant still, the situation includes the other members of the lab collaborating on this exper-iment, published articles—and their authors—whose conflict or missing ele-ments are the immediate spur of puzzlement that led to the experiment, as well as others that provide background knowledge necessary to carrying it out and making sense of it. The situation includes at its horizon a series of events and objects that formed the long course of training and education that pre-pared our biologist for this line of work, and so on.

A common but vague interpretation is to say that a situation is a relation or interaction of organism and environment. The sense of "environment" is not so much that of physics or biology but is most closely aligned with the sense of J. J. Gibson's ecological psychology: "This is not the world of physics but the world at the level of ecology" (1979, 2). Instead, "the environment consists of the *surroundings* of animals" (7–8). In Gibson's sense, an environment depends on what the organism can perceive and respond to, what is "ambient" for it, and the contents of the environment are the more-or-less familiar middle-size ob-jects from acorns to oak trees. As Dewey puts it, "nature is an environment only as involved in interaction with an organism, or self" (*LW* 12:110). Dewey's concept of environment is, however, more expansive. In particular, scientific inquirers develop techniques that allow them to make things ambient for them that are not for "ordinary" perceivers, from quarks to quasars.[15] The human environment contains not only inanimate and animate objects but also social, cultural, technological, and symbolic ones. Dewey wants to point to continuity between organism-environment relations in general and the situation in delib-erate, reflective inquiry, but that continuity does not amount to identity.

Gibson's theory of environment lacks one component that is crucial to understanding Dewey's situations. A Deweyan situation includes the inquiring agent(s) and all aspects of the environment relevant to the practices and activ-ities that spur the inquiry.[16] It is not the case that mere distance determines

15. Note that Dewey has a somewhat complicated and sophisticated take on the issues of unobservables and scientific realism, however, that will not be addressed in this essay. See Godfrey-Smith (2002, 2010) and Shook (2003).

16. Jung (2010, 154–57) gives a nice description of the interdependence among habits, activities, actions, and situations.

what constitutes a situation: many things that are nearby will not be included, as will some things distant in time and space. This relevance criterion is also key to understanding the limits of situations. Above, I mentioned that Burke (1994) reconstructs Russell's criticism of Dewey's logic as a concern about the limits of situations, namely, that Dewey cannot in principle make any situation smaller than the entire universe. Put differently, Russell can be taken as worrying that if a situation includes everything that is relevant to any inquiry, then in principle it includes everything that is. Russell suggests the bounds of relevance should be drawn causally: "Anything causally connected to a situation is pertinent to its resolution, and is therefore part of the situation" (51). Because a physical universe forms a causal continuum, in principle anything in the universe is part of the situation.

There are two responses to be made here. One is that Russell (or Burke's reconstruction) is half right: anything that is causally connected to a situation is potentially relevant and thus potentially part of the situation—there is no way to rule anything out a priori. But there is a long road between the possible and the actual; to be part of a situation requires being actually relevant (and finding out what is relevant may turn out to be difficult, in some inquiries). So, second, we still lack the proper sort of criteria for relevance: causal connection is too permissive.

Burke (1994) proposes an alternative: "Anything which is part of the disturbance which constitutes a situation is part of the situation" (51), but this depends on Burke's mistaken (and self-contradictory) interpretation of all situations as indeterminate or problematic, as we have seen. But it is a perfectly serviceable criterion in the special case of such situations, given that they are characterized by disturbance, and so on. So how can we generalize the point to situations of all kinds?

Situations are agent relative and practice relative. They depend on the needs and abilities, habits and activities of the agent or agents engaged in a certain kind of practice. What counts as relevant will be (at least partially) a normative question, dependent on the nature of the practice or activity in question and what things are proper to the practice or activity. Both examples above, of Dewey and Balz in discussion and of the biologist conducting an experiment, give a sense of how those judgments of relevance go: the situation will include those things that are an intimate part of the practice and that are constitutive of it and bear on it in a meaningful fashion. Situations will generally have a vague horizon; there are many things that are clearly irrelevant for understanding the practices in question. This connects with Dewey's metaphysical view about interactions: "while there is no isolated occurrence in nature, yet interaction and connection are not wholesale and homogeneous. Interacting

events have tighter and looser ties, which qualify them with certain beginnings and endings, and which mark them off from other fields of interaction" (*Experience and Nature* [*LW* 1:207–8]; quoted in Burke 2009a, 42). Among such "fields of interaction" are the agent-centered situations.

Despite the fact that situations are agent relative and practice relative, they are nevertheless objective aspects of the agent-environment interactions. Situations are not subjective/mental entities; they are concrete elements of the natural world. Agents perceive not only the constituents of their situations but the "pervasive qualitative character" of the situation, a qualitative perception (or feeling) of the character of objective transactions between the agent and the environment. The existence of a situation having a certain character is not constituted by the agent's awareness of it; agents may in fact fail to notice on occasion the sort of situation they are in. Nonetheless, the perception of a certain unifying quality of a situation is in a sense not open to error; the feeling is what it is. This ends up being a relatively trivial point, however, since one can easily be in error in judging oneself to be in a situation of a certain kind (more on this in the case of indeterminate situations below).

Finally, it is worth pointing out that situations are not some sort of obscure metaphysical entities. Dewey's theory requires the recognition of a background composed of ordinary objects, events, agents, and their interactions as the relevant context of a practice or inquiry, as well as a perceptual claim about the qualitative unity of that context. Vagueness at the boundaries and the fact that situations overlap may show the category to be open to interpretation—namely, to interpretation of a practice or activity—but that does not render it particularly mysterious.

6. Inquiry Defined

Dewey's theory of inquiry is sometimes glossed as a theory of problem solving (sometimes in connection with Kuhn and Laudan; e.g., McMullin 1979). This is in the right spirit, but it is oversimplified in important ways. On Dewey's account, the most "basic conception of inquiry" is "as determination of an indeterminate situation" (*Logic*; *LW* 12:3). Rather than problem solving, which assumes that problems are given as the input to inquiry and that the resulting process is an attempt to give a satisfactory solution to the problem as given, Dewey conceives of inquiry as the attempt to overcome an indeterminate situation, what in less technical writings he sometimes calls a "perplexity." Processes of inquiry are active processes of an embodied human agent; perplexities and problems arise, not out of pure intellectual considerations but out of experienced difficulties in navigating situations and successfully

conducting affairs. They are resolved by transforming the relations between agent and environment in a way that removes the difficulties.

Dewey gives the following "definition" of inquiry: "Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (*Logic*; *LW* 12:108). Inquiry is the deliberate attempt to transform an indeterminate situation or perplexity into a resolved or settled state (relative to that particular indeterminacy or perplexity).

Browning (2002) raises some important objections to Dewey's definition. First, the definition does not characterize inquiry, as such, but successful inquiry, "where success is marked by the actual termination of inquiry in the establishment of a determinate situation." The definition rules out "unsuccessful and truncated cases" of inquiry as well as cases of successful transformation that were not "controlled or directed" (168). Browning also suggests the use of "unified whole" to characterize the goal of inquiry (the mark of determinate situations) since it is elsewhere clear, as discussed above, that all situations are "unified wholes" in virtue of their pervasive quality (169).

Burke (2009b) attempts to answer these two charges. In dealing with the latter charge, he distinguishes between two senses of unity and wholeness at work in Dewey's *Logic*. The first is the "*qualitative* wholeness" of situations that belongs to all situations whatsoever, as Browning points out, and the "integration of" respective "organism/environment interactions" that characterizes determinate situations:

> So far as situations are concerned, there are clearly two distinct notions of "unified" here such that the one (qualitative uniqueness) does not entail the other (stable interactive integration). Both integrated and disintegrated fields of organism/environment interactions will, respectively, have unique overall qualitative aspects of some sort. Dewey's definition of (successful, properly controlled) inquiry is referring to the achievement of a robust integration of organism/environment interactions. The inquiry is not substantially completed (made whole? unified?) without such achievement. In contrast, qualitative wholeness, though changing, is present all along (e.g., some initial pervasive quality of discordance will eventually be succeeded by a pervasive quality of coherence). (Burke 2009b, 166)

An indeterminate situation is one that is marked by a certain kind of perplexity or difficulty, one that is unclear, uncertain, ambiguous, doubtful, or precarious

with respect to what is going on and what is to be done. Those are the qualities that unify such a situation as a situation. The settlement of doubt and uncertainty yields a different kind of unified wholeness, which we might characterize as a clear, unambiguous sense of what is happening and how to respond.

