1. See Porter, who argues that the inductive method of seventeenth-century experimental philosophy serves as a Romantic strategy for dealing with information saturation across fields (Introduction).

2. Richard Kearney links the demise of the imagination with the decline of humanism’s fortunes. He argues for a postmodern imagination that will preserve narrative identity and creativity (32–33). William St. Clair labels the imagination “a key concept of later constructions of Romanticism . . . [because] it was seldom approved of by those who believed reading had lasting effects” (283), but this is to ignore its contemporaneous scientific and cultural importance. It is especially telling that, in a recent book on virtual reality, Peter Otto dispenses with the imagination almost entirely (Multiplying Worlds). By contrast, when Kant argues that “a pure transcendental synthesis of imagination . . . underlies the possibility of all experience” (CPR A102), he made it impossible to do away with the imagination.

3. Damrosch notes that Blake, like Boehme, “sought a richer apprehension of this world, not an escape to a higher realm” (124). In The Politics of Imagination in Coleridge’s Critical Thought, Leask connects Coleridge’s theory of imagination and his interest in Naturphilosophie to his desire to replace the aristocracy with the professional middle class.

4. Beiser would suggest “formal requirements” instead of “conditions” because human cognition requires forms it can recognize, and “formal requirements” are more modest than “conditions,” which might promise too much. I use “conditions” to avoid splitting hairs this early in the book, but I think Beiser is right. Beiser describes the paradox of Kant’s transcendental subject thusly: the transcendental subject cannot know itself because self-knowledge “requires the application of the categories; but to apply the categories to myself is to make myself passive and determined” (German Idealism 156). Thus, principles like the unity of apperception are a formal requirement that tells us that all representations have a subject, but it tells us precious little about the nature of the individual subject.

5. The Eighteenth-Century Collections Online database of Science, Medicine and Technology lists 2,962 items that contain the word “imagination.” See http://find.galegroup.com.proxyau.wrlc.org/ecco/subjectAreaLimiter.do?qrySerId=Locale%28en%2C%2C%2C%29%3AFQE%3D%28oX%2CNone%2Cui%29imagination%3AAnd%3ALQE%3D%28BA%2CNone%2C4%29oLM%24&searchResultsPerPage=10&inPS=true&prodId
Some quite select examples documenting the centrality of imagination to Romantic science follow. In his unpublished 1784 paper, “Meteorological Imaginations and Conjectures,” Ben Franklin speculates on how hail can fall during the summer and imagines parts of the atmosphere where it is always winter. He distinguishes between inquiries that are worth it and not. Davy credited his love of “invent[ing] and form[ing] stories of my own perhaps this passion has produced all my originality . . . I never loved to imitate but always to invent. This has been the case in all the sciences that I have studied—hence [inviting?] of my errors” (“Personal Notebooks” HD/13/D, page 23). Astronomer Jean Sylvain Bailly credited the imagination with the ability to “rappeller les sensations en nombre, d’enchaîner les idées de leur rapport, et d’en former des composés suivant un plan et relativement à certaines vues. C’est cette imagination qui fait invention” (1: 116). Geoffroy St. Hilaire wrote, “Je venais d’imaginer une nouvelle méthode de détermination tant des organes que de leurs matériaux constitutifs” when coming up with his theory of amniotic adhesions to explain monstrosity (2: 540). He had initially warned against the popular imagination’s tendency to excitation, especially over monsters (2: 500). Yeo notes that Whewell recognized that “great discoverers were imaginative and speculative in their quest for knowledge of nature” (13).

Though he valued the imagination, Einstein lamented that “humans have a poor faculty for independent thought and creative imagination. Even when the external and scientific preconditions for the formulation of an idea have long been present, an external incentive is mostly needed for its emergence; the subject must be right in front of a person’s nose, so to speak, for the thought to arrive” (14: 466).

6. In Life, Denise Gigante argues that, when Life becomes a “power,” it threatens to leave the orbit of representation and thus slip out of imaginative control (2–3). Yet I think this is to overestimate imaginative control and underestimate the protocols they put in place to operationalize such control. Gigante captures how the biological and aesthetic come together in the period. She submits that cell theory in the 1830s killed off Romanticism’s sense of unity between beauty and life (36). Amanda Goldstein takes an opposite tack in Sweet Science, about which I will have much more to say below. While her materialist approach astutely captures the negative surrounding life, it comes at the cost of separating science from aesthetics and of not taking seriously enough scientific interest in phenomenology.

7. The ECCO Science, Medicine, and Technology database lists 2,512 instances of “phenomena,” suggesting that this kind of bracketing was common within science, and that perhaps Kant’s concept of the thing in and of itself may have owed something to the science of the times.

A disciplined imagination that could offer useful hypotheses was considered crucial for scientific advancement. Yet how could one possibly know what was useful in advance of its application? In Anatomical and Physiological Lectures, for instance, John Abernethy insisted that “we know nothing of the properties of bodies, nothing of electricity or magnetism; nothing of the properties of the percipient; we know that from these motions of matter it forms certain notions of external objects” (333). Methodologically, this could lead to seeing the value of a thesis and an antithesis, and then working through to some kind of synthesis or dialectic. William Whewell may have advanced scientific induction, but we should not forget he was a Kantian.
On the pervasive influence of Kantianism on nineteenth-century science, see Friedman and Nordmann, Robert J. Richards (Conception), and the August 2016 special issue of Studies in History and Philosophy of Science, with its cluster of essays on “Kant and the Empirical Sciences.” Nassar shows how analogy in Kant works to allow him to extrapolate rules from one domain to another (62–65). Malcolm Nicolson shows Kant’s extensive influence on geography. Class argues that F. A. Nitsch extended Kant’s influence in 1790s Britain significantly (chapter 1).

On phenomenology and science, see Seamon and Zajonc; and Hankins. Though Seamon argues that phenomenology was how Goethe sought to know the “thing in itself,” the examples he cites from Goethe all rest in experience (2–3). “Phenomenology” was coined by the Swiss mathematician Johann Lambert in 1764, and Kant considered its goal to be the evaluation of what sensibility could in fact know. Although Seamon and Zajonc understand phenomenology to be about experience without concepts, as it would later become, for Kant this is not possible. Steinle highlights the importance of “systematic phenomenology” in which “multiple regularities are knit together” for the period’s experiments (Exploratory Experiments 322–26). For an innovative and outstanding study of form as rhythm, see Janina Wellmann, The Form of Becoming, especially the chapters on physiology and embryology, which think about how rhythm provides a structure for becoming.

