SCIENCE AS ART: A DEWEYAN PERSPECTIVE

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Abstract: In this article, I will outline and defend John Dewey's philosophy of science, according to which science is an art. I will point out two lacunae in mainstream analytic philosophy of science and suggest a remedy from his point of view. He argued that theorizing is not opposed to practice but, rather, is one practice among others. He explained that inquiry begins with a problematic situation and terminates in the concrete transformation of that situation into a resolved one. I conclude that he understood knowledge as practice. Dewey understood science technologically in a broad sense. One of the purposes of science is to serve as a vehicle of social and moral reform, train intelligent and critical modes of perception, and enhance the meaningfulness of the world.

INTRODUCTION

Mainstream analytic philosophy of science[1] has traditionally treated science first and foremost as a system of representations (propositions, theories, axiomatic–deductive systems, model-theoretic structures, models, diagrams, etc.). These representations are considered independent of how they are arrived at and experimentally justified in practice. Thus mainstream analytic philosophy of science passes over concrete scientific practices in silence. It does so as if it were obvious that such practices be merely accidental, irrelevant or even harmful for understanding scientific knowledge and as if representations made sense independently of practice.[2] The origin of this notion can be traced to no one else but Plato himself and his

[1] I follow Joseph Rouse, *Engaging Science: How to Understand Its Practices Philosophically* (Ithaca and London: Cornell University Press, 1996) and *How Scientific Practices Matter: Reclaiming Philosophical Naturalism* (Chicago and London: The University of Chicago Press, 2002), ch. 4, in defining mainstream philosophy of science as scientific realism, instrumentalism, historical rationalism, and social constructivism. He argues that these rival schools have a common denominator: the commitment to representationalism in epistemology and philosophy of language. Representationalism maintains that "knowledge" denotes a coherent kind, like the Platonic justified true representation, and not merely an arbitrary collection of more or less related items which merely share a name. Thus these schools agree that the legitimation of science can be either established or undermined globally, through an exercise of philosophy of language or other analysis of knowledge as a coherent kind. Rouse's alternative is to conceive knowledge as located in various practices. As I shall show, Dewey's alternative is even more radical: that knowledge *is* practice.

[2] See, e.g., Bas C. van Fraassen, *The Scientific Image* (Oxford: Oxford University Press, 1980); *Laws and Symmetry* (Oxford: Clarendon, 1989); Larry Laudan, "A Confutation of Convergent Realism," in *Philosophy of Science 48* (1981), pp. 19–48; "Discussion: Realism without the Real," in *Philosophy of Science 51*(1) (1984), pp. 156–162; "Demystifying Underdetermination," in *Scientific Theories* (*Minnesota Studies in the Philosophy of Science*, vol. 14; C. Wade Savage, ed.; Minneapolis: University of Minnesota Press, 1990), pp. 267–97; Jarrett Leplin, "Truth and Scientific Progress," in *Studies in History and Philosophy of Science 12* (1981), pp. 269–92; *A Novel Defence of Scientific Realism* (Oxford: Oxford University Press, 1997); Clyde L Hardin and Alexander Rosenberg, "In Defence of Convergent Realism," in *Philosophy of Science 49*(4) (1982), pp. 604–15; Hilary Putnam, "Three Kinds of Scientific Realism," in *Philosophical Quarterly 32*(128) (1982), pp. 195–200; Robert Boyd, "The Current Status of Scientific Realism," in *Scientific Realism* (J. Leplin, ed., Berkeley: University of California Press, 1984), pp. 41–82; "What Realism Implies and What it Does Not," in *Dialectica 43*(1–2) (1989), pp. 5–29; "Realism, Approximate Truth and Philosophical Method," in *Scientific Theories* (*Minnesota Studies in the Philosophy of Science*, vol. 14; C. Wade Savage, ed., Minneapolis: University of Minnesota Press, 1990), pp. 355–91; "Kinds as the 'Workmanship of Men': Realism, Constructivism, and Natural Kinds," in *Rationalität, Realismus, Revision: Proceedings of the Third International Congress, Gesellschaft für Analytische Philosophie* (J. Nida-Rümelin, ed., Berlin: de Gruyter, 1999), pp. 52–89; Ilkka Niiniluoto, *Truthlikeness* (Dordrecht: Reidel, 1987); *Critical Scientific Realism* (Oxford: Oxford University Press, 1999); Michael Devitt, *Realism and Truth* (Oxford: Blackwell, 1991); "Scientific Realism," in Frank Jackson & Michael Smith (eds.), *The Oxford Handbook of Contemporary Philosophy* (Oxford: Oxford University

"classical" analysis of knowledge.[3] Studying scientific representation is not wrong as such. But it is narrow, and such confinement has not been justified by argument. Important aspects of science might remain outside the scope of mainstream philosophy of science. It risks entertaining an unrealistic picture of what scientists actually do most of their time.

But a practical turn seems to have occurred some decades ago in the sociology of scientific knowledge (SSK) and science and technology studies (STS).[4] It is partly a reaction to mainstream analytic

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Press, 2005), pp. 767–91; Larry Laudan and Jarrett Leplin, "Empirical Equivalence and Underdetermination," in *Journal of Philosophy 88*(9) (1991), pp. 449–472; Philip Kitcher, *The Advancement of Science: Science Without Legend, Objectivity without Illusions* (Oxford: Oxford University Press, 1993); "Real Realism: The Galilean Strategy," in *The Philosophical Review* 110(2) (2001), pp. 151–197; James W. McAllister, "Scientific Realism and the Criteria for Theory-Choice," in *Erkenntnis 38*(2) (1993), pp. 203–222; Gideon Rosen, "What is Constructive Empiricism?" in *Philosophical Studies 74*(2) (1994), pp. 143–178; Howard Sankey, *The Incommensurability Thesis* (London: Ashgate, 1994); James Ladyman, Igor Douven, Leon Horsten and Bas C. van Fraassen, "A Defence of van Fraassen's Critique of Abductive Inference: Reply to Psillos," in *Philosophical Quarterly 47*(188) (1997), pp. 305–321; Andre Kukla, *Studies in Scientific Realism* (Oxford: Oxford University Press, 1998); Stathis Psillos, *Scientific Realism: How Science Tracks Truth* (London: Routledge, 1999); Tim Lewens, "Realism and the Strong Program," in *British Journal for the Philosophy of Science 56*(3) (2005), pp. 559–577; Kyle P. Stanford, *Exceeding Our Grasp: Science, History, and the Problem of Unconceived Alternatives* (Oxford: Oxford University Press, 2006); Stephen Leeds, "Correspondence Truth and Scientific Realism," in *Synthese 159*(1) (2007), pp. 1–21; David Harker, "Two Arguments for Scientific Realism Unified," in *Studies in History and Philosophy of Science 41* (2010), pp. 192–202; David Papineau, "Realism, Ramsey Sentences and the Pessimistic Meta-Induction," in *Studies in History and Philosophy of Science 41* (2010), pp. 375–385; Steven French, *The Structure of the World: Metaphysics and Representation* (Oxford: Oxford University Press, 2014); Anders Landig, "Partial Reference, Scientific Realism and Possible Worlds," in *Studies in History and Philosophy of Science 47* (2014), pp. 1–9; Anjan Chakravartty, "Scientific Realism" (2017), retrieved 7 Jan, 2021, from https://plato.stanford.edu/entries/scientific-realism/. Taking the point of Joseph Rouse, *Knowledge and Power: Toward a Political Philosophy of Science* (Ithaca and London: Cornell University Press, 1987), ch. 2, I do not include Thomas Kuhn on this list. I have arbitrarily only included works published after 1980. The mainstream reaches back to the works of Mach, Duhem, and Poincaré at the turn of the 20th century; logical positivism and empiricism in the first half of the 20th century; and its demise in the 50s and 60s after the publication of works by figures like Quine, the later Wittgenstein, Michael Polanyi, Thomas Kuhn, and Paul Feyerabend. I also consider the strong programme of the SSK in the 70s as part of the mainstream; see Rouse (1996); Rouse (2002), ch. 4.