In addressing Browning's objection to the definition of inquiry as successful and controlled, Burke (2009b) attempts to supplement Dewey's definition of inquiry:

a. *Inquiry* is the deliberate transformation of an indeterminate situation *toward* one that would no longer be indeterminate.
b. *Properly controlled inquiry* is an inquiry employing tested and proven methods for successfully achieving what by all accounts are warrantably conclusive results.
c. *Successful inquiry* is an inquiry with a resulting situation sufficiently determinate in its constituent distinctions and relations so as to convert the elements of the original situation into a robustly stable integrated whole. (160)

These seem like perfectly reasonable amendments to Dewey's definition, but what Browning and Burke miss is that Dewey might use "inquiry" as a success term. That is, properly speaking, engaging in inquiry requires exercising proper control and the eventual settlement on a determinate situation. To not engage in a deliberate and controlled attempt to transform an indeterminate into a determinate situation thus would be not to inquire but to grope haphazardly; to end the process of inquiry before its proper conclusion would be to give up on the inquiry before it is complete. Dewey then would not say that the inquiry had terminated unsuccessfully, which implies a process came to an end, so much as merely ceased and dissolved prematurely.

The importance and meaning of the term "situation" has already been discussed. "Indeterminacy" is the pervasive qualitative character of the situation that evokes inquiry. It is not just a felt quality but also a feature of the transactions that characterize the situation. Relative to a certain practice or activity that an agent engages in (from the basic biological activities of life to complex cultural practices like science or politics), the situation's indeterminacy is an objective feature of the relations between the agent and the environment, a discoordination or disequilibrium, and a disruption of a previously smoothly operating practice or habit, reflected in a feeling on the part of the agent of doubtfulness or hesitancy. The agent is doubtful about what is going on and how to proceed, and his or her situated behavior reflects that as well.

Burke (2000) wrongly interprets Dewey as insisting that our immediate access to the qualitative character of our situations creates an infallible foundation for epistemology, as discussed above: "we have evidence here of an epistemological foundation, i.e., an epistemological ground which transcends the appearance/reality distinction" (97). Burke is right that Dewey seeks a place to transcend the appearance/reality distinction. Dewey wrote in a related but much earlier essay "The Postulate of Immediate Empiricism" that "things … are what they are experienced as" (*MW* 3:158), and the basic idea is retained in the *Logic*—a situation that is felt as doubtful is doubtful; a situation that is felt as settled is settled. If Burke had said that these pervasive qualitative characters of a situation acted as a guide to inquiry, this would have been accurate. In the 1930 essay "Qualitative Thought," Dewey argues that "thought [i.e., inquiry] is definitely regulated by qualitative considerations" (*LW* 5:243), including the qualitative characteristics of situations. But situations are not fit to be regarded as grounds or foundations of anything. "The situation as such is not and cannot be *stated* or *made explicit*" (*LW* 5:243, emphasis added). The perception of the qualitative wholeness of a situation has no cognitive content but is rather more like an affective state (hence, Dewey prefers to say that the pervasive quality is "felt" rather than "perceived"). It is distinct from the judgment "I am in a doubtful situation" or more commonsense assertions of doubt and uncertainty.

Dewey does recognize a type of situation that is perceptually similar to an indeterminate situation, in the sense that it might also lead one to judge that a situation is doubtful. He calls this situation a "mania of doubting":

> It is the *situation* that has these traits. *We* are doubtful because the situation is inherently doubtful. Personal states of doubt that are not evoked by and are not relative to some existential situation are pathological; when they are extreme they constitute the mania of doubting. Consequently, situations that are disturbed and troubled, confused or obscure, cannot be straightened out, cleared up and put in order, by manipulation of our personal states of mind. … It is, accordingly, a mistake to suppose that a situation is doubtful only in a "subjective" sense. The notion that in actual existence everything is completely determinate has been rendered questionable by the progress of physical science itself. Even if it had not been, complete determination would not hold of existences as an *environment*. (*Logic*; *LW* 12:109–10)

The difference is that the "mania of doubting" lacks an objectively indeterminate situation or, strictly speaking, even a felt pervasive quality of indeterminacy,

doubtfulness, and so on. Rather, that person's pathology leads him to believe that he is in such a situation.

It is tempting to characterize Dewey as a sort of disjunctivist with respect to the perception of situations, so that we treat separately the case of veridical perception of an indeterminate situation and the pathological state of ungrounded doubt as different kinds of states. It is right that Dewey treats these as two separate types, but that perception lacks any cognitive content and so cannot be called "veridical," while the mania of doubting has (false) cognitive content—the false judgment that the situation is doubtful. The difference is important because the pervasive quality of a situation is immediately, spontaneously felt and direct, whereas no judgment whatsoever on Dewey's view is immediate, spontaneous, direct, or infallible.

Once we recognize that the perplexity or the indeterminacy of the situation should be resolved by undertaking inquiry and choose to do so, we call it a "problematic situation" (problems or problematicity, then, being strictly speaking all and only what is open to inquiry). The step from indeterminate situations to inquiry is thus not necessary but involves a component of recognition and choice. There are indeterminate situations that we may remain not fully aware of or avoid as unimportant. Still, recognizing the existence of a problematic situation does not, on its own, generate a conception of what the problem is.

We can compare Dewey's account to C. S. Peirce's doubt-belief schema for the fixation of belief. For Peirce, all genuine inquiry must address a genuine doubt or a genuine problem; this meant that the impulse to inquiry had to be a state of doubt characterized by a certain feeling of uncertainty or difficulty (phenomenological component), it had to act as an impediment to action (practical component), and it had to lead to a genuine struggle after new belief (epistemic component). All of this is compatible with doubt being a personal mental state, which is a significant difference between Dewey and Peirce.[17] As mentioned, for Dewey, the impulse to inquiry comes from a situation, not an individual or a mental state. The situation is characterized by a "pervasive qualitative character" of doubtfulness, precariousness, uncertainty, indeterminacy, unsettledness, and so on. This overall aesthetic quality or mood that characterizes the situation stands in for the phenomenological component of Peirce's "doubt." Dewey retains Peirce's practical component as well; indeed, the situation is in part defined by the interactions or transactions between agents and environments that characterize human practices,

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17. The difference may be downplayed if one takes on some features of Peirce's theory of mind, but that is beyond the scope of this investigation.

and the doubtfulness that characterizes an indeterminate situation is a result of some discoordination or disequilibrium in those interactions.

It is important to recognize, however, that scientists do not passively wait around for genuine problems or doubts to arise on their own:

> Here is where ordinary thinking and thinking that is scrupulous diverge from each other. The natural man is impatient with doubt and suspense: he impatiently hurries to be shut of it. A disciplined mind takes delight in the problematic, and cherishes it until a way out is found that approves itself upon examination. The questionable becomes an active questioning, a search; desire for the emotion of certitude gives place to quest for the objects by which the obscure and unsettled may be developed into the stable and the clear. The scientific attitude may almost be defined as that which is capable of enjoying the doubtful; scientific method is, in one aspect, a technique for making productive use of doubt by converting it into operations of definite inquiry. … Attainment of the relatively secure and settled takes place, however, only with respect to *specified* problematic situations; quest for certainty that is universal, applying to everything, is a compensatory perversion. One question is disposed of; another offers itself and thought is kept alive. (Dewey, *The Quest for Certainty*; *LW* 4:182)

The scientific spirit requires seeking out indeterminate situations that have not yet made themselves known because they have not risen to anyone's awareness or because the elements that are in tension have not yet come into conflict. Further, while inquiry transforms some indeterminate situation into one that is settled and secure, there is no reason to think that science as a whole is moving from less to more certainty, from more to fewer problems. New conditions and new results may spur new problems, and in any case, scientists positively go hunting for new problems to attack. (Indeed, as others have frequently pointed out, the fruitfulness of an idea depends on its ability to create new problems.)