8. Priestley uses “imagination” to refer to theories or hypotheses needing confirmation. For instance, in “Priestley’s Phlogiston and the Conversion of Water into Air, 1783,” he “imagined [phlogiston] consisted of it, and something else. However, I was then satisfied that it would be in my power to determine in a very satisfactory manner whether the phlogiston in inflammable air had any base or not” (3). Of course, phlogiston, believed to be the fatty earth that burned away during combustion, is really oxygen. He also uses imagination when applying a new process to other substances: “Being now master of a new and easy process, I was willing to extend it to other liquid substances, and I presently found, as I then imagined, that, by this other means, I could give permanent aerial form to any liquid substance that had been previously thrown into the form of vapour” (21). He also uses “imagined” to come up with reasons why his results were not as expected (8). Contrast these to how Priestley tars Burke with a “heated imagination.” See Barrell 12–20.

9. In his Essais sur L’Ame, Bonnet wrote, “N’oubliez point que ce que nous appelons essence des choses, n’est que leur essence nominale” (14).

10. Schwartz uses “diplopia” to name a Romantic “cognitive inconsistency between what is perceived and what is actually present” (20).

11. Kant, PNM 313. Ian Hacking and Bruno Latour argue that facts, interpretations, procedures, theories, and social relations are coproducing, thereby enabling a fit between the theories that last and the world (Hacking 31). Coleridge got there first and pursues the subjective and objective lines of argument in his Biographia simultaneously.

12. On this problem, see Beiser’s German Idealism: The Struggle against Subjectivism, 1781–1801. In his March 15, 1819, philosophy lecture, Coleridge insists that scientific researchers are not immune from “gratifications which its novelty affords to our curiosity . . . and by the keener excitement which an unsettled mind is bound to inspire” (PL, 343; all citations to Coleridge’s Philosophical Lectures will be from the
Coburn edition, unless otherwise stipulated). He continues, “He who supposes science possesses an immunity [from influences] like this, knows little of human nature, and how impossible it is for man to separate part of his nature wholly and entirely from the remaining parts” (ibid.). Science involves emotion and needs to deal with it.

13. Matter has been subsumed by physicalism, the doctrine that all things which exist are entities recognized by physics (J. Kim 11–14). Unlike materialism, physicalism accounts for entities like energy and fields. Edwards in Artscience assumes that the line between the arts and sciences can be a generative source of creativity because it demands negotiating difference. Of course, that line was never a natural feature, especially since “art” could mean skill resulting from practice.

14. Engell shows that Alexander Gerard, Mark Akenside, Johann Fichte, and Percy Shelley all used the magnet to explain the power of individual imagination (260). Matter has been subsumed by physicalism, the doctrine that all things which exist are entities recognized by physics (J. Kim 11–14). Unlike materialism, physicalism accounts for entities like energy and fields. Edwards in Artscience assumes that the line between the arts and sciences can be a generative source of creativity because it demands negotiating difference. Of course, that line was never a natural feature, especially since “art” could mean skill resulting from practice.

15. Coleridge insists, “It is clear that abstraction is an imaginary process” (Logic 14).

16. Daston associates Romantic science with the second modernity within the history of science (“When Science”). She argues science then became a salaried profession and allied itself with state interests.

17. Richard Saumarez defined the principle of life “by the energy of which various species of matter are converted to one kind under one system” (New System 1: 18). Count Rumford credited accidents and “the playful excursions of the imagination” for his experiments surrounding the source of heat in friction. See his 1798 Philosophical Transactions paper.

18. Neuroscientist Nancy C. Andreasen studies highly creative people and focuses on the association cortices of the brain. See chapters 5 and 6 of The Creative Brain. By cultivating relationality, Romantic science primed the pump for the exploitation of various kinds of sensory information. Did this insistence upon relationality foster synesthesia?

19. In October 1829, Mary Shelley wrote, “The discoveries of science, engrossing as they are, and often delightful, are inefficient to take the sting from life, changing its burthen to gladness: this miracle is left for the affections.” See Shelley’s Reader, edited by Bennett and Robinson, page 365.

20. Gregory warned that “a student of genius . . . gives so much room for imagination, and so little for experiment, apparently ingenious, but really trifling and useless” (Lectures on the Duties 190). The imagination of a genius was too preoccupied with “subtleties of its own creation,” so much so that it becomes “incapable of a patient . . . examination of nature” (ibid.).

21. In his published papers, Faraday regularly uses the phrase “forms of experiments,” and “form” here facilitates continued improvisation, as it implies a kind of looseness. Romantic form is not mere abstraction, because it has a sensuous presence that must be felt. Yet that sensuous presence is not identical to ontology, and thus feelings can prompt better articulations of form. Thus, when J. Robert Barth insists that Coleridge would never “accept a merely formal correspondence between ‘idea’ and ‘things’” (131), he neither grants form nor correspondence sufficient complexity. Recall Kant recognizes that things exist but that form is merely what we can claim to know about them. For Kant, the appearance of the thing is “always to be regarded as something actually given—except insofar as the object’s character depends on the
subject's way of intuiting this given object” (CPR B70). Crucially, appearance is of something, and this view, the object is not denied. We just can’t know it.

22. In *Diotima’s Children*, Beiser connects the aesthetics of Alexander Baumgarten back to rationality and rules: it was a “science of beauty” (3).

23. Morphology gave similarity and difference a dialectical kick. Von Baer writes in “On the Genesis of the Ovum,” “The study of morphology has long taught that all the differences of any organ whatsoever—not to speak of all the organs—exist within the limits of strong similarity” (142). Goldstein argues that “morphology manages to represent life as a condition rather than a power, to turn from self-sufficient integrity toward a proto-ecological notion of contingency and interrelation” (*Sweet Science* 74). Her account of Goethe highlights his gentle mocking of Kant’s epistemological modesty (126–29). Wellmann suggests that Goethe’s insistence upon seeing metamorphosis in terms of alternating patterns of contraction and expansion “prevents the particulars from prevailing” (121). Yet, as Nassar points out, Kant warned that the analogy of form should not be used to make explanatory claims, especially about the origin of species (65). For an overview of transcendental anatomy in Romanticism, see Rehbock.

24. Tresch suggests that for Comte, relationality did not entail ontological claims (186). In *Emile*, Jean-Jacques Rousseau insists that relationality at least initially cannot be perceived but must be felt: “The child perceives the objects, but cannot perceive the relations linking them” (169). Kauffman shows how materialism works through aesthetic strategies and makes the important corrective to the New Historicism that Romantic art is not about aesthetic delusion or ideology but rather offers art as a formal illusion and thus resists aestheticization (698–702). Haekel submits that literary critics are still within the Romantic episteme, insofar as the period’s literature made literary theory part of its own definition (*Handbook* 9–10).