[3] Parry, Richard, "Episteme and Techne" (2020) retrieved Oct 10, 2020, from https://plato.stanford.edu/entries/episteme-techne/.

[4] E.g. Bruno Latour and Steve Woolgar. *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 2nd edition, [1979] 1986); Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (Oxford: Pergamon Press, 1981); *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, MA: Harvard University Press, 1999); Nancy Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983); Ian Hacking, *Representing and Intervening* (Cambridge: Cambridge University Press, 1983); Andrew Pickering, *Constructing Quarks: A Sociological History of Particle Physics* (Chicago: University of Chicago Press, 1984); *The Mangle of Practice: Time, Agency, and Science* (Chicago: University of Chicago Press, 1995); Robert J. Ackermann, *Data, Instruments, and Theory: A Dialectical Approach to Understanding Science* (Princeton: Princeton University Press, 1985); Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump* (Princeton: Princeton University Press, 1985); Allan Franklin, *The Neglect of Experiment* (Cambridge: Cambridge University Press, 1987); Peter Galison, *How Experiments End* (Chicago: University of Chicago Press, 1987); *Image and Logic* (Chicago: University of Chicago Press, 1997); Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge, MA: Harvard University Press, 1987); *The Pasteurization of France* (Cambridge, MA: Harvard University Press, 1988); *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, MA: Harvard University Press, 2000); Rouse (1987); Rouse (1996); Rouse (2002); Joseph Rouse, *Articulating the World: Conceptual Understanding and the Scientific Image* (Chicago and London: The University of Chicago Press, 2015); Hans Radder, *The Materialization of Science* (Assen: Van Gorcum, 1988); *In and about the World: Philosophical Studies of Science and Technology* (Albany: SUNY Press, 1996); Sharon Traweek, *Beamtimes and Lifetimes* (Cambridge, MA: Harvard University Press, 1988); David Gooding, Trevor Pinch and Simon Schaffer (eds.), *The Uses of Experiment* (Cambridge: Cambridge University Press, 1989); David Gooding, *Experiment and the Making of Meaning* (Boston: Kluwer, 1990); Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994); Jed Buchwald, *Scientific Practice: Theories and Stories of Doing Physics* (Chicago: University of Chicago Press, 1995); Hans-Jörg Rheinberger, *Toward a History of Epistemic Things* (Stanford: Stanford University Press, 1997); Hasok Chang, *Inventing*

philosophy of science. Scholars have started to study scientific practices as a legitimate object of philosophy of science on their own right. The result has been a revision in how science is conceived philosophically. Nowadays virtually all philosophers of science profess fallibilism and recognize the social and institutional dimension of science. But what is still missing – except in the large number of case studies undertaken by the SSK – is the philosophy of scientific practices.

This development has a precedent roughly a century ago about which most scholars remain ignorant, even those who have contributed to the practical turn. John Dewey conceived science first and foremost as concrete and practical solving of problematic situations which takes place in a biological and social matrix.[5] Rather than a true and justified representation, he argued that knowledge is a kind of action. In a word, science is an art for him. He also pointed out that the identification of knowledge and action[6] has already been made in the practice of modern physical science but not in philosophy – a claim which seems to hold even today.[7]

The position which I oppose is not a thesis but rather the absence of theses, namely theses about scientific practices in philosophy of science, both historical and contemporary. I also reproach the policy that usually no argument is provided to justify such omission. I will argue in this article that philosophy of science cannot afford neglecting scientific practices. Dewey's identification of science with art both points this out and suggests a revision. His arguments were designed for the discussion in the 1920s but apply to much of contemporary philosophy of science as well. The situation has improved, but there are still many philosophers who consider science exclusively as representation and ignore practice without argument. First, I will briefly outline pragmatist philosophy of science. Then I will explain Dewey's philosophy of science in more detail. My explanation is based mainly on his books *Experience and Nature*[8] and *The Quest for Certainty*.[9] I will occasionally make use of *Democracy and Education*,[10] *Human Nature and Conduct*,[11] and *Logic*[12] as well. I have included replies to some obvious criticisms. I will proceed to elaborate the concept of practice. After that, I will defend Dewey's idea that science should be understood as an art. I take these arguments to show that there is no distinction between the theory and the practice of science but, rather, theorizing is one of scientific practices; and that therefore contemporary philosophy of science should not overlook scientific practices in general. Finally, I will conclude with some critical remarks.

Pragmatism

Temperature: Measurement and Scientific Progress (Oxford and New York: Oxford University Press, 2004); *Is Water H_2O? Evidence, Realism and Pluralism* (Dordrecht, Heidelberg, New York, and London: Springer, 2012); Rein Vihalemm, "Towards a practical realist philosophy of science," in *Baltic Journal of European Studies 1*(1) (2011), pp. 46–60; "Practical realism: against standard scientific realism and anti-realism," in *Studia Philosophica Estonica 5*(2) (2012), pp. 7–22; "What is a scientific concept: some considerations concerning chemistry in practical realist philosophy of science," in J.-P. Llored (ed.): *The philosophy of chemistry: practices, methodologies and concepts* (Cambridge: Cambridge Scholars Publishing, 2013), pp. 364–84; "Philosophy of Chemistry against Standard Scientific Realism and Anti-Realism," in *Philosophia Scientiæ 19*(1) (2015), pp. 99–113; Adrian Currie, *Rock, Bone, and Ruin: An Optimist's Guide to the Historical Sciences* (Cambridge, MA and London: The MIT Press, 2018).

[5] John Dewey, *Logic: The Theory of Inquiry* (New York: Henry Holt and Company, 1938), chs. II–III. Arguably, it takes place in a technological matrix as well, as Ave Mets astutely pointed out (private communication).

[6] Using such phrase, Dewey means also *potential* action, and it includes speech acts as well.