Inquiry is a transformation in the sense that the resolution of a problematic situation or perplexity in general requires not just a change in the inquirer's state of mind or beliefs but a change in the situation itself. Even when no physical modification of an environment is necessary to resolve a problem, changing the beliefs, attitudes, and habits of the inquirer changes the relations, interactions, and activities that characterize the situation and will lead to immediate changes to the potentialities of objects and mediate physical changes to the environment that follow from putting the solution into practice
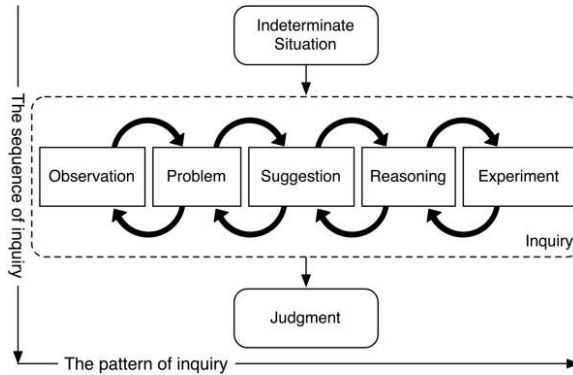
Figure 1. Dewey's two-dimensional theory of inquiry. The first dimension is the linear sequence of temporal stages captured by Dewey's "definition" of inquiry. The second dimension is the nonlinear set of functional phases that Dewey calls the "pattern of inquiry."

(Godfrey-Smith 2002). The objective and final product of inquiry is a judgment. Inquiry continues until one of the hypotheses is adjudged to be the most warranted among the alternatives, and the alternatives have been more or less ruled out. A judgment that satisfies the conditions of good inquiry and can be used as a settled means to future inquiry has the property of *warranted assertability*.

Dewey's theory of inquiry is a two-dimensional theory of inquiry (fig. 1). Along the first dimension, Dewey describes the origin and goals of inquiry: inquiry begins with an indeterminate situation, taken up as a problematic situation by the inquirer (this section), while inquiry results in judgment and the resolution of that indeterminate situation into a situation that is determinate and unified (sec. 8). These are three temporal stages of inquiry: indeterminate situation, inquiry, and judgment. Along the second dimension, Dewey describes the characteristic pattern of inquiry as a set of functionally defined and interrelated phases in a reciprocal and iterated process—following this pattern is what makes inquiry "controlled and directed." This pattern involves normative (but defeasible) constraints on inquiry, but it does not distinguish scientific from nonscientific types of inquiry, nor does it present a set of methodological procedures or a step-by-step algorithm guaranteed to produce successful results.

7. The Pattern of Inquiry

Dewey describes inquiry as having a complex pattern with multiple phases. The precise nature and enumeration of those phases turns out to be a surprisingly difficult interpretive question open to various misinterpretations. The idea of

logic, thought, or inquiry having stages or phases appears very early on, in "Some Stages of Logical Thought" (1900).[18] This early paper refers to the first dimension discussed under the "definition" of inquiry above, at that time in terms of Peirce's doubt-inquiry-belief sequences (in the more mature terminology, indeterminate situation, inquiry, judgment/determinate situation). The first formulation that is recognizably like the mature view of the *Logic* in that it describes the complex functional structure of inquiry (the intermediate stage along the temporal sequence) is the first edition of *How We Think* (1910). "Upon examination, each instance reveals, more or less clearly, five logically distinct steps: (i) a felt difficulty; (ii) its location and definition; (iii) suggestion of possible solution; (iv) development by reasoning of the bearings of the suggestion; (v) further observation and experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief" (*MW* 6:236–37).

Here the two dimensions are arranged in linear fashion; that is, the "felt difficulty" or indeterminate situation and the resolution (still "belief" in 1910) are part of the phases of inquiry. In the revised edition of *How We Think* (1933), Dewey has clearly articulated a two-dimensional structure of inquiry.[19] Here's how he describes the first dimension (i.e., the definition of inquiry): "In the preceding chapter we saw that the two limits of every unit of thinking are a perplexed, troubled, or confused situation at the beginning and a cleared-up, unified, resolved situation at the close. The first of these situations may be called pre-reflective. It sets the problem to be solved; out of it grows the question that reflection has to answer. In the final situation the doubt has been dispelled; the situation is post-reflective; there results a direct experience of mastery, satisfaction, enjoyment. Here, then, are the limits within which reflection falls" (*LW* 8:199–200). And here is the list of phases:

> In between, as states of thinking, are (1) suggestions, in which the mind leaps forward to a possible solution; (2) an intellectualization of the difficulty or perplexity that has been felt (directly experienced) into a problem to be solved, a question for which the answer must be sought; (3) the use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide observation and other operations in collection of factual material; (4) the mental elaboration of the idea or supposition as an idea or supposition (reasoning, in the sense in which reasoning is a

18. Revised and reprinted in Dewey (1916/2007).
19. The revised edition includes the new subtitle "A Restatement of the Relation of Reflective Thinking to the Educative Process."

part, not the whole, of inference); and (5) testing the hypothesis by overt or imaginative action. (*LW* 8:200)

This list of five phases is the clearest mature statement of the pattern of inquiry, although it is not identical with the view presented in the 1938 *Logic*. It is absolutely crucial to understand the distinction drawn, in this related but somewhat earlier work, between the temporal sequence in which inquiry is intermediate and the functionally distinct phases of inquiry.

Before pressing on, it is worth pointing out an elementary error that one might make when discussing this second dimension of the structure of inquiry. Most careful readers of Dewey's views here agree that it would be a mistake to think of the phases as linear steps, or absolutely distinct categories. Ernest Nagel, in his introduction to the *Logic* in the *Collected Works*, does seem to make this mistake:[20]

As Dewey saw the pattern of inquiry, it is a succession of distinguishable stages. In the first, the problem implicit in such an interruption is located, formulated, and developed; in the second, hypotheses (or suggestions) for solving the problem are introduced and are examined, with a view to determining by reasoning just what is implied by them that may have a bearing on the problem; in the third, a hypothesis is tested by appropriate experiments that either verify or disconfirm such logical consequences of the hypothesis; and the inquiry is terminated by a judgment as to whether a proposed hypothesis does (or does not) resolve the problem that initiated the inquiry. This pattern obviously includes, but goes beyond, what has been called the "hypothetico-deductive method" of scientific investigation. (*LW* 12:xiii–xiv)

For Dewey, specifying a pattern of inquiry means specifying a set of functional relationships to be satisfied, although not an algorithm or set of temporally arranged steps for doing so. The misreading may further tempt readers today because of some superficial similarities with the cartoonish version of "The Scientific Method" as a step-by-step recipe taught in grade school.[21] Dewey is clear that this is a mistake: "The five phases, terminals, or functions of thought, that we have noted do not follow one another in a set order" (*LW* 8:206), but

20. See Dorstewitz (2011, 207–8) for discussion of Nagel's mistake on this point. Note also that Nagel reduces the pattern to three stages, in line with Dorstewitz's own view.

21. In fact, that cartoon probably itself derives from a drastic oversimplification of Dewey's own work (Blachowicz 2009).

rather, each movement forward in inquiry bears on or has consequences for the other phases. It more closely fits Dewey's descriptions to think of them as repeated, reciprocal functions or as "concurrent and interdependent activity-modes" that work in "parallel streams" and in "nonlinear interaction" (Dorstewitz 2011, 208–9).[22]

The superficial structured of chapter 6 of the *Logic* suggests a reversion to something like the 1910 formulation. The main section headings are (1) "The Antecedent Conditions of Inquiry: The Indeterminate Situation," (2) "Institution of a Problem," (3) "The Determination of a Problem-Solution" (which Dewey calls "ideas" or "suggestions"), (4) "Reasoning" (where Dewey equates "ideas" and "hypotheses"), and (5) "The Operational Character of Facts-Meanings" (where Dewey discusses the interaction of facts and ideas and discusses the "necessity for experiment"). Several commentators have taken this as the definitive list of phases of inquiry. For example, Hildebrand (2008), in his discussion of the pattern of inquiry, lists these five phases: (1) "An indeterminate situation in which a difficulty is felt," (2) "the institution of a problem; its location and definition," (3) "hypothesis of a possible solution," (4) "reasoning out the bearings of the suggestion," and (5) "active experimental or observational testing of the hypothesis" (53–56). Thayer (1952) gives the same list, except he adds a sixth phase: "inquiry concluded and warranted assertion" (63).