25. Janelle Schwartz suggests that because Blake manipulates the ground around the form in relief etching, his creations are a kind of “emboîtement for artistic creation” (125). While I appreciate this thoughtful extension of form, there are several problems. He writes on the plate with an acid resist, and that too is part of form. Preformation further grants God all the power, insisting on a binary between humanity and divinity.

26. To wit, Schwartz tracks how Erasmus Darwin uses “unchanging but in form” to talk about differentiation in generation and regeneration (chapter 2).

27. Helpful here is J. Robert Barth’s definition of imagination as “the faculty by which the multiform reality of the world is seen in relationship” (30).

28. Given how much we are learning about our brain’s creation of our perceptions of reality—that much of it is unconscious and affective—Kantian epistemology and its insistence upon thinking about things in terms of appearances acquire even greater power. See, for example, Hoffman.

29. In a long footnote on Chimborazo, Humboldt does warn that although narratives of mountain expeditions have captured the public imagination, they are of “very little scientific value” (172).

30. To get around the imagination’s status as black box, Asma names “evolution” as its author, and this, in turn, grounds a dominant primitive imagination that works through the limbic system (47). In addition to Nancy Andreasen’s work, another major
neuroscientific approach to the imagination is to connect it to “mind wandering” and to the “default mode network,” a term coined by Marcus Raichle in 2001. This network encompasses both the rich simulation of things not present and abstraction. Because the “system” connects kinds of activities that are so different, is it a useful heuristic? For more on this debate, see the Imagination Institute’s “Neuroscience Retreat.”

Faraday stipulates the following as good science: “those philosophers who pursue the inquiry zealously yet cautiously, combining experiment with analogy, suspicious of their preconceived notions, paying more respect to fact than a theory, not too hasty to generalize, and above all things, willing at every step to cross-examine their own opinions, both by reasoning and experiment” (Experimental Researches, Dec. 1837, page 1).

31. In Memoirs of the Literary and Philosophical Society of Manchester, Thomas Barnes argues that “the vigour of the imagination will give correspondent vigour to the judgment” (1: 375). Because the mind is unified by a common spirit, Barnes insists the “imagination giv[es] strength and clearness to the understanding” (1: 378). Honorary members of this society included John Birch, Erasmus Darwin, John Haygarth, Antoine Lavoisier, Joseph Priestley, Alessandro Volta, and Josiah Wedgwood. Dalton was a member and later became its president. Most of his laboratory work was undertaken in the society’s house.

32. On reinterpretation: scientists are always revising previous observations and, in many cases, dramatically revising what is being seen. Huneman shows how Schelling and Hegel were influenced by Kant to think of nature in terms of hermeneutics, that is, to interpret it as being like an organism (72–74). Hanna underscores “Kant’s fallibilistic thesis to the effect that rational insight yields at best only a subjective aspect of a priori knowledge, or conviction, but not, in and of itself, objective certainty” (22). In this view, blind imagination is not a threat, but only insofar as one factors in its blindness.

A word about binary thought is perhaps in order. To the extent that deconstruction names binary thought the enemy insofar as it leads to an ideological privileging of one side over another, it cannot grasp the power of it. Binary thought is so pervasive because it makes knowledge symmetrical and thus allows claims for one side to speak automatically (by negating) the other side. In this view, binary thought functions to make cognition efficient. I am indebted here to Nate Harshman and to his conversations with me about information and symmetry. Ideology may be an outcome, but we should not underestimate what the symmetry of the binary allows us to do. Romantic science is such a fruitful area of concern because of its power to reconfigure binaries. In that incessant work of reconfiguration, the polarities of thought literally energize the field. Of course, Blake ups the ante with his fourfold symmetry.

33. See Dear, Intelligibility; and Porter, who argues that Baconian induction was transformed into a “science of relations” (52). In the same way that current science allows for future verification, the Romantics see unity as something that will be more fully verified in the future. In Orsted’s “Metaphysics of External Nature,” he stipulates that “no experience can arise except through a necessary link between several observations” (Selected Scientific Works 81). He deduces from this, “Phenomena, insofar as they are simultaneously perceptible in space, are in interchange, i.e., one acts on the other” (82). Relationality becomes central to both experience and to the interaction
between objects. In 1905, Poincaré argued that “the aim of science is not things themselves, as the dogmatists in their simplicity imagine, but the relations between things” (xix). Devin Griffiths argues for analogy as a comparative method between literature and science during the time between the Darwins, Erasmus (Charles’s grandfather) and Charles.

34. In Meteorological Observations and Essays (1834), Dalton uses “imagination” to mark a hunch, as in “it may be imagined that the relative velocity of the winds, should be continually on the increase” (90). In his “Twelfth Philosophical Lecture,” Coleridge criticizes early philosophy for allowing the imagination to “transfer its own experiences to every object presented from without” (PL 340). As a consequence, “forms of thought proceeded to act in their own emptiness” (341). He encourages experiment as a counter to this specific error.

35. Geneticist François Jacob reminds us that Darwinian evolution “cannot be directly verified in any way” but has “scientific character because it opens itself up to experimental contradiction” (13). If verification fails, science turns to falsification.

36. The Romantic distaste for rules could be rhetorical. Beiser reminds us both that rules defy creativity predominantly in their misapplication and that, because pleasure was considered rational, rules were not taboo (Diotima’s Children 15, 23). Engell quotes Goethe on the fact that although “the imagination appears to have no rules . . . [I]t becomes regulated . . . through feeling, through moral considerations, through the need of action, and most happily, . . . through taste” (280). Even as Hazlitt defines “expression” beyond rules in “Table Talk,” he smuggles rules in through the back door when he compares the imagination to a lodestone working through elective affinities (6: 47). Elective affinities, of course, had been standardized into tables by eighteenth-century chemists, making them subject to rules. In his Anthropology, Kant initially argues that “the realm of imagination is the proper domain of genius because imagination is creative and, being less subject than other powers to the constraint of rules, more apt for originality.” If originality initially requires the breaking of rules, Kant is quick to add that “every art needs certain mechanic basic rules—rules for making the work suit the Idea underlying it” (93). By making aesthetic taste an instance of the free lawfulness of imagination and not a counter to it, Kant allows creativity freedom in the pursuit of rules.

37. Redfield’s immediate subject is “beauty,” because it “names and conceals the problems of judging judgment” (7). He suggests that “aesthetic judgment is a free play that is harmonious with, or analogous to, mere rule” and is therefore analogous with the logical and the ethical” (31). This analogy allows the bildungsroman to be a metonym for literary theory. For Kant, synthetic principles attend to empirical facts by harmonizing them into rules.

38. Kant insists, “The principles of possible experience are then at the same time the universal laws of nature, which can be cognized a priori” (PMN 306).