[7] John Dewey, *Experience and Nature*, (London: George Allen & Unwin, Ltd., 2nd revised edition, [1925] 1929a); *The Quest for Certainty: A Study of the Relation of Knowledge and Action* (New York: Minton, Balch & Company, 1929b); Dewey (1938).

[8] Dewey ([1925] 1929a).

[9] Dewey (1929b).

[10] John Dewey, *Democracy and Education: An Introduction to the Philosophy of Education* (New York: Macmillan, 1916).

[11] John Dewey, *Human Nature and Conduct: An Introduction to Social Psychology* (New York: Henry Holt and Company, 1922).

[12] Dewey (1938).

Arguably, the classical pragmatists were the first who explicitly rejected the notion of science as representation.[13]

Charles S. Peirce (1839–1914), the founder of pragmatism, proposed the following definition of "meaning" in 1878:

> Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object.[14]

This definition has been called the "pragmatic maxim." He explains what he means in the same paper:

> [...] what a thing means is simply what habits it involves.[15]

After 1903, Peirce realized that his notion of "practical bearings" should not be restricted to what actually takes place. Rather, it should encompass what *would* take place, if certain states of affairs *would* obtain.[16] Moreover, he did not restrict his notion of "meaning" to language, but it certainly does include language as a special case.

One can apply this maxim to the criteria of the correct attribution of the predicates "knows" and "understands." Because the practical bearings of knowing and understanding are manifest only in what the attributee does, including both the skillful use of the things in question and verbal responses, then the (fallible) criterion of the application of such psychological predicates is *behavior*.[17] The concept of behavior includes scientific practices. Thus it turns out that *to know and to understand something is to know what to do with it*. By this discussion, the sentence "A knows that electrons exist" can be analyzed into two different senses, (1) a strong and (2) a weak one: (1) "there are scientists and certain kinds of instruments so that the scientists are able to perform certain operations on certain objects using these instruments, yielding certain results and not others";[18] and (2) "according to testimony, it is possible to manipulate certain kinds of

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[13] Karl Marx and Friedrich Engels may have done this half a century earlier but only implicitly at most. See the relevant passages in Karl Marx and Friedrich Engels, *Karl Marx Friedrich Engels Werke* (henceforth MEW) (Berlin: Dietz Verlag, 46 volumes, 1956–). They include, e.g., *Ökonomisch–philosophische Manuskripte aus dem Jahre 1844* (1844) by Marx (MEW 40, pp. 515–7, 537, 542–5, 563, 569–70), "Thesen über Feuerbach" (1845) by Marx and edited by Engels (MEW 3, pp. 5–7, 533–5), *Die deutsche Ideologie* (1845) by Marx and Engels (MEW 3, pp. 20–1), the famous *Vorwort* of *Zur Kritik der politischen Ökonomie* (1859) by Marx (MEW 13, pp. 7–11), the first volume of *Das Kapital* (1867) by Marx (MEW 23, pp. 192–200), *Herrn Eugen Dührings Umwälzung der Wissenschaft (Anti-Dühring)* (1878) by Engels (MEW 20, pp. 1–303), "Die Entwicklung des Sozialismus von der Utopie zur Wissenschaft" (1880) by Engels (MEW 19, pp. 177–228), the unfinished *Dialektik der Natur* (1883) by Engels (MEW 20, pp. 305–570), and "Ludwig Feuerbach und der Ausgang der klassischen deutschen Philosophie" (1886) by Engels (MEW 21, pp. 276–7). *Ökonomische Manuskripte 1857/1858*, or *Grundrisse*, (1857–8) by Marx (MEW 42) is also rich in such suggestions but, as an early draft of *Das Kapital*, it is not finished for publication and hence sketchy, rambling, and disorganized. Thus I have decided to refer to the text as a whole. Marx (MEW 19, p. 181) claims that Engels had formulated some general principles of scientific socialism already in his 1844 essay "Umrisse zu einer Kritik der Nationalökonomie" (MEW 1, pp. 499–524).

[14] Charles Sanders Peirce, *The Collected Papers of Charles Sanders Peirce* (henceforth CP) (Cambridge, MA: Harvard University Press, 8 volumes. Volumes 1–6 edited by Charles Hartshorne and Paul Weiss, 1931–5. Volumes 7–8 edited by Arthur W. Burks, 1958): 5.402 (the first number before the dot indicates the volume, the second number after the dot indicates the paragraph); *The Essential Peirce: Selected Philosophical Writings* (henceforth EP) (Bloomington: Indiana University Press, 2 volumes. Volume 1 edited by Nathan Houser and Christian J. W. Kloesel, 1992. Volume 2 edited by The Peirce Edition Project, 1998) 1: 132 (the first number before the colon indicates the volume, the second number after the colon indicates the page).

[15] Peirce CP 5.400; EP 1: 131.

[16] E.g. Peirce CP 5.425ff., 5.438ff.; EP 2: 340ff., 346ff.; T. L. Short, "The Development of Peirce's Theory of Signs," in Misak, Cheryl (ed.): *The Cambridge Companion to Peirce* (Cambridge: Cambridge University Press, 2004), pp. 214–40; *Peirce's Theory of Signs* (Cambridge: Cambridge University Press, 2007), pp. 53–6.

[17] Thus the main argument of M. R. Bennett and P. M. S. Hacker, *Philosophical Foundations of Neuroscience* (Malden, MA and Oxford and Victoria: Wiley-Blackwell, 2003), esp. ch. 4, seems to follow from the application of the "pragmatic maxim" to psychological predicates. The criterion is fallible because, for instance, one can know what to do in a given kind of situation, but such situation never takes place, and thus others have no evidence of this knowledge.

[18] Cf. Hacking (1983), pp. 22–4.

entities in certain ways and not others." The strong sense requires ability to perform such operations correctly and ability to report them clearly. Only scientists themselves have knowledge in the strong sense. The weak sense only requires ability to give a correct verbal account, maybe with reference to a reliable source. It is derivative from the strong sense. Informed nonprofessionals have knowledge only in the weak sense. *Pace* Plato, it turns out that it is craft knowledge which is stronger, primary and more demanding, and theoretical knowledge which is weaker, secondary and more easily defeasible. People with a sense of irony could say that the latter *mimics* the former.[19] If a verbal account has no experimental grounds, it does not qualify as knowledge, only as a hypothesis – whatever its initial plausibility.

So far the implications for science are only implicit in the "pragmatic maxim." But Peirce may also have been the first to *explicitly* define science as the living practice of scientists. He did so at least in one instance in 1898 in the fourth lecture of a series of lectures delivered in Cambridge.[20] This fits well with the "pragmatic maxim" and its implications to the concepts of knowledge and understanding. To my knowledge, he never recanted this position – though he surprisingly had already claimed in passing in the first lecture that "pure science has nothing at all to do with *action*."[21] At any rate, whatever his final opinion was, and independently of whether he was committed to what he said, he still was arguably the first to publicly and explicitly identify science with practice.