Dorstewitz (2011) repeats the list of section headings but adds some clarification: (1) "Indeterminate Situation: Punctuated Equilibrium," (2) "Institution of a Problem: Recognizing a Problematic situation," (3) "Determination of 'problem-solutions': Forming a hypothesis," (4) "Reasoning: transforming symbols and arriving at a judgment," and (5) "Operational character of Facts-Meanings: Controlled experiment" (207). Actually, there are some problems with his clarifications, which I hope to correct below; however, Dorstewitz does recognize the two-dimensional nature of Dewey's account of inquiry, and so he distinguishes the "'macro' pattern of inquiry"—the first dimension of temporal stages discussed above—and the "internal structure" of an inquiry, which he reduces to three phases: hypothesis, reasoning, and experiment (208–9).[23]

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22. Dewey is nowhere as clear in the *Logic* on this point as he is in *How We Think* (rev. ed.), but many descriptions presuppose the revision and revisiting of the products of various phases, and so it is clearly necessary that the phases be reciprocal.

23. Dorstewitz suggestively adds a "core" that includes "warrants, norms, imagination"—the very standards and methods of inquiry that constitute the subject matter of logic according to Dewey, along with a role for creativity (2011, 211–14). In a way, these are the logical forms and operations that govern all the phases of inquiry. I choose not to include them on my own list, but I have no major objection to doing so.

Thayer and Hildebrand make a serious mistake in treating indeterminate situation and judgment as phases like the rest. They fail to recognize an important difference between the temporal sequence of stages in which inquiry plays the intermediate role and the interlocking functional complexity of inquiry itself. Dewey's account of inquiry is two-dimensional. The first dimension is captured by the definition; the second, by the functional phases.[24] Dorstewitz more accurately captures the two-dimensional nature of inquiry, but he oversimplifies the second dimension by reducing it to three main phases. In collapsing the two dimensions of inquiry, they encourage the mistake of confusing functional phases with temporal stages—but this distinction is crucial to Dewey's view.

A better account of the pattern according to the *Logic* can be had by analyzing closely the discussion in chapter 6, section 3 ("The Determination of a Problem-Solution"), where Dewey describes the process of inquiry in full (along with a simple example), as well as by noting the fundamental duality of operations dealing with facts and with ideas and the importance of experiment emphasized in the summary at the end of chapter 6 and by attending to the redescription of the phases in the later chapter "Social Inquiry." The first part of the key discussion in section 3 is lengthy:

> *The first step* then is to search out the constituents of a given situation which, as constituents, are settled. When an alarm of fire is sounded in a crowded assembly hall, there is much that is indeterminate as regards the activities that may produce a favorable issue. One may get out safely or one may be trampled and burned. The fire is characterized, however, by some settled traits. It is, for example, located somewhere. Then the aisles and exits are at fixed places. Since they are settled or determinate in existence, *the first step in institution of a problem* is to settle them in *observation*. There are other factors which, while they are not as temporally and spatially fixed, are yet observable constituents; for example, the behavior and movements of other members of the audience. All of these observed conditions taken together constitute "the facts of the case." They constitute the terms of the problem, because they are conditions that must be reckoned with or taken account of in any relevant solution that is proposed.

24. Sleeper (1986, 49–50)—focusing heavily on the early logical writings—reduces the "pattern of inquiry" to Peirce's doubt-belief schema, but this is what Dewey calls the "definition of inquiry" rather than the "pattern of inquiry."

A possible relevant *solution* is then *suggested* by the determination of factual conditions which are secured by observation. The possible solution presents itself, therefore, as an *idea*, just as the terms of the problem (which are facts) are instituted by observation. Ideas are anticipated consequences (forecasts) of what will happen when certain operations are executed under and with respect to observed conditions. Observation of facts and suggested meanings or ideas arise and develop in correspondence with each other. The more the facts of the case come to light in consequence of being subjected to observation, the clearer and more pertinent become the conceptions of the way the problem constituted by these facts is to be dealt with. (*LW* 12:112–13, emphasis added)

There are a couple of key points here. The first is that Dewey puts a lot of emphasis on observation as the "first step in institution of a problem." The goal of observation is to determine the "facts of the case," which then set the "terms of the problem." It is at least worth considering whether observation is a candidate for an independent phase of inquiry.

Another key to notice is the parallel that Dewey draws between facts and ideas; the distinction between facts and ideas, existential and conceptual operations, and so on, is a major theme throughout the *Logic*. Dewey also goes on to draw a distinction between suggestions and ideas (or hypotheses): "Every idea originates as a suggestion, but not every suggestion is an idea. The suggestion becomes an idea when it is examined with reference to its functional fitness; its capacity as a means of resolving the given situation" (*LW* 12:113). Suggestions arise almost spontaneously in the face of a problematic situation; to take up the functional role of an idea or hypothesis, a suggestion must be picked out to be examined by inquiry as a possible solution and used to guide other phases of inquiry.

The move from suggestion to idea leads to another phase, reasoning, which gives us a better grasp on the idea and allows us to render it more precise. Dewey describes one final step in this section: "But the final test of its possession of these properties is determined when it actually functions—that is, when it is put into operation so as to institute by means of observations facts not previously observed, and is then used to organize them with other facts into a coherent whole" (*LW* 12:114). Note that the function of these observations is very different from those discussed in the first step; this later phase Dewey usually refers to as "experiment," and this is why I insist on distinguishing between observation and experiment.

On the basis of this discussion, I believe our options for identifying the list of phases fall between these two extremes:

1. Problem statement	1a. Observation
2. Suggestion	1b. Problem statement
3. Reasoning	2a. Suggestion
4. Experimentation	2b. Guiding hypothesis
	3. Reasoning
	4. Experimentation

One thing that Dewey seems consistent about across otherwise widely differing texts is that his model involves five stages. While I do not think anything major hangs on this (as Dewey says, "There is nothing especially sacred about the number five"; *LW* 8:207), I choose to follow his intentions here by picking out the following five functionally specified, interlocking, and reciprocal phases:

1. **Observation** collects data or determines the facts of the case in order to take stock of the fixed conditions of the situation that shape the problem.
2. **Institution of a problem** specifies what is perplexing or indeterminate in the situation in order to formulate a problem statement.
3. **Suggestion** proposes hypotheses (or ideas) for solving the problem.
4. **Reasoning** refines hypotheses, brings hypotheses into relation with larger theories and conceptual frameworks, coordinates observations and hypothesis, suggests new observations, and proposes experimental tests.
5. **Experimentation** tests the hypothesis by tentative or limited application to the situation that involves intervening or acting in the situation.

The products of each phase are provisional and may be revised many times in the course of an inquiry. Apart from the relatively arbitrary choice of the number five, I think there are two good reasons for laying out the pattern of inquiry according to this list, one internal and one external. The internal reason is that it provides us with a balance between facts and ideas that is important throughout Dewey's writings: two existential stages (observation, problem), two conceptual stages (hypothesis, reasoning), and one mixed (experimentation). Externally, highlighting observation as a stage makes Dewey's pattern of inquiry somewhat more relevant to philosophy of science, which has traditionally put a lot of attention into the relationship between observation and hypothesis. This matches nicely with two further points that are internal to Dewey's text: first, that his actual examples of inquiry usually start with

operations of observation and, second, that it brings out his own key distinction between initial observation (aimed at determining the facts of the case) and experimentation (aimed at actively testing the hypothesis).

In the remainder of this section, I lay out in detail some of the major features of these phases of inquiry. In section 8, I discuss in further detail the termination of inquiry in judgment and warranted assertion. In section 9, I lay out the basics of the role of values in scientific inquiry according to Dewey's theory.

7.1. Facts and Problems

Of the functions and factors of inquiry, instituting the problem is one of the most important and underappreciated. For Dewey, all inquiry is centered around a problematic situation and its resolution, represented by the inquirer as a problem and its solution. As we have seen, inquiry does not happen if there is no perplexity, if there is nothing in the situation that provokes inquiry. In formulating a coherent, antiskeptical fallibilism, Dewey sided with Peirce in thinking that one could not doubt settled convictions or conceptions without a positive reason to do so. If no genuine doubt arises or can be stirred, if we feel settled and certain, then inquiry cannot arise, and beliefs will not be changed.

We do not begin inquiry with an already set problem but with some implicit or poorly expressed perplexity, a problematic situation. A problem, or a problem statement, is an explicit formulation of the source of the perplexity; that is, it states what the difficulty is and which factors contribute to it. It is hard work to get the problem right: "A problem well-put is half-solved" (*LW* 12:112). And in fact, we should say also that a problem perfectly well put is entirely solved. That is, we can never quite set a statement of the problem in stone until we have found its solution since it could always be that to find the solution we might need to reformulate the problem.