39. John Barrell argues that, when the creativity of the imagination went beyond a limit, “aesthetics was anxious to pass the concept over to psychiatry” (6). Imagining the King’s Death thus focuses on the imagination as it was used in political writing from 1793 to 1796.

Perhaps to limit the novel’s appearance of raving, Percy Shelley argued at the outset of his preface to Mary’s Frankenstein that “the event upon which this fiction is
founded, has been supposed by Dr. Darwin, and some of the physiological writers of Germany, as not of impossible occurrence” (5).

40. In *Historia*, Pomata and Siraisi show that history and natural history were conflated up until the Enlightenment, another reason why science and literature were not clearly distinct. Mary Wollstonecraft saw no split when she recommended that women employ their minds on “gardening, experimental philosophy, and literature” (80). Keats’s chemistry teacher, William Babington, opened his “Lectures on Chemistry” by recounting that it had been considered both a science and an art. He later distinguished the two by labeling art “manual” and science “mental” (1–2). For a critique of the limits of Snow’s “two cultures” arguments, see James (“Introduction”).

If recent decades have replaced Snow’s two cultures of arts and sciences with one culture, neither framework gets it right. I suggest, with Klahner’s help, that the arts and sciences were force fields in the Romantic period, and at stake in the activation of differences was the claim of creativity. Of course, there could be so much interaction because the scientist had a very anomalous position within society, and the artist perhaps had more prestige. Monism, moreover, does not inspire vitality, and dualism demands that difference be overcome. Devin Griffith’s “comparative historicism” insists upon the relationality of differences and thus offers a helpful model for rethinking the relation of science to literature in this period.

41. George Rousseau does suggest that Coleridge and Kant felt compelled to reject the modes of explanation of the physiologist (NA 86), but in my chapter on Coleridge, I show why this was not the case. See also my “Towards a Physiology of the Romantic Imagination.” Haekel shows the continuity of Aristotelian thought in Romanticism, whereby the body was defined in terms of material potentiality (*Soul* chapter 2). Aristotle further defined the soul as both form and substance. He thus shows how history does not support a teleology toward materialism.

42. In Romanticism, “science” moves from the generalized meaning of systematic knowledge acquired by study and mastery to being a particular branch of knowledge. In the 1830s the British Association for the Advancement of Science sought to limit science to natural knowledge (Yeo 33). Markus Iseli remarks that De Quincey noticed a fundamental shift toward specialization within science and industry in 1824 (108). Flanders documents how our notions of creativity are indebted to the Romantics; his study unfortunately neglects scientific creativity, and thus he defines “creativity” in terms of free emotional expression, when in fact feeling was the route to scientific truth.

43. François Jacob captures why biology after genetics was able to embrace teleology scientifically: “for a long time, the biologist treated teleology as a woman he could not do without, but did not care to be seen with in public. The concept of [genetic] programme has made an honest woman of teleology” (9). He qualifies this, however, by reminding us that the genetic program only “sets the limits of action by the environment” (9). Epigenetics demands even stronger qualification, as the surround of the genetic material helps determine whether the gene gets switched on or not. In his “Fragment on God,” Percy Shelley rejects deism and the idea of an intelligent designer, insisting that “it is impossible indeed to prescribe limits to learned error, when philosophy relinquishes experience for speculation” (13).

Goldstein argues for a Lucretian counter-spirit with Romantic life sciences, one that
worked to “de-couple professionalizing aesthetics and biology from their shared rhetoric of autonomy, impartiality, and power” (Sweet Science 22–23).

44. Kwame Appiah insists that idealization serves to make phenomena intelligible, and that, as such, idealizations are not empirical theories (54). Their import is conceptual, not empirical (56). Cuvier argues that in nature “particular forms and dispositions are created without any apparent view to utility. It seems sufficient that they should be possible, that is to say, that they do not destroy the harmony of the whole” (1: 58). Nature’s purposiveness thus mirrors art’s imaginative creative spontaneity geared toward the harmony of the whole, and thus the one, biology/physiology/neurology, might tell us something about the other, art.

45. Goldstein cautions that, whereas Kant did not want subjects to become objects, Goethe’s “tender empiricism . . . advocates the observer’s susceptibility to transformation by the objects under view” (Sweet Science 125).

46. Romantic embodiment is tricky business. The period generated enough correlations between mind and body/brain to make an embodied imagination likely, but many were wary of claiming a correlation as identity. In his Critique of Judgment, Kant, for instance, wrote that “nor can it be denied that all presentations in us, . . . can in the subject be connected with gratification or pain . . . [I]t cannot even be denied, as Epicurus maintained, gratification and pain are ultimately always of the body, whether they come from imagination or even from the presentations of the understanding” (278). Imagination here is embodied, but the means to this apprehension must be through a triple denial of its role. At issue are the costs of embodiment: possible determinism and mechanism’s inability to account for how organic parts relate to wholes. Yet the Romantic emphasis on active perception and vitality as feeling made more permeable the dividing line between brain and world. Jaegwon Kim submits that, for correlation to be scientific, it usually is deduced from more fundamental correlations or laws or shows that correlated phenomena “are collateral effects of a common cause” (105). To the extent that is true, scientific correlation now approaches both identity and causality.

Romanticism anticipates what Barrett calls “constructed emotion” (153), which means that it is not universal and preexisting but rather constructed neurally, socially, and psychologically on the fly (ibid.).

47. Expert on memory and learning Eric Kandel has demonstrated how “creative” our perception really is (Reductionism chapter 14). Perception synthesizes a top-down and bottom-up visual processing. The Romantics anticipate ideas of the creativity within perception, thus both attuning them to the costs of a subjective/objective split and making a Kantian approach to things more salient. To be sure, much of this “creativity” is unintended, and accounts for binding (our sense of our perceptions as a unified field, which allows consciousness and a self to appear to us). Whereas our current sense of binding is inwardly directed, the Romantics, in their insistence upon relationality, moved in both outward and inward directions simultaneously.

48. In his recent study of imagination, Stephen Asma argues that the body and the emotions are the true source of imaginative creativity and what he, borrowing from behavioral economist Daniel Kahneman, calls “hot cognition,” our ability to make spontaneous choices. The more deliberative cognition is called cold cognition, but this is in his view a minor player with regard to imagination. See chapter 2. Lisa Feldman
Barrett, in *How Emotions Are Made*, also thinks emotions are central to decision making, but she ties them to our sensing and managing of our own bodily energy. One could point to Blakean energy as having anticipated this. Davy in the Notebooks writes, “Pleasure must be modified by pain to produce energy” (HD 21/b, page 8).