William James (1842—1910), his contemporary and collaborator, may or may not have agreed; to my knowledge, he never discussed philosophy of science in length.[22] But, one generation later, John Dewey (1859—1952) made a lot more out of this notion: he claimed that science is an art.[23]

Dewey's epistemology might be best understood as part of his philosophy of education. That, in turn, might be best understood as his preferred vehicle of social reform. It seems that he considered the purpose of science to be the enrichment of human experience and the intelligent regulation of social and industrial conditions. During and after the *belle époque*, urbanization, industrialization, commerce, democratization, and the triumph of science and technology put the justification of traditional institutions to question. Society and morals were in transformation which still continues. Dewey hoped that his discussions of science and education would help intelligently and justly control this transformation.[24] Dewey's philosophy of science has therefore profound moral, social and political overtones in a way not unlike Friedrich Schiller.[25] Here his philosophy remains modern in echoing Baconian techno-optimism.

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[19] Cf. Plato, *Ion*, in *Plato in Twelve Volumes VIII* (Cambridge, MA and London: Harvard University Press and William Heinemann, 1975, translated from the Greek by W. R. M. Lamb, pp. 401—47), 532c, 535b, 540c; *The Republic Volume I: Books I–V*, in T. E. Page, E. Capps, & W. H. D. Rouse (Eds.), *Plato in Twelve Volumes V* (Cambridge, MA and London: Harvard University Press and William Heinemann, 1937, translated from the Greek by Paul Shorey), bks. II—III; *The Republic Volume II: Books VI–X*, in G. P. Goold (ed.), *Plato in Twelve Volumes VI* (Cambridge, MA and London: Harvard University Press and William Heinemann, 1980, translated from the Greek by Paul Shorey.), bk. X.

[20] Peirce CP 1.232–5; EP 2: 129–31.

[21] Peirce CP 1.635; EP 2: 33. This seems contradictory. I presume that he meant *action* in a specific technical sense, as essentially value-laden and carried out for the sake of utility; while he may still have adhered to the somewhat naïve conception of science as disinterested, even if it be understood as practice.

[22] William James, *Pragmatism: A New Name for Some Old Ways of Thinking* (New York, London, Bombay and Calcutta: Longmans, Green, and Co., [1907] 1916) and *The Meaning of Truth: A Sequel to 'Pragmatism'* (London, New York, Bombay and Calcutta: Longmans, Green, and Co., 1909) do not involve anything regarding this issue.

[23] Dewey ([1925] 1929a), ch. IX.

[24] E.g. John Dewey and James H. Tufts, *Ethics* (New York: Henry Holt and Company, [1908] 1959), pp. iii, 175—6; Dewey (1916), p. 321.

[25] Dewey (1916); John Dewey, *Reconstruction in Philosophy* (New York: Henry Holt and Company, 1920); Dewey (1922); John Dewey, *Art as Experience* (New York: Perigee, [1934] 1980); Friedrich Schiller, *Über die ästhetische Erziehung des Menschen*. (Stuttgart: J. G. Cotta'scher Verlag; Schillers sämmtliche Werke, zwölfter Band, [1795] 1860). Dewey (1916), pp. 317—22 even suggests that the way in which an infant learns is the experimental method, equating experience with experimentation.

That can be challenged, but I will not pursue that issue here. Dewey mentions the "pragmatic maxim" only occasionally,[26] but I understand his philosophy of science as its repeated application.

Science as Art and Knowledge as a Kind of Action

In *Experience and Nature*, Dewey questions many traditional distinctions. Here I focus on his rejections of the distinction between theory and practice and that between science and art. He claims that the only distinction worth drawing is not between practice and theory, but between those modes of practice that are not intelligent, not inherently and immediately enjoyable, and those which are full of enjoyed meanings.[27] This notion implicitly refutes a distinction made by Descartes: on the one hand, the mind as the source of all rationality; on the other, the body as an unintelligent mechanism and practice as mindless repetition. Dewey argues, in effect, that all purposeful action is intelligent on its own right and therefore there is no reason to oppose mental activity to bodily activity.[28] To be sure, all intentional bodily motions are controlled by the nervous system and hence require mental effort.

Dewey provided a confusing array of characterizations of the relation between science and art. He claimed that "science is an art, [...] art is practice";[29] "art [...] is the complete culmination of nature, and [...] 'science' is properly a handmaiden that conducts natural events to this happy issue";[30] "[t]hought, intelligence, science is the intentional direction of natural events to meanings capable of immediate possession and enjoyment; this direction – which is operative art – is itself a natural event in which nature otherwise partial and incomplete comes fully to itself";[31] "[s]cience is an instrumentality of and for art because it is the intelligent factor *in* art";[32] "[k]nowledge or science, as a work of art, like any other work of art, confers upon things traits and potentialities which did not *previously* belong to them";[33] "science is one among the arts and among the works of art";[34] and "[t]he history of science in its distinct emergence from religious, ceremonial and poetic arts is the record of a differentiation of arts, not a record of separation from art."[35] A closer look reveals that these characterizations are compatible. Science can be the intelligent factor in art which is itself an art and developed as a work of art.

If science is an art, then, what kind of art is it – useful or fine? Originally there was no such distinction: say, paintings and mechanical inventions were considered works of art in the same sense. In the 18th century, this situation changed, when figures like Immanuel Kant and Alexander Gottlieb Baumgarten established aesthetics as an independent discipline. They argued that the object of aesthetics is beauty. The appreciation of beauty was considered disinterested, while that of utility was not. Hence there arose a distinction between fine and useful art.[36] Presumably aesthetic goods were taken as ends in themselves, while instrumental goods were straightforwardly taken as mere means for something else. But Dewey rejects such distinction. He argues that the end of the useful is fine; and that smooth, efficient operation is itself an immediate, aesthetic good.[37] He also says that fine art consciously undertaken as such

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[26] E.g. Dewey (1929b), p. 111n2.
[27] Dewey (1922), p. 69; Dewey ([1925] 1929a), p. 358; cf. ch. V. See also Rouse (1996), p. 127.
[28] Dewey (1922), pp. 70–2.
[29] Dewey ([1925] 1929a), p.358.
[30] Ibid.
[31] Ibid.
[32] Ibid., p. 367.
[33] Ibid., p. 381.
[34] Ibid., p. 383.
[35] Ibid., p. 388.
[36] Ilkka Niiniluoto, *Tekniikan filosofia* (*Philosophy of Technology*; Tallinn: Gaudeamus, 2020), pp. 113–4. This work is currently only available in Finnish.
[37] Dewey ([1925] 1929a), p. 364–5.

is peculiarly instrumental in quality, a device in experimentation carried on for the sake of education; it exists for the sake of training of modes of perception.[38]

According to Dewey, all intelligent activities of men, no matter whether expressed in science, fine arts, or social relationships, have for their task the conversion of causal relations into means and consequences.[39] He means that when a causal relation is discovered, one learns to regulate the occurrence of the effect by manipulating the cause. This allows, again in Bacon's fashion, one to increase beneficial phenomena and to decrease harmful phenomena. This is, he claims, the way in which *meaning* emerges from interaction with the environment.[40] When the task is fulfilled, he calls the result *art*.[41]

In *The Quest for Certainty*, Dewey continues in the same spirit but with different terminology. His opponent is the *spectator theory of knowledge*. This theory implicitly or explicitly holds that objects are knowable only if they are maintained intact and that the knower is therefore passive.[42] This doctrine flies in the face of experimental science where knowledge is emphatically produced by instituting changes deliberately.[43] For the spectator theory, experiments would compromise the possibility of knowledge at the outset.