The foremost function of facts in inquiry is determining what the problem is, although that is not their only role. For Dewey, facts are context-dependent, functionally defined, and constructed. Something is a fact if it plays a certain role or performs a certain set of functions in an inquiry; in other circumstances, it might not be taken as a fact at all. Facts are constructed in that they are not "out there," not some metaphysical object or state that propositions correspond to, but they are a type of proposition. Facts could also be called "data," and sometimes Dewey uses this term as well. Facts are not given in experience; rather, they are taken, which is to say that they are ways of taking experience to be a certain way. They are attempts to make certain features of experience explicit in a pellucid way and, as such, are subject to

selective interest and interpretation. Not only do facts make explicit what is already there, but in many cases in science, we are concerned to construct new facts—phenomena that exist nowhere in "nature"—using human artifacts such as electric circuits, digital computers, lasers, or even balls rolling down near-frictionless inclined planes.[25]

If we focus carefully on the functional roles of facts within an inquiry, however, Dewey's account looks somewhat more familiar. Facts capture the fixed conditions with which inquiry must cope. They provide the resources for locating and formulating the problem of inquiry. The facts also suggest certain hypotheses for solving the problem (e.g., determining that we have an oil fire rather than a wastepaper fire suggests a different method of solution be tried). Likewise, once a hypothesis has been suggested and elaborated, further examination and determination of the facts can help test the hypothesis and suggest acceptance, rejection, or further refinement. "Since transformation of a problematic situation (a confused situation whose constituents conflict with one another) is effected by interaction of specially discriminated existential conditions, facts have to be determined in their dual function as obstacles and as resources. … No existing situation can be modified without counteracting obstructive and deflecting forces that render a given situation confused and conflicting. … Nor can an objectively unified situation be instituted except as the *positive* factors of existing conditions are released and ordered so as to move in the direction of the objective consequence desired" (*Logic*; *LW* 12:493).

Facts are not the ultimate test of a hypothesis, however. The relationship is not a foundational one, and facts and hypotheses are symmetrical with regard to their revisability. What matters is that they "fit" with each other such that together they function to guide successful experimentation and eventual resolution of the underlying problematic situation. Instead, facts and ideas coevolve: sometimes facts suggest new ideas or revisions, and sometimes reasoning through ideas suggests further operations of observation, restatement of the facts, or even rejection of some data as spurious. The ultimate test of both is the transformation of the situation to resolve its problematicity.

Another important point to make is that facts for Dewey are not always singular or particular matters. Nor are there "atomic" or "basic" facts that transcend particular inquiries. Even high-level models of data or inclusion-exclusion relationships between high-order kinds can count as facts. In both

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25. Dewey's description of facts is not unlike a generalization of Cartwright's *nomological machines* in this way (see Cartwright 1999, chap. 3). See also Hacking (2002, 15) for the case of lasers and the Hall effect.

cases, what the facts express is about fixed conditions with which inquiry must deal: that the data show a certain general trend that fits a exponential curve, or that whales are mammals rather than fish, provides constraints that must be dealt with. Of course, what we can go on to infer from any set of facts is another matter: while facts capture fixed conditions, hypotheses capture potentialities or possibilities of future development of the situation. They tell us what we can expect and how we can act in order to direct the situation toward a better end.

This leads us to the last key point about facts: Dewey's subtle take on the theory-observation distinction. The examples of curve-fitting and the whale-mammal-fish relationships bring up concerns about what has usually been called theory ladeness. Dewey would agree that these kinds of facts, and indeed any statements of facts whatsoever, rely on categories and concepts developed by inquiry and involved in theories. It has become a commonplace in some quarters that facts and theories must "speak the same language" in order for them to be relatable to each other.[26] Nevertheless, although facts depend on what we might call "theoretical concepts," there is a clear and important distinction between facts and theories, namely, that they occupy distinct and opposite functional roles within an inquiry. Facts are responsible to actual conditions, and theories are responsible to possibilities. And ultimately, both are responsible to something that is not at all theory laden, the precognitive felt perplexity that must be resolved and the situation that must be transformed. This is, however, merely a functional and context-dependent distinction, which in part explains the easy commerce between facts and theories. In the context of very different inquiries, the superficially same claim might be a fact, or it might be a theoretical hypothesis.

7.2. Ideas and Solutions

As already mentioned, coordinate with the role of facts in inquiry is the role of hypotheses or ideas (which Dewey also sometimes called "concepts," "conceptual contents," "meanings," and "theories"). In other words, "idea" is Dewey's generic term for whatever conceptual-theoretical materials play a role in inquiry. Ideas are proposals or suggestions for solving a problem (as when we might say, "I have an idea!" when a solution occurs to us). Whereas facts capture the observed conditions of the situation, ideas capture the possibilities

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26. See, e.g., Culp (1995, 439–40), although most writers in this tradition focus on teaching facts to speak the language of theory, rather than making theory speak the language of facts (by operationalizing).

inherent in it, both in terms of what we can expect to happen and what operations we might perform to affect the course of events. Facts are what is present, whereas ideas indicate what is possible. Ideas are originally suggested (as possibly relevant or applicable) by the determination of facts and the formulation of the problem. They are then worked out through processes of reasoning, checked against further facts, tried out in experimental applications, and ultimately evaluated on the basis of their "functional fitness" in bringing the problematic situation to resolution: "The suggestion becomes an idea when it is examined with reference to its functional fitness; its capacity as a means of resolving the given situation. ... The final test of its possession of these properties is determined when it actually functions—that is, when it is put into operation so as to institute by means of observations facts not previously observed, and is then used to organize them with other facts into a coherent whole" (*Logic*; *LW* 12:114).

While it might be easy to see how some set of practical hypotheses might work in the way Dewey suggests, it is difficult to see how a scientific theory can be understood as a resolution of a problematic situation or how its content essentially involves operational interventions and their consequences.[27] One thing that theories do is express connections between events or things. To use some classic examples, if all ravens are black, then I expect that if I have found a raven, I will also find it to be black, and if it is the case that if there are low, dark clouds there will likely be rain, then I can expect that if I see such clouds, it may well rain. These show the possibilities or connections inherent in present situations, and these connections can be put to operational use in solving the particular problems at hand. Further, theories of a higher level of complexity and abstractness than these examples can be seen as more general mechanisms of generating more specific suggestions. That is, while a hypothesis like, "If you have a headache, you should take aspirin," if it is fairly adequate, will solve a wide variety of problems, a comprehensive medical knowledge of many features of the human body can generate an even greater variety of solutions.[28] If we regard the generation of these more specific ideas as the main function of theories, then we can see how even

27. Although, see Pearl (2000) and other manipulability or interventionist accounts of causation for reason to think that at least all (causal) laws of nature are connected with interventions and means-consequences relations.

28. Although we should be cautious: greater unity or comprehensiveness is not always a virtue; it can often trade off against more specific and disconnected yet more effective knowledge (a point made repeatedly by Feyerabend in many contexts; see, e.g., Feyerabend 1988). Further, it might well be the case that an overlapping set of incompatible, comprehensive theories of the human body might also be more effective, despite any difficulties in adjudicating contradictory hypotheses generated from them.

high-level theoretical systems can fit the general role of working toward the solution of the problem. Finally, developed scientific fields generate their own problematic situations when their theoretical or experimental practices exhibit doubt, tension, indeterminacy, and so on.

7.3. The Coordinate Development of Facts and Ideas

It is crucial to Dewey's theory of inquiry, and it is a powerful innovation on prior accounts, that facts and ideas develop in inquiry in coordination with one another. The key to successful inquiry is getting the right sort of functional fitness between the facts, or the terms of the problem, and ideas, or problem solutions. In summarizing his view, Dewey brings this element to the forefront: "Inquiry is the directed or controlled transformation of an indeterminate situation into a determinately unified one. The transition is achieved by means of operations of *two kinds* which are in functional correspondence with each other. One kind of operation deals with ideational or conceptual subject-matter. … The other kind of operation is made up of activities involving the techniques and organs of observation" (*LW* 12:121, emphasis mine).