49. In fairness to Engell, he does deal with Brown’s “chemistry of mind” (168).

50. Robert Mitchell links experimentation with the generation of differences. Yet difference in science cannot always be the ground of meaning that it sometimes is within literature, because some data must be relegated either to the environment or noise. There is also the demand for reproducibility. Enormously suggestive, however, is his point that experimenting with experimentalism “aims—if it can be said to ‘aim’ at anything—only at facilitating new forms of thought and sensation” (35). I further agree that we should desynonymize experiment and innovation, because that coupling reduces experiment to neoliberal means of capitalism (227), and both experiment and innovation can be destructive. At the same time, we must recognize that the association of innovation with experiment displaces the fantasy of science as merely rote method.

51. Klein adds, “The term ‘laboratory’ was increasingly used in the eighteenth century, to include, in addition to academic-chemical and pharmaceutical laboratories, workplaces in arsenals, metallurgy (assaying), mints, dye manufactories, porcelain manufactories, distilleries, and perfumeries. More historical studies are necessary to understand the use of the term” (774). On Priestley’s laboratory and its contents, see McKie.

52. Ralph O’Connor studies the ways in which writers specializing in geology exploited imaginative techniques like poetic imagery to bring their narratives to life (introduction).

53. Gabriel Trop explains that while Kant’s purposiveness is made possible by human reflective judgment, Schelling makes it a part of the “objective structure of nature.” See his “Aesthetics of Schelling’s Naturphilosophie,” 5–7. Of course, “objective” is not without its complications.

54. Reill argues that Humboldt positioned himself very carefully vis à vis Naturphilosophie by praising their efforts yet insisting upon the superiority of his own empirical approach, eschewing claims of “internal nature” (239–40).

55. At the 2017 American Comparative Literature Association conference in Utrecht, Gabriel Trop called the problem of Naturphilosophie individuation, because it aborts attempts toward the absolute. If nature tends toward individuality, it veers outside normativity. Nature in this view is paradoxically unnatural. Perhaps it might be said that it has the appearance of the unnatural. And yet, for unification to remain a form of intellectual work for Naturphilosophie to encourage, difference cannot simply dissolve into unity.

56. Orsted also wrote poetry, which remains radically understudied. James Clerk Maxwell eventually realized that electromagnetism required a new fundamental entity (beyond those required by Newtonian physics), that of electrical charge.

57. Hacking’s attention to how science actively cultivates a sense of stability, which he recognizes can make science dead, suggests another reason why the imagination would not be credited within science (41–43).

58. All citations to Blake will be from David Erdman’s edition, unless otherwise noted, designated by an E.
59. Holmes’s engaging study does not address how this wonder needed to be disciplined into science and art. In his essay “History of Astronomy,” Adam Smith comments that the imagination is struck by singularity, but, when the object is grouped among others in the same class, wonder dissipates (13). With regard to astronomy, he suggests that the imagination is “disturbed” when it cannot connect events together (20). Natural philosophy thus underscores the “invisible chains” that connect disparate objects (20).

60. Tallis notes that “it was not science . . . but . . . the scientism of Enlightenment figures such as La Mettrie, Hartley and Laplace” that was the Romantic enemy (12). He further decries the hubris that defined the sciences as lacking human values, urging that science be regarded as part of the humanities (10). John Thelwall agreed, noting “the humanizing pursuits of Intellect and Science” (15). Kandel argues that although the “artistic process is often portrayed as the pure expression of human imagination” (Reductionism 4), abstract artists often employed methodologies similar to those of scientists. One might think about how Romantic artists cultivated methods such as Gainsborough’s practice of using a six-foot paintbrush so he could see how the viewer might consider his work or Turner’s interest in how color might attract attention from the other side of the room. Both art and science resist rote methods. Hacking laments that “descriptions of experimental procedures have long been regimented to make them look as if experiments have much in common” (43), and this makes it more difficult to couple imagination and experiment. Golinski considers how the laboratory’s constructions become universal phenomena (Making Natural Knowledge 32), perhaps another reason why the scientific imagination does not get credit. Finally, the recent turn within the history of science to the idea of cultures of scientific practice has begun to restore the diversity of scientific acts, which can become wooden in the name of “culture,” and even more so under “Romantic culture.” Romantic science could not be reduced to experiment. That diversity may finally enable Romantic science to be considered imaginative (though experiments certainly require it) and not just pejoratively so, even as “practices” might imbue imagination with different kinds of material specificity.

61. Steinle thus makes the case for “exploratory experimentation,” which he contrasts to theory-driven experiments (Exploratory Experiments 312–20).

62. Historicist critics of the imagination include Levinson, Liu, and McGann. In response, a new wave of critics has suggested that Romantic writers on the imagination were far more self-conscious of its limitations than historicists recognized: see Pyle, White, and Whale, among others. Rather than repeat this material here, I cover this ground in my essay on imagination in the Handbook to Romanticism Studies. In his Lectures on Physiology, William Lawrence did warn against an “unnatural union” between observation and imagination. Like all unnatural unions, he believed this one would be sterile (83).

63. Here’s why the line between the material and immaterial was so muddled. In biology, there is no cell theory until the 1830s. In chemistry and physics, the atom does not become real and calculable until 1905. Until scale is fixed and consequences become calculable, materiality lacks precise consequences and thus, one might argue, functions primarily metaphorically, thus leaving the door ajar for spirit. Cauldwell argues that nineteenth-century medical professionals generally considered science and
religion to be separate entities, and as such could have metaphysical commitments, but
would defer them within science (27). Kirkby argues for the importance of “spiritual
sciences” in the period, including mesmerism. Tristram Wolff quotes Cassirer’s point
that the difference between nature and culture “is no longer to be bridged through
a spiritualization of nature, [as in Cassirer’s version of Romanticism], but through a
materialization of culture” (621). If Romantic nature hovered between materiality and
spirit, culture now hovers between them.

64. Stephen Hales’s invention of the pneumatic trough, for instance, enabled the
identification of many kinds of different airs (gases), and his work helped Joseph
Priestley to discover many gases. Thus, in the period, air becomes multiple kinds of
air. See chapter 5 of Trevor Levere, *Transforming Matter*. In Romanticism, moreover,
ontology was divided into numerous kinds of essences: M. Kim argues that eighteenth-
century chemistry was satisfied with operational essences, and Knight in *Atoms and
Elements* argues that Boscovich believes in structural essences (atoms as geometric
points and not ontological entities). Our current understanding of essence misses these
nuances entirely.