Dewey's main thesis of the volume is that knowing is a kind of action.[44] This is a refutation of the traditional distinction between knowing and doing. This somewhat cryptic claim requires explanation which Dewey himself did not provide. If actions come in kinds, then it is natural to ask, what these kinds could be. I suggest that the kind of action that knowledge is is *practice*. Dewey himself could have said in his mid-career that kinds of action are *habits*;[45] but I think that Joseph Rouse's concept of practice[46] captures better what Dewey tried to express. I will discuss this possibility below. At any rate, knowledge as a kind of action does not seem to represent anything.[47] This makes Dewey's epistemology anti-representationalist, anticipating Richard Rorty.[48]

Dewey also provides an account, how meaning emerges from experiment. First, a known change is introduced. Then something else (possibly nothing) changes as a result. This change is measured. Then these changes are correlated. If the correlation persists in varied circumstances, an experimental practice can arise, whereby these changes become signs of each other: the presence of one is a (fallible) sign of the presence of the other.[49]

Dewey also rejects Parmenides's influential distinction between appearance and reality: "[t]he world as we experience it is a real world."[50] Experience is fallible. But what refutes an experience is not reason

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[38] Ibid., p. 392.
[39] Ibid., pp. 369—70.
[40] Ibid., p. 136, ch. V (esp. pp. 177, 180—3).
[41] Dewey ([1925] 1929a), p. 370; cf. Dewey (1916), p. 320.
[42] Dewey (1929b), pp. 23, 196, 204, 211, 213, 245, 291.
[43] Cf. Dewey (1916), pp. 321—2.
[44] Dewey (1929b), pp. 83–8, 102–3, 167, 193.
[45] Cf. Dewey (1922).
[46] Rouse (1987), chs. 4 and 7; Rouse (1996), chs. 5—9; Rouse (2002), chs. 5—9. Curiously, Rouse comes close to Dewey in many respects without citing him.
[47] Though Jason Stanley and Timothy Williamson, "Knowing How," in *The Journal of Philosophy* 98(8) (2001), pp. 411—44 and Jason Stanley, *Know How* (Oxford: Oxford University Press, 2011) have argued that know-how is propositional. Their arguments seem cogent, but they do not explain, what it *means* for know-how to represent anything, and what it is that it represents. I remain unconvinced about their thesis, also for other reasons.
[48] Cf. e.g. Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton and Oxford: Princeton University Press, [1979] 2009); *Consequences of Pragmatism* (Minneapolis: University of Minnesota Press, 1982); *Essays on Heidegger and Others: Philosophical Papers, Vol. 2* (Cambridge: Cambridge University Press, 1991a); *Objectivity, Relativism, and Truth: Philosophical Papers, Vol. 1* (Cambridge: Cambridge University Press, 1991b).
[49] Dewey (1929b), p. 84; cf. Dewey (1916), p. 320; Dewey ([1925] 1929a), ch. V.
[50] Dewey (1929b), p. 295

conceived as something distinct from or opposed to experience. Rather, it is reason informed by some *other* experience. Hence there is no need to postulate a supra-empirical, transcendent, noumenal world, inaccessible to experience, let alone to conceive it as somehow "more real" than experience.

In a word, Dewey's understanding of science is *technological* – subsumed under the heading of skilled manipulation. Hence he came to the same conclusion which Heidegger made. Heidegger argued for the primacy of readiness-to-hand (*Zuhandenheit*) to presence-at-hand (*Vorhandenheit*) in his *Sein und Zeit*,[51] by which he meant that *Dasein* understands things primarily or positively as tools and only secondarily or privatively as use-independent objects which can thenceforth be investigated scientifically. A couple of decades later in his essay "Die Frage nach der Technik,"[52] he also argued that the essence of modern technology is enframing (*Gestell*) which is "ontologically" prior to modern science. But in other respects their accounts and especially their valuation of this primacy of technology differ significantly.

Niiniluoto criticizes such "materialist" or "technological" views of science. He argues that science, when it emerged 2600 years ago, was theoretical and devoid of instrumental concerns.[53] Dewey was deeply aware about that, as one can see from his lengthy discussions about Greek science scattered along his later works.[54] He does not say it explicitly, but I have understood his position to be that Greek "science" was not *science proper*, except perhaps mathematics, precisely because of the absence of practical and experimental basis. For Dewey, proto-science became science only after the adoption of the experimental method. He thinks that this adoption took place at the dawn of modernity, but he seems to have been unaware about medieval treatises on experiments by, e.g., Ibn al-Haytham (Alhazen), Ibn Sīnā (Avicenna), Abu'l-Barakāt al-Baghdādī, Robert Grosseteste, and Roger Bacon. Both Dewey and Niiniluoto seem to ignore ancient experimenters like Strato of Lampsacus, Archimedes, and Hero of Alexandria.

It should be emphasized that pragmatists do not reject representations as such or their significance. They only reject the notion that everything in science be reducible to representations, and that these representations be intelligible when abstracted from practice. They (with the possible exception of Peirce) do reject *internal* representations, though. The representations which are relevant for science are emphatically *external*: models, diagrams, maps, simulations, etc.

Dewey emphasizes continuity between common sense and science.[55] He does not mean that "anything goes."[56] He argues that common sense includes the basic structure of the experimental method. But this does not imply that *everything* in common sense qualify as science. His point is, rather, to show that common sense involves the method for its self-criticism. Thus there is no need to postulate science as something distinct from and opposed to common sense.

Pragmatism can legitimately be understood as an expansion of empiricism: that all knowledge is *a posteriori*, but the notion of experience does not merely encompass sensation but also action. Hence especially Dewey modeled his notion of experience after concrete interaction between an organism and its environment.[57] Thus "experience" does not denote "subjective," "mental" or "private" entities distinct from nature but real, public processes which take place *within* nature and can be empirically studied if need be.

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[51] Martin Heidegger, *Sein und Zeit* (Frankfurt am Main: Vittorio Klostermann; *Gesamtausgabe 2*, [1927] 1977), §§15–6.

[52] Martin Heidegger, "Die Frage nach der Technik," in *Vorträge und Aufsätze* (Frankfurt am Main: Vittorio Klostermann; *Gesamtausgabe 7*, [1953] 2000), pp. 5–36.

[53] Niiniluoto (2020), pp. 130–1.

[54] E.g. Dewey ([1925] 1929a); Dewey (1929b); Dewey (1938), pt. 1.

[55] E.g. Dewey (1929b), pp. 84–5, 220, 240–2, 271, 295; Dewey (1938), ch. IV.