Dewey thought that the enduring insight of Kant was his recognition of the need for perceptions and conceptions to work together. Kant made an error, according to Dewey, in thinking that perceptions and conceptions "originate from different sources" and require an activity of "synthetic understanding" to bring them together. But they need not have a third activity to bring together because determination of fact and development of ideas work in concert, controlled by and with an eye toward the other. As Dewey says, "In logical fact, perceptual and conceptual materials are instituted in functional correlativity with each other, in such a manner that the former locates and describes the problem while the latter represents the possible method of solution" (*LW* 12:115). So it is not clear that we can conceive of an activity of perception or of concept formation apart from the other since each is defined by a functional relationship with the other. Furthermore, both come from the same, not different, sources. "Both are determinations in and by inquiry of the original problematic situation whose pervasive quality controls their institution and their contents. Both are finally checked by their capacity to work together to introduce a resolved unified situation" (*LW* 12:115).

Finally, it is crucial to note that, "as distinctions they represent logical divisions of labor" (*LW* 12:115); that is, the distinction between percepts and concepts, facts and ideas, is a contextual and functional one. No proposition is a fact or a hypothesis in itself, for all time, in all inquiries. The distinction

between concepts and percepts is not, in other words, ontological but logical. Whether something is counted a fact depends on what role it plays in the inquiry at hand. For example, in a certain inquiry in chemistry, it may be appropriate to take certain atomic events as fixed facts, while in the bleeding edge of particle physics, the same things may be taken as ideas for testing (or even as rejected). Ideas and facts exist as ideas and facts relative to each other and to the problems and purposes of the inquiries in which they play a role.

It is crucial to understanding the correlative role of facts and ideas that, as Dewey says, "it is recognized that both observed facts and entertained ideas are operational" (*LW* 12:116). It would otherwise seem mysterious, according to Dewey, since facts, which locate and describe the problem, are "existential"; that is, they deal with the fixed conditions of the present situation as revealed by activities of observation, while ideas, referring to potentiality and possible solutions, are "nonexistential" (not referring to features of the actual situation). That ideas are operational means that they "instigate and direct further operations of observation," and they provide proposed plans for action to "bring new facts to light and to organize all the selected facts into a coherent whole" (*LW* 12:116) in a way that leads to a resolution of the problem at hand.

Facts are operational in that they are the result of operations performed by the inquirer. They are not given passively in sensation, nor do we find them ready-made, lying around in our environment. In scientific observation, inquirers engage in often quite complex activities that set up a natural event—including interaction with a measuring device. We record the results of this event using linguistic means (broadly construing "language" to include data, maps, models, etc.; *LW* 8:27). Facts are doubly constructed: they are the result of inquirers engaging in operations that physically produce them, and they are necessarily rendered lasting and social in inquiry by way of being captured in language. Finally, facts "operate" to guide problem description, hypothesis formation, and reasoning processes in inquiry.

It is important to remember that, for Dewey, neither facts nor ideas are absolutely given. Some facts may be settled before the inquiry at hand—they are taken from prior inquiries on a provisional basis only. The facts are taken, not given, as conditions for the inquiry, and the factual conditions are revisable within the inquiry in light of new information; the facts are a matter of "selective emphasis" for the purpose of resolving a particular problem (*LW* 1:31–32). Even when the facts are actually treated as unquestioned conditions or as evidence, this should be understood to have logical, not metaphysical, import; it is only a matter of their functional role in inquiry. Ideas are suggested by the determined factual conditions and by the creative efforts

of the inquirers; they begin life as suggestions that simply spring up or occur to us in a flash (*LW* 12:113–14). The two work together to move inquiry toward resolution.

Although Dewey never uses the term to describe his view, we could easily describe the relationship of facts and ideas in an inquiry as "dialectical."[29] The two develop in constant back and forth with each other. Significant development in the determination of facts immediately prompts new ideas or helps develop the working hypotheses already at hand. Development of a working hypothesis suggests new observations and tests. It would be misleading to call the two elements dialectical in the sense of two separate sources or faculties in dialogue. As Tom Burke says in his introduction to the critical edition of Dewey's *Essays in Experimental Logic*, "We have to make distinctions … but … we must not posit two different but mysteriously linked faculties where sensation, apprehension, perception, observation, and experimentation are essentially separate from thought, understanding, judgment, cognition, comprehension, calculation, and computation. Placing experience over and against reason in this way is a fundamental flaw in modern epistemology and contemporary cognitive science. It only gives rise to interminable debates concerning various priorities and dependencies among the elements and operations of these two separate faculties" (Burke 2007, xviii). On Dewey's view, by contrast, facts and ideas, perception and reason, are both types of experience or activities that occur within the course of experience. They do not have separate sources or consist of separate realms of existence; they are distinctions drawn within the course of reason. There is no reason on this view to regard their interaction as mysterious or problematic. This is the core of Dewey's critique of epistemology: once one adopts a functional logic, those problems that have so long exercised modern epistemology, which arise due to recurrent and pernicious dualisms of mind/body, internal/external, and so on, dissolve.

It is also interesting that this sort of pragmatism contradicts empiricist nominalism about empirical categories since particular matters of fact depend on theoretical generalizations as much as generalizations depend on particulars. On Dewey's view, it is only due to a confusion of what Burke describes as the "status of being logically primitive or elementary" (Burke 2007, xix) with being either psychologically or metaphysically primitive that doctrines such as nominalism, sense-data empiricism, or logical atomism make sense.

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29. In the *Logic* and elsewhere, Dewey uses "dialectical" as a pejorative term to describe philosophical arguments and theories that are "barren … disputes about definitions and classifications" (*LW* 1:107), that start from the traditional assumptions (unquestioned and unjustified) of a philosophical tradition, or that strive only for internal consistency or reasoning ungrounded in fact or observation (*LW* 8:145, 506).

7.4. Reasoning and Conceptual Frameworks

Reasoning is a crucial feature of inquiry for Dewey; without it, warranted judgment and thus knowledge is impossible: "When a suggested meaning [hypothesis, idea] is immediately accepted, inquiry is cut short. Hence the conclusion reached is not grounded, even if it happens to be correct. The check upon immediate acceptance is the examination of the meaning as a meaning" (*LW* 12:115). In other words, a grounded conclusion must be checked by reasoning, which Dewey characterizes in the following way: "[Reasoning] consists in noting what the meaning in question implies in relation to other meanings in the system of which it is a member. … If such and such a relation of meanings is accepted, then we are committed to such and such other relation of meanings because of their membership in the same system. Through a series of intermediate meanings, a meaning is finally reached which is more clearly *relevant* to the problem in hand than the originally suggested idea" (*LW* 12:115). These remarks on the nature of reasoning imply the existence of a conceptual framework and a modest form of conceptual holism. So a suggested hypothesis is reasoned through by tracing the conceptual structures to which it is related.

For example, suppose that a physicist, when studying some electromagnetic repulsion phenomenon, encounters an anomalous result. Suppose, furthermore, that she hypothesizes that there is a gravitational effect at work interfering with her experiment. Our physicist will then reason through the variety of connections among the electromagnetic relations she thought would be at work, the theory of gravitation, and what connections gravitational and electromagnetic phenomena may have (including, perhaps, the high-level theoretical principles of Newton's laws and the rules about balancing forces or the revised principles of modern physics). Through this process, then, the hypothesis is refined into one "which is more clearly relevant to the problem in hand" because "it indicates operations which can be performed to test its applicability, whereas the original idea is usually too vague to determine crucial operations. In other words, the idea or meaning when developed in discourse directs the activities which, when executed, provide needed evidential material" (*LW* 12:115). In other words, it is developed "until it receives a form in which it can instigate and direct an experiment that will disclose precisely those conditions which have the maximum possible force in determining whether the hypothesis should be accepted or rejected … or … indicate what modifications are required in the hypothesis" (*LW* 12:115–16). It is important to point out that Dewey's innovation here is not in having anything strikingly original to say about the procedures of reasoning, which ought to be fairly familiar, but rather

in what he says about the functional role of processes of reasoning in advancing inquiry.

7.5. The Necessity of Experiments

According to Dewey, solving any problem requires operations of making and doing. Ideas cannot be tested by a purely passive collection of facts through observation.[30] Active interventions of an experimental nature have an "indispensable place … in inquiry" (*LW* 8:41) because they provide necessary evidence about the prospective effectiveness of solutions. There are two key differences between experimentation and mere observation. An experiment is a deliberately guided intervention into the situation on the basis of the hypothesis: "Observation formed by variation of conditions on the basis of some idea or theory constitute experiment" (*How We Think*, rev. ed.; *LW* 8:273). Functionally, the roles of observation include recording fixed conditions, specifying the problem, guiding reasoning, and coordinating with the hypothesis; the special functional role of experiment is to try out the hypothesis as a solution to the problem.