65. Knight argues that while Dalton considered the elements to be composed of
irreducibly different atoms, Davy considered the elements to be composed of the same
kind of atoms (*Atoms and Elements* 26). To be sure, Coleridge credited Lavoisier for
having reduced the “infinite variety of chemical phenomena to the actions, reactions,
and interchanges of a few elementary substances” (*PL* 343). My point is that, in
Romanticism, polarity generates differences; atmosphere became many gases; there
were new kinds of imponderable matter like electromagnetism, heat, and light; Hum-
boldt includes time and space in his catalogue of natural philosophy; and Dalton
makes persuasive the case that atoms are not uniform but different.

66. Golinski (*Experimental Self*) attends to how the role of a natural philosopher
forced Davy to negotiate his social obligations to benefit society with pure intellect
and disinterest. How did a natural philosopher shape the history of objectivity?

67. Whether this abstraction or synthesis is spontaneous, and whether that
spontaneity means that any unity is inherent, are two key issues that have bearing on
how science is to understand it, if it can at all. Makkreel argues that, for Kant, the
imagination is associated with a creative spirit, an enlivening power that is a feeling
of vitality. By associating this power with *Zusammenhängend*, Makkreel submits that
Kant insists on the inherent unity of it: “What is felt through the interior sense already
coheres and hangs together” (97). However, so long as the imagination’s powers stand
outside rules, science must be wary of its contributions. Hence, Kant calls “the asso-
ciation of presentations . . . an empirical basis of reproduction according to rules”
(*CPR* A121).

68. One of those limits, for some, could be the limits of experience itself. Orsted,
for instance, insisted that “experience can only teach us what is but not necessarily
what must be” (*Fundamentals of the Metaphysics of Nature* 46). Here he separates the
“is” from the “ought.”

69. Asma argues that there are two imaginations, an emotional one with a long
evolutionary history and a newer, more rational one. He thinks the older, emotional
one is the more powerful of the two, as it accounts for our ability to successfully
improvise and our “cognitive fluidity” (160–63).
70. Beddoes suggests that, in the absence of brain lesions, it might be possible to account for insanity by studying the individual’s biochemistry (Hunter and Malcalpine 578). When one level does not yield correlations, one can go to another level of analysis.

71. For an overview of the imagination’s links to insanity and madness, see Hunter and Malcalpine. Their collection of books profiled in Three Hundred Years is housed at Cambridge University Library.

72. See Beiser on Bildung, Imperative, 88–105.

73. Thanks to April Shelford for pointing me to this essay.

74. Asma leverages association over algorithm to argue that computational understandings of the mind have gotten it wrong. In this, perhaps the Romantic interest in association, going so far as to consider it a law, offers some current enlightenment.

75. Scottish poet James Beattie, in Dissertations moral and critical, insisted that since no one knew where the imagination was in the brain nor how it was connected, “neither can we explain these faculties, by experiments made upon matter; or in any other way, than by attending to what passes in our minds” (1: 3). Beattie goes on to refute the idea that the impressions of imagination are fainter than those of memory (1: 6–7).

76. M. Kim, for example, shows how eighteenth-century chemistry had operational over ontological criteria of chemical stability (146).

77. See also Kant, CJ 379. Müller-Wille and Rheinberger note that causality is complicated by prevailing Aristotelian theories of it that understood cause and effect “as simultaneous and contiguous events. Causes did not precede their effects, but shared points of contact, so to speak, with their effects” (23).

78. Appiah reminds us that “as if” arguments are delimited to specific contexts (16) and in this way highlights the modesty within strands of idealism.

79. Robert Richards cautions that even scientists had trouble sticking to the distinction between regulative and constitutive reasoning (Conception 227–29). In his “Critique of Teleological Judgment” (within the CJ), Kant does distinguish between formal purposiveness, which would be regulative, and “material, objective purposiveness,” which is constitutive. Constitutive purposiveness considers not just the product’s form but also the form’s necessity. Necessity has two criteria to meet: “The possibility of its parts . . . must depend on their relation to the whole,” and “the parts of the thing combine into the unity of a whole because they are reciprocally cause and effect of their form” (CJ 373). We should note how high the bar is for showing constitutive purposiveness, without which the imagination would have too much freedom. In his Philosophy of Material Nature, Kant acknowledged the importance of Hume’s critique of causality for showing how reason relied upon “bastard[s] of imagination, impregnated by experience”: “We cannot at all see why, in consequence of the existence of one thing, another must necessarily exist” (258). Nassar explains that Kant turns to teleology to explain causality because mechanism is insufficient (60).

80. Here’s Faraday on imponderable matter and materiality: “Imponderable substances are such as have no appreciable weight, and do not evince properties belonging to materiality. They cannot be accumulated in masses, or confined, and we can only ascertain their effects when in a transient state” (“Lectures on Chemistry,” 113). Faraday’s claim of the lack of evident material properties, however, is not a claim of
immateriality. Coleridge provides a different wrinkle: according to Coburn, he claims that “ponderable substances . . . appear by weight” and thus have a “body,” whereas “that which appears, but not by weight, or imponderable substance, is Matter” (PL 370). Yet, according to the British Library manuscript Egerton MS 3057, an unknown attendee recorded, “That which is actually substance and in chemistry would be called ponderable is in Philosophy body. That which is without perceptible weight termed the imponderable is Matter such as the Sunshine” (28). “Perceptible” is an important difference, because it implies that future technologies can make it perceptible. The manuscript version makes more sense because it stipulates sunshine to be an example of imponderable matter as opposed to requiring all matter to be imponderable.

81. Einstein credits imagination for natural laws, writing, “Not only are the fundamental laws the result of an act of imagination that cannot be controlled, but so are their ingredients, the ideas derived from those laws” (14: 725). Of note is Einstein’s insistence that the act of imagination cannot be controlled.

82. As biologist Michel Morange points out, fixed definitions of life are not possible because life is capable of generating new properties (152).

83. Cuvier cites Kant in Lectures on Comparative Anatomy (1: 6).

84. Asma argues that the imagination’s greatest strength is its improvisatory, playful nature (73–83). In this view, the very control of it risks the loss of its power to think outside the box.

85. I am indebted here to conversations with Stefani Engelstein about Goethe.

86. Faraday brackets his observations with phenomena when he argues, “Though effects may sometimes occur, dependent on the compound nature of what we call simple substances, yet it is better to own our ignorance of these phenomena, if we cannot by their means ascertain satisfactorily the true circumstances of the case, than to forge an hypothesis which shall in accounting for a single instance give birth to a thousand chimera elsewhere” (“Lectures on Chemistry” 157).

87. Feelings thus underwrite the continuity between visual perception and the visionary imagination that Alan Richardson traces in his The Neural Sublime (46–48). Vickers argues that Coleridge turned to touch over visual ideas because “visual ideas without tangible force results in a lack of vitality” (124).