[56] See Paul Feyerabend, *Against Method* (New York: Verso Books, [1975] 2010).

[57] Dewey (1938), chs. I–V; John Dewey, "Propositions, Warranted Assertibility, and Truth," in *The Journal of Philosophy 38*(7) (1941), pp. 183–4; cf. Dewey (1922), pp. 14ff.

Dewey's notion of experience comes close to what Ian Hacking and Joseph Rouse meant by "phenomenon".[58]

Some readers might be upset for the identification of science with practice. Practice brings interests and values in, the argument could go, compromising the objectivity and neutrality of knowledge in general and of science in particular. I presume Dewey would have bitten the bullet, asserting that objectivity and neutrality might be valuable if they could be attained; but they cannot, at least in practice. It is just a fact of life that all knowledge is interest- and value-laden and hence there is always the risk of partiality. But that risk is not removed by entertaining standards impossible to come by. Moreover, partial knowledge is still knowledge. It is not opposed to complete knowledge but constitutes a part of it. He might have added, inverting the criticism, that the ideals of objectivity and neutrality themselves compromise the possibility of knowledge and also display social irresponsibility. If efforts are channeled towards these values, they are wasted in a never-ending quest. They are also channeled away from other projects which are partial but nevertheless practically important. The marginal utility of allocating resources to partial projects rather than to impartial ones can be a lot higher for society. The interests are already there; taking them into account *increases* the objectivity of an inquiry when compared to pretending that they are not there. The quest for perfection is expensive in the terms of opportunity cost.

The Concept of Practice

I have indicated that the existence of theories cannot be taken for granted. I postpone this issue to the following sections, but I can already make some remarks as I explain what scientific practices are. A critic of my account could point out that some mainstream philosophers of science have already accounted for hypothesis generation and hence also for scientific practices.[59]

Hypothesis generation is indeed an important part of scientific practice. In philosophy of science, it has been called *abduction*[60] or, more colloquially, *inference to the best explanation* (IBE).[61] In the tradition of pragmatism, its significance has been understood since the beginning – already in 1868, if not earlier.[62] Peirce's logic of abduction is an integral part of his version of pragmatism.[63] (Peirce's not infrequent allusions to *il lumen naturale* which guided the ratiocinations of Galileo[64] only provide a name for the process of hypothesis generation, not an explanation. Moreover, Peirce was not the first theorist of abduction: he knew Aristotle, from whom he adopted the very term "abduction" (ἀπαγωγὴ),[65] and at least some of William Whewell's works.[66])

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[58] Hacking (1983), pp. 220–32; Rouse (2002), ch. 8. Interestingly, here may be an affinity with Buddhist metaphysics and epistemology; see Stephen J. Laumakis, *An Introduction to Buddhist Philosophy* (Cambridge: Cambridge University Press, 2008), pp. 13–4, chs. 6–7. Perhaps Heraclitus (see Hermann Diels and Walther Kranz, *Die Fragmente der Vorsokratiker; Griechisch und Deutsch. Erster Band* (Berlin: Weidmannsche Verlagsbuchhandlung, 1960), 22B1ff.) and Alfred North Whitehead, *Process and Reality: An Essay in Cosmology* (New York: Macmillan, 1929) entertained similar thoughts too.

[59] E.g. Lindley Darden, *Theory Change in Science: Strategies from Mendelian Genetics* (Oxford: Oxford University Press, 1991); Kenneth Schaffner, *Discovery and Explanation in Biology and Medicine* (Chicago: University of Chicago Press, 1993); Marcel Weber, *Philosophy of Experimental Biology* (Cambridge: Cambridge University Press, 2005).

[60] E.g. Ilkka Niiniluoto, *Truth-Seeking by Abduction* (Cham: Springer, 2018).

[61] E.g. Peter Lipton, *Inference to the Best Explanation*. (New York: Routledge; 2nd edition, [1991] 2004).

[62] Peirce CP 5.272–80; EP 1: 32–7; see also CP 2.619–44; EP 1: 186–99.

[63] See the 1903 *Harvard Lectures on Pragmatism*: Peirce CP 1.314–6, 5.14–81, 5.88–212, 5.77n; EP 2: 133–241.

[64] E.g. Peirce CP 1.630, 5.589, 6.477; EP 2: 32, 55, 444.

[65] Peirce EP 2: 527n11; Aristotle, *Prior Analytics*, in *The Categories; On Interpretation; Prior Analytics* (London and Cambridge, MA: William Heinemann Ltd. and Harvard University Press, 1962, translated from the Greek by Hugh Tredennick), 69a30–36.

[66] These works include at least William Whewell, *History of the Inductive Sciences, From the Earliest to the Present Time* (London: John W. Parker and Son; 3rd edition; 3 volumes, [1837] 1857) and *Novum Organon Renovatum, Being the Second Part of the Philosophy of the Inductive Sciences* (London: John W. Parker and Son, 3rd edition, 1858b) and possibly also *The Philosophy of the*

But one should not get the idea that scientific practices only amount to or reduce to generating hypotheses. To be sure, that would display the Platonist presuppositions that only theories matter and that bodily action be cognitively barren. Peirce himself may have had one foot in the Platonic tradition, but at least he understood induction as not merely formal but as expending effort concretely in the laboratory or fieldwork.[67] He also claimed at least once that retroduction – his near-equivalent term for abduction – be itself an experiment and that a retroductive research be an experimental research.[68]

Surprisingly, the classical pragmatists have next to nothing to say about scientific practices in detail: they have merely taken a couple of steps away from the abstractions of mainstream philosophy of science. Even Peirce, who practiced experimental science himself, keeps details at arm's length. But one can consult Rouse who has always emphasized the material dimension of practice. For him, theorizing is not opposed to practices but rather one practice among others.[69] A practice involves not only the doings of scientists but also the material setting in which they take place: instruments and environment.[70] Rouse has also emphasized that practices are essentially normative. A practice does not consist of regularities. Rather, whatever regularity a practice displays is accidental and presupposes its normativity.[71] Moreover, he acknowledges that practices are inherently meaningful and significant, and they matter to their practitioners. Thus he maintains that practices are essentially discursive.[72] He also emphasizes that scientific practices are part of the phenomena investigated.[73]

Scientific practices are rich and complex. They include, but are not limited to, the following: maintaining order in the laboratory; using instruments; devising and building experimental setups; manipulating objects; running experiments; calibrating instruments; purifying samples; keeping track of materials, specimens and assays, and of operations performed upon them; knowing one's way in the laboratory; having a feel of whether or not instruments are working properly and, if not, repairing them; and having a sense of how the field of study is developing and which lines of inquiry are worth pursuing. Moreover, an important public effect of scientific practices is the extension of laboratory phenomena outside the laboratory by predicting and controlling the behavior of people and disturbances in the environment.[74] None of these are trivial. Any one of them requires intensive, long training to master. The sheer difficulty of scientific work inspires awe already in such mundane occupations. But more to my purpose: none of these follow from theory, unless the term "theory" be stipulated to include at least some features of bodily actions.