Experimental interventions are not exclusively the type found in stereotypical laboratory settings. The only necessary conditions are that they be conceptually guided and that they function as application of the solution to the problem. Ideally, experiments should be active and deliberate interventions that are controlled. Frequently, Dewey's language suggests that active intervention is a necessary condition for experimentation, but he equally clearly insists on the functional nature of the phases of inquiry. Dewey might also have considered so-called natural experiments in which unplanned and uncontrolled events occur as if a controlled experiment had been performed; treatment and control conditions are assigned "by nature" or by chance in a way similar enough to how we would want to assign them such that we can treat the occurrence as if it were a proper experiment. Since such cases function like experiments, Dewey's view suggests we treat them as a limit case of experiments. Another limit case of experimentation is mere novel prediction, for example, in the case of pointing your telescope at a certain place at a certain time in order to observe an event your hypothesis predicts. Here we have active intervention guided by the hypothesis, but the intervention covers

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30. Strictly speaking, observation is never a passive process. Relatively early in his career ("The Reflex-Arc Concept in Psychology"; *EW* 5:96–110), Dewey debunked this idea. (For a contemporary take on the same issue, see Noë [2004].) Still, the function of observation is to determine the already-fixed facts in a situation, not to actively apply the hypothesis to test its efficacy.

merely the inquirer's body and measuring instruments. These are the main types of experiments open to astronomy and paleontology (*LW* 12:451 n. 2, 460–61), although they are supplemented by laboratory experiments (e.g., in spectral analysis; see *LW* 12:388). A third limit case are experiments in which one has very little control over the conditions of the intervention, as in field experiments.[31] Even an entirely conceptual subject matter (like mathematics) requires that new ideas be "tried out," that attempts be made to see how things would be different if new ideas and theories were put into operation. Directly, this requires only calculating or imagining how new concepts would function in possible cases; indirectly, new mathematical ideas are tested by their role in improving existential inquiries (*LW* 12:413). Non-Euclidean geometries were first tried out in the sense that they were shown to have interesting and coherent features; later, their direct applicability to calculations on nonflat surfaces or in relativistic physics gave them greater significance (and so, in Dewey's terms, we might say that they were more "valid" conceptions).[32]

If the problems of inquiry arose merely from personal states of doubt, then the manipulation of purely personal states of mind would (in principle) be sufficient for solving problems and, thus, sufficient for inquiry. Experimentation would then be a merely accidental feature of science: one possible method for arriving at new observations, themselves only useful as means to forming and justifying further beliefs of a more theoretical nature. Indeed, it would seem that traditional epistemology and philosophy of science have often been committed to just such a view.

From the point of view of the history and practice of science, this approach is totally absurd. The experimental method, which involves not only observation but active intervention, is one of most crucial innovations of science, as close as most anything comes to being an essential differentia of modern science. We would expect nothing less, from Dewey's point of view, for resolving a problematic situation requires putting a solution into practice.

31. Dewey argues that we ought to think of policies as the experiments in social/political inquiry, despite difficulties in control (*LW* 12:502).

32. This is a somewhat obscure and difficult point in Dewey's philosophy of science, the treatment of formal disciplines like mathematics. I cannot go into in much detail here. Dewey fully recognizes that in some sense, the only criterion for mathematical conceptions is their internal consistency, and otherwise mathematicians have carte blanche in developing new ideas. Nevertheless, Dewey believes that in some sense the ultimate value of mathematical discourse pursued in this way is that it produces mathematical conceptions that are valid in empirical inquiry (in the same way in which scientific conceptions ultimately must be valid in commonsense inquiry). Dewey's use of "validity" is idiosyncratic here, referring to any element that proves successful in moving the situation to resolution, including not only forms of inference but also factual/existential and hypothetical/theoretical propositions.

Dewey parts company with Quine: science is not about systematizing the stimuli that excite our sensory organs.[33] Sensory stimulations are not the data of science. Facts are, and their content deals with existential constituents of the world, and, except for the most mundane of facts, those cannot be determined without intervening in the world.[34] Systematization is also not the goal of science. The resolution of a problematic situation is. Problem solutions involve changes in our ways of acting in the world, and those can only be properly tested by means of controlled interventions. This pragmatic standpoint that recognizes science as an activity of live, embodied creatures trying to cope with an environment—that the significance of scientific questions comes from disruptions to that activity—is able to faithfully capture the significance of experimental methods, whereas more traditional empiricist theories of science are not.

8. Final Judgment and the Close of Inquiry

Inquiry ends in judgment; "judgment" is the "settled outcome of inquiry" (*LW* 12:123). If the operations of inquiry have run their course, if the ideas suggested by the facts of the situation have been reasoned through carefully, if they have been used to gather new facts relevant to their proposed problem solutions, if they have been thoroughly tested by experimental operations, and if all the parts of inquiry have achieved "functional fitness," then the final judgment with which the inquiry closes can be called a "warranted assertion" and has the property called "warranted assertability" (*Logic*; *LW* 12:16–17).[35] This notion is inquiry relative; what is warranted on the basis of inquiry in a particular situation may no longer have that status some time down the road, in a very different situation. But so long as inquiry is done well and the judgment actually succeeds in resolving the problematic situation from which the inquiry began, then it is fair to call the judgment warranted.[36]

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33. All the same arguments apply to the "Humeanism" of David Lewis, just as well, swapping out "sensory stimulations" for the "mosaic of spatio-temporally distributed intrinsic qualities" (Lewis 1986).

34. I use "facts" in Dewey's sense, or what some contemporary philosophers call "phenomena."

35. Dewey prefers this term to "knowledge" because of unwanted meanings that have accrued to the latter.

36. Ultimately, though, warranted assertability looks forward, to the future and to whether the results can be asserted in the future. In the continuum of inquiry, forms and techniques of inquiry are explicitly formulated to allow judgments to have relevance and staying power beyond the immediate situation they develop in response to. The generality of many scientific results in the sense of independence from particular applications is a marker, for Dewey, of scientific inquiry (*LW* 12:77, 119–20), but generality is a goal, not a guarantee.

A feature of judgment that Dewey emphasizes is that judgment is an active affair that changes the situation: "The pre-cognitive unsettled situation can be settled *only* by modification of its constituents" (*LW* 12:121, emphasis mine). It has what Dewey calls "direct existential import" (*LW* 12:123). An inquiry establishes new objects of knowledge (*LW* 12:122; cf. Godfrey-Smith 2002). That does not mean that it creates existences out of thin air; rather, it means that it adds new meanings and connections to the qualities, events, and things of our experience and that these will be taken up in our activities in different ways as a result. We pick things out and use them differently. Thus, inquiry that uncovers iron as a new object, or alters the object by uncovering important new properties or potentialities in it, not only changes how we see, think of, and value the parts of the world that we now pick out as "iron" (although it does do that). It also alters the face of mountains, the ore that we extract from them, and creates a whole new set of industrial practices and practical use activities in which this quite revolutionary material plays a role. In this unmysterious sense, for Dewey, changes in science create changes in the world.

Judgment also alters the background conditions of a situation. In order for us to establish reliable patterns that we may use, we must, to a large extent, control the situation so that only the relevant factors are available. Not only must agriculture learn how to encourage the growth of plants, it must learn to eliminate factors that interfere, such as competing plants, parasites, and animals that would eat those plants. Chemistry and materials science must refine materials so that they fit neatly into the categories that we know how to deal with; not any rock or piece of earth will do. Using principles from physics in application relies just as much on eliminating factors that physics does not know how to deal with as it does on applying the laws and principles of its theories to specific situations (e.g., Cartwright 1983, 6, 156; 1999, 4, 49ff.). Part of the tenacious difficulty that plagues quantum computing, and will keep it from having any practical payoff for years to come, is the difficulty in regimenting the environment around the qubits so that the rather strict requirements for applying quantum mechanics obtain and doing so for a sufficiently long time with sufficiently many qubits such that useful computations might be performed (i.e., the problem of decoherence effects; Unruh 1995).