88. Dear traces Aristotle’s idea of “reasoned facts” as he understood that the goal of facts was explanation (Revolutionizing the Sciences 4–7). Alexander Schlutz argues that, for Kant, “rational subjectivity is thus simultaneously dependent upon and constructed in opposition to the imagination, and the resulting ambivalence is one of the fundamental conditions of modern subjectivity” (7). For German idealists like Schelling, by contrast, “the representational power of imagination [was] the indispensable precondition for the unity of self-consciousness” (9). I here consider how science as phenomenology helped cope with the gap between imagination and reason.

89. In his “Notebook on Education and On Nitric Oxide, circa 1800,” Davy has “Hints Towards a Treatise to be entitled Observations on Education and on the Formation of the Human Intellect Designed for the Use of Parents and Instructors.” Here, Davy insists that perceptive existence begins with the feelings of the infant before birth. “The spark of life has been kindled by a number of feelings perceived during the mysterious formation of organs, a number of impressions of touch, of taste of smell &
perhaps of sound” (3). He later in this notebook emphasizes that feelings are the basis of associations: “His feelings are connected with aggregates & consequently referred to aggregates as to causes” (17).

90. Jan Golinski comments that, within the Royal Society, “communal norms seemed to have exerted little restraint. Instead, they served as rhetorical weapons” (Making Natural Knowledge 55). Jonathan Smith argues that Wordsworth, in declaring poetry’s superiority over science, is trying to thread a needle between praise of Bacon and chastising his followers for being too literal in their interpretation of him (53). He goes on to consider Wordsworth’s use of “poetic induction.”

91. William Smith reads Hunt rhetorically; after he seems to denigrate science, he invokes botany (49–50).

92. Kant in his Metaphysical Foundations of Natural Science insisted that proper science requires a pure part “in which the apodictic certainty of its first principles is founded, and in which the possibility of physical objects is guaranteed by a construction of its concept in pure intuition” (Pulte 102). In his manuscript notebook treating his 1827 “Lectures on the Philosophy and Practice of Chemical Manipulation,” Faraday announces that he will impart to his students “beautiful facts” (1), reminding us that aesthetics and science went hand in hand (“Notes for his Lectures”). Aesthetics can have scientific use, as, for example, any symmetry can shortcut the calculations that need to be made. He also describes many “beautiful experiments,” ascribing to them a simplicity and elegance.

93. An added complication: Mi Gyung Kim charts how Enlightenment chemical affinity tables are analyzed by historians of chemistry as both fact and theory, and she cites Keller’s recognition that theory itself could mean “the analysis of a set of facts in their relation to one another” or the “general or abstract principles of a body of fact” (141–43).

94. Orsted argued that “in the writings of good chemists who describe their works in great detail, phenomena are often reported which in Winterl’s work belong to a system of facts but which are presented there merely as rare phenomena originating from accidental causes” (“Chemistry of the Nineteenth Century” 124). In this view, phenomena are crucial for chemists to record. Good chemists allow certain phenomena to remain accidents. Great chemists like Winterl recognize that what looks like accident nonetheless indicates systems of facts. This insistence upon system will not allow facts alone the power to immunize the imagination from error.

95. At one point during his chemical lectures, Faraday declaimed, “I will point out the history of this substance [chlorine] as an answer to those who are in the habit of saying to every new fact what is its use. Dr. Franklin says to such what is the use of an infant? The answer of the experimentalist would be to endeavor to make it useful” (“Lectures on Chemistry” 175).

96. In his 1844 preface to the English translation of his Elements of Physiophilosophy, Oken warned of the dangers of “blindly and laboriously groping about in the dense labyrinth of facts” (ix).

97. On sensibility and its importance to Enlightenment science in France, see Riskin. Nicolson’s pioneering Science and Imagination examined the effect of scientific technology on the literary imagination. On the links between colonialism and science, see Fulford, Lee, and Kitson; and Bewell, Romanticism and Colonial Disease and
Natures in Translation. In a 1788 essay, Coleridge argued, “If their [children’s] reason is grown stronger, their Passions and Appetites are likewise grown proportionally more powerful” (“Liber Aureus” Ashley 3506 (3), page 5). He does not see an inverse relationship between the growth of reason and of passion.

98. Hanna argues that Kant’s insistence upon the primacy of human nature provides an important alternative to scientific naturalism, giving the sciences a practical orientation: “Nothing can be knowable in the exact sciences that ultimately contradicts the real possibility of human persons and their capacity for autonomy” (33–34).

99. Consider as well how often Davy insists on “form” or “appearance” or “phenomena” in his published researches on chemistry. Likewise, his “Lectures on Chemistry” are replete with “instances,” and he reflects upon when those instances can and cannot support generalizations (“Electrochemistry,” 85–87, 88, 89).

100. As Jonathan Smith perceptively comments, despite the turn away from science and art as two cultures and toward one culture, there is lurking within it a sense of “a fundamental difference between science and literature” (5). His study charts the rising and falling fortunes of Baconianism in the nineteenth century and as science defines itself by its distance to sense impressions.

101. Barrett argues that “believing is feeling” (78). Insisting that emotions are constructed in the moment based on a lifetime of experiences, Barrett shows how emotions facilitate our predictions about the world, which shape our constructions of it. With emotions, she argues there can be no accuracy; instead, there is only social consensus (140). Barrett’s work undermines the theory that universal emotions exist and thus makes Romantic phenomenality and Kant’s interventions all the more salient.

102. Abrams overestimates the differences between scientific scrutiny and poetry in The Mirror and the Lamp (303–12). Steinle argues that, unlike Kant, Ampère thought that aspects of the noumenal could be scientifically known (Exploratory Experiments 79).

103. Jocelyn Holland treats Goethe’s Urpflänze as an “imagined plant, if conceived according to the correct model of generation and organization, to have the same ‘truth’ and ‘necessity’ as a living one” (German Romanticism 20). The problem of observing and describing metamorphosis leads Goethe to recognize how these acts are fundamentally creative and thus poetic language can contribute to science (33). See also Wellmann, who argues that Goethe uses the distich as an in-between space which fuses biologism and aestheticism (132–33).

104. Terada worries about the evasiveness of this deferral (Looking Away 16). If phenomenality gave a sense that one was in touch with the universal, it could be associated with positive feelings, which Terada neglects. Stengers argues that “the sciences do not owe their existence to the disqualification, with which they are identified, of so-called ‘pre-scientific,’ or nonrational, knowledge” (Cosmopolitics I 11).