Inductive Sciences, Founded upon Their History (London: John W. Parker; 2nd edition, 2 volumes, [1840] 1847); *History of Scientific Ideas, Being the First Part of the Philosophy of the Inductive Sciences* (London: John W. Parker and Son; 3rd edition; 2 volumes, 1858a); and *On the Philosophy of Discovery, Chapters Historical and Critical; Including the Completion of the Third Edition of the Philosophy of Inductive Sciences* (London: John W. Parker and Son, 1860). For suggestions, see Peirce EP 2: 507n7, 507n12, 524n20.

[67] E.g. Peirce CP 5.145, 5.168, 5.170, 5.197, 5.579–84, 7.206, 7.218; EP 2: 45–8, 96–7, 106, 205, 216, 225, 234–5, 288.

[68] Peirce CP 5.581; EP 2: 46.

[69] Rouse (1996), p. 127; cf. Dewey (1922), p. 69; Dewey ([1925] 1929a), p. 358.

[70] Rouse (1996), ch. 5; Rouse (2002), chs. 5–9.

[71] Rouse (2002), chs. 5–9.

[72] Rouse (1996), chs. 5–9; Rouse (2002), chs. 5–9.

[73] Rouse (2002), ch. 8.

[74] Such examples are discussed by Rouse (1987), chs. 4 and 7; Rouse (1996), chs. 5–9; and Rouse (2002), chs. 5–9. More examples can be found in the literature in the praxis tradition cited in the Introduction. There arises the question, whether such craft knowledge is propositional or not. I will not examine the issue here. For discussion, the most relevant sources are probably Gilbert Ryle, *The Concept of Mind* (Watford, Herts, UK: William Brendon and Son, Ltd., Mayower Press, [1949] 1951), ch. 2; Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (London: Routledge, [1958] 1962); *The Tacit Dimension* (Gloucester, MA: Peter Smith, [1966] 1983); Stanley and Williamson (2001); Stanley (2011); and Jeremy Fantl, "Knowing How" (2012), retrieved Jan 4, 2021, from https://plato.stanford.edu/entries/knowledge-how/.

Hans Reichenbach's distinction between the "context of discovery" and the "context of justification," of which only the latter be philosophically important,[75] no longer obtains. Discovery is not merely a "subjective" event but involves publicly accessible, causal, and "objective" material interactions. Success in all such practices, presumably part of the "context of discovery," is also ineliminably part of the "context of justification." Otherwise the competence of the scientists involved in the inquiry could be questioned.

Why Conceive Science as Art?

Dewey's arguments reveal two serious lacunae in mainstream philosophy of science.

Dewey argues that symbols are proxies for possible operations.[76] Hence theories, models, propositions, etc. do not make sense in abstraction from practice. The same goes for observations: without some guidelines provided by previous ideas and a possible purpose, we would be buried under a flood of observations, we would not understand their meaning and significance, and hence we could not cope with the situation.[77] This makes practices epistemologically prior to both observations and theories. Purposeful practices are needed to make observations and theories act in concert: observation to guide theorizing and theories to inform observations as to what to look for, what to discard as irrelevant with regard to the problem at hand, and how to rearrange data as to yield information. The significance of both theories and observations is operational: to help transform a problematic situation into a resolved one.[78] (This transformation may involve change in belief; but its point is a concrete transformation of the world itself.) In this sense, "[e]xperimentation has a life of its own."[79] Scientific observations are not just any observations whatever but emphatically results of experimentation designed on the basis of previous knowledge taken as a working hypothesis. Hence mainstream philosophy of science, which remains interested in theories and observations, merely presupposes their intelligibility without explaining it.[80]

Dewey argues that realists of his time make the results of inquiry the default state of affairs.[81] I suggest that if Rouse is correct in that most realists and anti-realists alike are still committed to representationalism,[82] then this applies to anti-realists as well. Such a position leaves it unexplained, how science ever got there. In this picture, scientific practice would not make sense before obtaining results: it would appear as random groping. Like the strong programme of the SSK and Bruno Latour[83] have pointed out, it will not do to claim that science has attained a result because it is true. What is true is found out in the conclusion of an inquiry, if at all. Hence, excluding the possibility of teleological explanation, truth cannot have influenced inquiry when it was still in progress. But like I said above, in reality, inquiry is not random trial-and-error: it is guided by the purpose to solve a problem and by previously established ideas.[84] These provide (fallible) clues, how to proceed: which observations to take as information about something else and which to ignore. At any rate, scientists perform scientific work without which there would not be theories or other representations in the first place. These two points are connected: both well from acknowledging the importance of practice in devising theories.

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[75] Hans Reichenbach, *Experience and Prediction: An Analysis of the Foundations and the Structure of Knowledge* (Chicago: University of Chicago Press, 1938a); "On Probability and Induction," in *Philosophy of Science* 5(1) (1938b), pp. 21–45.
[76] Dewey (1929b), pp. 163–5; Dewey (1938), ch. III.
[77] Dewey (1929b), pp. 112–3, 138; cf. Dewey (1938), pp. 108, 111.
[78] Dewey (1938), pp. 112–4.
[79] Hacking (1983), p. 150.
[80] See also how Peirce touches the issue in CP 1.184, 5.40; EP 2: 144, 259.
[81] Dewey ([1925] 1929a), pp. 308–9.
[82] Rouse (1996).
[83] Latour (1987).
[84] Dewey (1929b), pp. 86, 168, 273; Dewey (1938), pp. 112–4.

Even if science is understood in the narrow sense, as theorizing and observation, it must be conceived as an art. Both theorizing and observation themselves are arts which require training and skill and can be well or badly performed.[85]

Rather, it should be asked, why *not* conceive science as art. The reason, why science is not conceived as art, is Plato, Aristotle, the Stoics, Alexander of Aphrodisias and Plotinus. Originally knowledge (ἐπιστήμη) and skill or art (τέχνη) were considered synonymous: witness Xenophon who used the terms interchangeably. Plato made (but did not adopt himself) the analysis of knowledge as justified true belief,[86] not mentioning bodily activity. Arguably, his authority solidified this definition as the "classical" one. In Aristotle, the distinction between knowledge and skill or art is even sharper. Plotinus had little use for the notion of skill though he had a lot to say about knowledge.[87] For these historical reasons, I will call the notion that science be a system of representations *Platonist*. Dewey's epistemology in *The Quest for Certainty* rejects such Platonism and returns to the unity of knowledge and action.[88]

Criticism

Dewey uses citations extremely sparingly. Hence it easily comes to mind that he might be fighting straw men. It requires extensive background knowledge in the history of philosophy to understand that this is not the case: there indeed have been (and still are) philosophers who have maintained positions which he tries to refute. And, to be sure, they are not a rare exception but constitute the majority of the history of Western philosophy. The spectator theory of knowledge has been propounded by everybody whose epistemology passes over bodily activity in silence: e.g. Plato, Aristotle, the neo-Platonists, the scholastics,[89] Descartes, Leibniz, the British empiricists, Kant, the logical positivists and empiricists,[90] and mainstream analytic philosophy of science. But be it as it may, Dewey should have been more charitable to his readers and at least indicated whom he is arguing with in order to evaluate whether his criticism is just. The difficulty of following his argumentation may be one major reason why contemporary scholars do not cite him very often and uncritically propagate the prejudice that he be an "instrumentalist."[91]

Whether Dewey was an instrumentalist and in what sense is a contentious issue which I will not pursue here. I merely submit that in the works I have cited, Dewey indeed emphasizes that theories are instrumental, but he does not deny that correspondence may obtain or that "theoretical" entities literally exist in certain instances. At least once Dewey emphasized that he understands truth as correspondence,

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[85] Dewey ([1925] 1929a), pp. 378–9.