9. Science and Values

Dewey thoroughly rejected the view that science is value-free and the theory of values that says they are separate from situated and descriptive inquiry. For

Dewey, inquiry is a practice that is "socially conditioned" (*Logic*; *LW* 12:27), and thus cultural interests and values will shape the problems inquiry addresses and the standards for solution. In part, this is because inquiry must begin with the symbolic resources and practices of the current culture and because those symbolic resources and cultural practices are themselves normatively laden. But inquiry also has "cultural consequences" (*LW* 12:27, 483). According to Dewey, "every inquiry grows out of a background of culture and takes effect in greater or less modification of the conditions out of which it arises" (*LW* 12:27). On reflection, the fact that solving problems and gaining knowledge must modify the conditions of the culture in which it takes place renders untenable the idea that values are imposed on inquiry from outside. Because inquiry leads to action, because it changes habits and culture, and because it reshapes practice, the idea that values are fixed in the social world before inquiry and unchanged in the course of inquiry is a nonstarter. According to Dewey, logical theorists and logic-influenced philosophers of science have completely ignored a prima facie distinct species of judgment, judgments of practice. Such judgments are not, according to Dewey, reducible to mere descriptive judgments. They have a distinctive logic.[37] Judgments of practice are crucially judgments about what we shall do; they are necessary when the course of action is not obvious but confused or indeterminate. Judgments of practice crucially involve evaluation, of both means and ends, of possible courses of action and their consequences. Judgments of practice are future oriented; although they depend on an adequate evaluation of the present circumstances, they are judged entirely on the basis of their consequences. To wit, their verification is identical to their truth. If the new course of action pays off, if it leads to the return of unproblematic action, the judgment of what to do was correct.

Take a simple example of a judgment of practice from "The Logic of Judgments of Practice" (Dewey 1916/2007, 185, 189–90; *MW* 8:31–32, 37–38). Suppose that I need to buy a new suit because mine are all worn out, perhaps, or I do not have one that is nice enough for a certain occasion. If the choice is absolutely clear, then there is no need for judgment; I will be carried on by some unreflective habit. Suppose this is not the case. The very nice, stylish, and durable suits are all too expensive. I may have to trade off style versus

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37. See "The Logic of Judgments of Practice" in Dewey (1916/2007), chap. 14 (*MW* 8), and "Judgments of Practice: Evaluation" in *Logic: The Theory of Inquiry*, chap. 9 (*LW* 12:161–81), and Welchman (2002). The following deliberation owes much to Welchman's insightful discussion, although I attempt to go further in spelling out the implications for philosophy of science.

durability, or I may have to choose a less formal or fancy suit. I am pulled in different directions; apparent values conflict. I must reevaluate the options with an aim to integrate the competing values. Values accrue to objects or features in the course of inquiry and reflection as means toward coming to a decision of what to do. I think about the consequences of buying a cheap suit that will fall apart in a year or how this or that style will reflect on me. I think about whether buying on credit is an acceptable means of payment and how that affects my price limit. And so on. In the end, I evaluate the different suits, and I make a judgment as to my course of action and purchase some particular suit. If the financial impact is not in the end too dire, and the suit wears well, takes me smoothly through formal occasions, and gets a few compliments and no derisive remarks, then I will say that I made the right decision. If things go less well, I may say that I judged falsely.

It may already be clear to you, though, that Dewey does not, in the end, regard judgments of practice as a distinct kind of judgment but rather as part of, or even *the*, fundamental kind of judgment. "The net conclusion is that evaluations as judgments of practice are not a particular kind of judgment in the sense that they can be put over against other kinds, but are an inherent phase of judgment itself" (*LW* 12:180). And "we may frame at least a hypothesis that all judgments of fact have reference to a determination of courses of action to be tried and to the discovery of means for their realization. In the sense already explained all propositions which state discoveries or ascertainments, all categorical propositions, would be hypothetical, and their truth would coincide with their tested consequences effected by intelligent action" (1916/2007, 178; *MW* 8:22; see Welchman 2002).

Dewey's exposition here is difficult. He begins with a prima facie distinct form of judgment: judgments of practice. These judgments have a form different from the way we think about ordinary factual propositions. But then he turns around and argues that judgments of practice are implicated in judgments of fact and, furthermore, that practical judgment is *the* fundamental logical form. All scientific and descriptive judgments, too, are judgments about something to be done, whether immediately or in the future. There are, of course, relatively more or less practical judgments in which evaluation plays a major or minor, explicit or implicit role. But all descriptive and scientific judgments require evaluations, where evaluations are understood not as the application of some antecedent values but the reflective judgment that something has some value. It is not just a prizing but an appraisal. Even judgments of fit between facts and hypotheses are a kind of evaluation (*LW* 12:125, 176).

It is because all inquiry has to do with transforming a problematic, indeterminate situation into a unified one, which requires an active modification of one's circumstances, that all judgment is (in part) a judgment of practice because the "primary object of our attempts to understand the world is not to describe it but to *manage* it" (Welchman 2002, 39). A problematic situation is, as we have said, a disruption of some practice that matters; resolving it requires a judgment about how to reconstitute the practice. As a practice, science has a specific normative structure governed by values that help scientists determine "how they ought to pursue their inquiries, what they may count as evidence, and what they are entitled to believe in specific situations" (28). The selection of data is an active and evaluative enterprise. Inquirers must decide which instruments and techniques to use, which operations of observation to perform, which data to select as relevant, and which tolerances to set and errors to control. All inquiry requires experiments, which are at base practical operations of making and doing, which as a type of practical activity require values. There is no phase of inquiry in which values play no role. But these values do not remain fixed. In many parts of inquiry, explicit judgments of value, or evaluations, are required. And indeed, the inability to make good judgments about value would severely impair the ability to do science well. Values in scientific inquiry are not fixed and ultimate ends but ends in view that are held tentatively or "experimentally." Just as no putative fact and no conceptual system remain immune from change in the course of scientific inquiry, so too no values or value judgments are immune: there are no unmoved movers in inquiry.

The values we begin with influence to a large degree which inquiries we pursue, as well as their outcomes. Feminist critics have made the point quite compellingly with regard to sexist values in certain areas of research. Dewey was especially bothered by the way the values of laissez-faire capitalism and corporate interest ("Science and Society" [*LW* 6:56]; *Liberalism and Social Action* [*LW* 11:53]), as well as nationalistic interests in war making (*LW* 6:54; foreword to *Scientists Are Human* [*LW* 13:370]), had influenced the recent course of scientific inquiry.[38] We might point as well to the influence of the interests of wealthy nations in guiding biotechnological research, as Philip Kitcher does (Kitcher 2001, 2011; Flory and Kitcher 2004; Reiss and Kitcher 2010). But Dewey believed, in the spirit of the Enlightenment although against many of his and our contemporaries, that science had the power to transform values. Indeed, within its limited sphere, every judgment

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38. The parenthetical citation is to Dewey's foreword to David Lindsay Watson's book *Scientists Are Human*.

is a transvaluation of prior values.[39] But Dewey also believed in the ability of science to influence values more generally, although not to deliver values from on high.

10. Conclusion

This essay has focused on giving an interpretation of Dewey's writings on the epistemology and methodology of science, topics that Dewey regarded as falling under the heading of "logic." Dewey presents logic as the study of inquiry, and he presents scientific inquiry as a process that renders a perplexed or problematic situation settled and clear. Inquiry is a dynamic process, a practice with functionally complex, interlocking phases. Facts and ideas in inquiry are judged according to their functional fitness: not only their coherence with one another or the reliability with which they are produced but also their adequacy in resolving a perplexed situation.

The logic of science is a core topic in Dewey's philosophy of science, one of the most technical and the most important for understanding the rest of his philosophy. Much work remains to be done, however. Dewey has important views on scientific realism and constructivism, on laws of nature and causation, on the nature and role of modal judgments, and more could be said about the role of values in science and the bearing of science on values, and these connect with Dewey's views on the special features of the social sciences. The difference and interaction between commonsense and scientific inquiries has only been touched on, as have Dewey's views on the nature of mathematical inquiry. Future work on these issues must take into account the core ideas of Dewey's logic of science.

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39. Dewey remarks in characteristic wit that "Nietzsche would probably not have made so much of a sensation, but he would have been within the limits of wisdom, if he had confined himself to the assertion that all judgment, in the degree in which it is critically intelligent, is a transvaluation of prior values" ("The Logic of Judgments of Practice" in Dewey 1916/2007, 196; *MW* 8:47).

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