[86] Plato, *Meno*, in T. E. Page, E. Capps, W. H. D. Rouse, L. A. Post, & E. H. Warmington (eds.), *Plato in Twelve Volumes IV* (Cambridge, MA and London: Harvard University Press and William Heinemann, 1952, translated from the Greek by W. R. M. Lamb, pp. 259–371), 97d–98a; *Theaetetus*, in G. P. Goold (ed.), *Plato in Twelve Volumes VII* (Cambridge, MA and London: Harvard University Press and William Heinemann, 1977, translated from the Greek by H. N. Fowler, pp. 1–257), 201c–d.

[87] Parry (2020).

[88] Dewey (1929b), esp. pp. 74–6.

[89] Excluding certain figures like Robert Grosseteste and Roger Bacon.

[90] Possibly excluding Otto Neurath; cf. Rouse (2002), ch. 1.

[91] For example, Niiniluoto (2020), p. 130, and elsewhere considers Dewey as an instrumentalist without argument, simply citing Larry Hickman, *John Dewey's Pragmatic Technology* (Bloomington and Indianapolis: Indiana University Press, [1990] 1992). This is surprising, because Hickman describes Dewey's instrumentalism as completely different from the ordinary usage of the term. Hickman's ([1990] 1992, p. xii) interpretation of Dewey's thesis is that "tools or instruments cut across traditional boundary lines such as those between the psychical and the physical, the inner and the outer, and the real and the ideal." Instrumentalism in the ordinary sense is the doctrine that scientific theories are not literally true, or that so-called "unobservables" do not literally exist but are only postulated as conceptual shorthands or "economy of thought." These positions are logically independent.

though in an operational sense, that is, without transcendence.[92] When discussing the issue, I would hope that people would cite not only Hickman[93] but primarily Dewey's own works.

Niiniluoto has very persuasively argued for the independence of the value of theoretical knowledge from practical concerns and the distinctions between basic and applied research and between science and technology.[94] When it comes to the independence of the value of theoretical knowledge from practical concerns, Dewey probably would have replied that the value of theoretical knowledge might be independent of *utility*, but not of *practice or technology*,[95] because to know in the strong sense is to practice and thus to apply a technique or technology. Moreover, the value of knowing is not intrinsic. Rather, it is not independent of, but is derivative from, its application in education and culture, making life more intelligible and meaningful. Dewey might have also said that skills and abilities have intrinsic value besides instrumental value in the same way and on the same grounds as theoretical knowledge. Dewey probably would have accepted Niiniluoto's arguments for the distinctions mentioned. But that does not contradict Dewey's claim that science be an art, or skillful practice. Even if science and technology are not synonymous, and even if their purposes and valuations are distinct, both can still be arts. Moreover, even being distinct, science and technology are intertwined in many ways: for example, whatever intelligence technology or art manifests qualifies as science, and whatever experimentation science manifests qualifies as technology or art.

Dewey entertains a monolithic notion of *the* scientific method.[96] Rouse might reproach him for that – perhaps as an arbitrary imposition upon scientific practice – and add that sciences (in the plural) have a multitude of methods. Whether they are applicable, and in which inquiries, are problems which, he contends, can be solved with the resources of the sciences themselves.[97]

Conclusion

I have briefly sketched the pragmatist challenge to mainstream philosophy of science. Without being embedded in purposeful practice, neither theories nor observations make sense, and discoveries cannot be made save accidentally. If only theories, the result of inquiry, are considered philosophically significant, the process of discovering them would appear unintelligible. The majority of scientific work would be removed from the picture. Hence the existence of theories cannot be taken for granted as the default state of affairs. It might even be the case, in certain areas of knowledge, that no theory has been discovered at all, but inquiry proceeds without one. For instance, I surmise, this is the situation in some fields of medicine and pharmacy. Dewey's notion of science as an art and knowledge as a kind of action neatly solves these problems by pointing out the significance and intelligibility of practice. He surprisingly passes over the concrete particulars of practices in silence, but Rouse's account of practices can fill in for him.

This revision of the tradition of more than two millennia is significant. It is certainly not enough to refute representationalism for good. But at any rate, the arguments provided by the classical pragmatists make it impossible to take representationalism and the "classical" analysis of knowledge as the only

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[92] Dewey (1941), pp. 178–9.
[93] Hickman ([1990] 1992).
[94] Niiniluoto (2020), ch. 5.
[95] Practices and technologies do not imply utility. Some practices, like some forms of bureaucracy, can be engaged with without prospect of utility. This applies to some technologies, like Bonk art, invented by Alvar Gullichsen, for which there is a museum in Uusikaupunki, Finland (see https://visituusikaupunki.fi/en/what-see-and-do/bonk-museum-and-childrens-innovatorium, retrieved Jun 2, 2021). Some practices, like traffic jams, are dysfunctional and hence even harmful. Pacifists could argue that military technologies are harmful.
[96] Dewey (1929b), p. 84.
[97] Rouse (1996); Rouse (2002).

intelligible option and force their proponents to devise better arguments.[98] If nothing else is clear, at least one moral should be drawn: a realistic understanding of science cannot be had merely by studying representations abstracted from their practical context. Doing so implicitly presupposes that one unproblematically have access to representations, but the access to things, instruments, and practices be problematically mediated by them – a doctrine which Rouse considers as a vestige of Cartesianism which leaves ample room for global skepticism.[99]

But SSK and STS scholars rarely cite classical pragmatists. Even Rouse, who at least once conceived his project to align with pragmatism,[100] only cites Rorty the neo-pragmatist. Niiniluoto, a critical scientific realist, cites Peirce a number of times. But he still remains committed to a version of representationalism and interprets Peirce accordingly; and he does not discuss Dewey or scientific practices at all.[101] Hence I argue that SSK and STS could benefit from studying Peirce and Dewey as precursors of the practical turn. As I have shown, the practice-based approach in philosophy of science solves at least two problems which Dewey identified in the mainstream.

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[98] Cf. Rouse (1996), Introduction, chs. 7 and 8.
[99] Rouse (1996), p. 209.
[100] Ibid., p. 194.
[101] Niiniluoto (1999).