105. Rajan in “First Outline of a System of Theory: Schelling and the Margins of Philosophy” traces Schelling’s anxiety that absolute knowledge would overturn the requirements for a transcendental knowledge (315), and this meant that the contingency of nature would never be reconciled with freedom. Beiser argues that Romantic skepticism had a more positive side: the experience of art could allow an encounter
with the absolute, and although this experience did not necessarily demonstrate anything, at the same time, the aesthetic experience itself could not be refuted (German Idealism 373).

106. Tyndall embraces the speculative powers of imagination, exhorting his readers to come to terms with waves as a structuring principle of sound and light. He warns that the imagination will be productive to those who know its liberties without abusing them (31). Schaffer moves “discovery” outside of the mind of the heroic scientist and toward collective practices, and this turn to collective practices further explains why the imagination has fallen out of favor.

107. In Essays on Physiognomy, Lavater credited imagination with futurity: “Perhaps even futurity is comprehended in the circle of its inexplicable activity” (3: 185). In his experiments trying to determine the differences if any between animal matter and ordinary matter, Abernethy invoked empirical futurity and science as collective labor: “If related experiments should be considered insufficient to prove these doctrines, I heartily hope it may excite others to further investigation” (Surgical and Physiological Essays 106). Isabelle Stengers argues that “laws” and experimental staging allows science to smuggle in the “far horizon of scientific research” into current observations (Cosmopolitics I 89–91). Hans-Jorg Rheinberger shows how experiment relies upon what he calls fuzzy concepts and fluctuating objects (154–59).

108. For a strong overview of scientific metaphor, see Bono. His framing of scientific metaphor as a “medium of exchange” (72) that enables science to control metaphor is helpful.

109. Coleridge refers to scientific predictions as “prophetic powers” (PL 360).

110. In The Art of Scientific Investigation, Beveridge notes that “it is impossible to create ideas or control their creation” (74). Thus, he recommends allowing the imagination to wander freely (75). To the extent that the imagination’s role has been downplayed within accounts of scientific method, it is because it is difficult to control. Valdés and Guyon argue that educated imagination works in poetry to ask “as if” and “what if” in physics (29).

111. I am thinking here of the ways in which Theresa Kelley in Clandestine Marriage shows Romantic understanding of plants to act more like figures that challenge the taxonomies botany would impose upon them.

112. See also Kramnick, who shows how physics defined actions and objects and how mental action had to define actions and objects in relation to those definitions.

113. On Gefühl, see Henderson on Novalis, 154–55.

114. Laura Crouch made this case convincingly in 1965.

115. However, Joanna Picciotto argues that Bacon shifted the primal scene of discovery from Eve’s eating of the fruit to Adam’s naming of the animals and in this way redeemed curiosity (3). Martin Jay argues that Bacon replaced Montaigne’s more open notion of experience with an idea of experience closer to scientific experiment (28–31).

116. Davy alludes to Bacon’s idols when he claims that “we will go my friend together to combat in the cause of truth, to destroy the gigantic Idol of man language connected with feelings which like another Moloch has thousands of innocent victims daily immolated on his altars” (“Notebook on Education and On Nitric Oxide, circa 1800” 21). This passage is curiously orphaned. Although it would logically relate to the
material on page 20, Davy has turned the notebook upside down. Where the remarks on the previous pages are triumphant, these remarks are, by contrast, grim. The handwriting also looks hastier, less precise.

117. Steven Goldsmith argues that for Blake the gap between reason and imagination was the locus of the sublime agitation; the very invocation of judgment to heal the gap becomes a site of difference that can be harnessed for social disruption. See chapter 1 especially.

118. Orsted dismissed Kant’s rejection of the infinite divisibility of matter on the grounds that “the conception of infinitely small parts is merely an idea which reason has thought up in order to arrive at a limit, but nothing like it can ever be found in any possible experience” (Metaphysics of Nature 59).

119. Damrosch recounts Blake’s sense of the ancillary nature of proof. When Thomas Taylor was tutoring Blake in Euclid, Blake interrupted his demonstration with “what’s the use of going to prove it? Why, I see with my eyes that it is so, and do not require any proof to make it clearer” (126).

120. Exceptions here include Massey and Noel Jackson. Massey credits Keats with thinking about “the provisional nature of thought” (187). William Babington, Keats’s chemistry teacher, in his “Introduction to Natural Philosophy” equated imagination with wild hypotheses. He exclaimed, “You may imagine all the matter in the solar system to have formed originally one immense chaos, & portions of this chaos projected by some might arm, to constitute the several planets” (Lectures on Chemistry). He added, “This wild hypothesis is not only encumbered with difficulties but pressed with contradictions.”

121. In “Language, Discourse, and Science,” Golinski suggests that a hermeneutic approach to metaphor within science allows them “to be read as devices for the transfer of meaning between different disciplines, or between science and general culture” (115).

122. Morange, a molecular biologist, argues that life is an emergent phenomena that occurs after the chance conjunction of three phenomena: “the appearance of molecular structures, a series of intense chemical exchanges, and the autonomous capacity to reproduce” (146). Life is so difficult to reduce because it depends upon systematic relationships; hence the need to be cognizant of one’s role as interpreter. The object of interpretation is thus a form or appearance.

123. Psychiatrist Arnold Modell links the imagination to the biology of metaphor. He writes, “As a mode of cognition, metaphor is doubly embodied, first, as an unconscious neural process and, second, in that metaphors are generated from bodily feelings, so that it is possible to speak of the corporeal imagination” (27).

124. For more here, see Skolnick and Bloom. Physician, botanist, and patron of Blake, Robert Thornton, noted in his Medical Extracts that “the man of imagination makes a great an artificial happiness, by the pleasure of altering and combining” (2: 306).

125. Golinski calls Davy a “man of science” instead of a “scientist” on the grounds that “scientist” as professional identity is anachronistic. Yet this is to split hairs rather finely: Is “man of science” that much of an improvement? Suggestive is his thesis that making one’s living through science required creativity and resourcefulness. He thus shows how Davy fashions his identity in multiple ways. As a philosophical chemist, he claimed the authority of theory over those who pursued the chemical arts (Experimental Self 126).
126. See the TED Talk by Laura J. Snyder, “The Philosophical Breakfast Club.” Richard Yeo reminds us that “scientist” did not catch on until the close of the nineteenth century, because men of science like Faraday “preferred to think of their work as part of broader philosophical, theological and moral concerns” (5). Romantic science insisted upon those broader concerns, and thus “scientist” should not be ruled as inappropriate. Whewell, for example, turned to “scientist” to unite “astronomers, chemists, geologist, and botanists” in a common enterprise at a moment when science turns to specialization (Yeo 111).

127. See also Georg Braungart, “The Poetics of Nature.” Geology, Braungart argues, dealt a huge blow to the human ego, because it demonstrated the relative insignificance of human history that had to be overcome by the imagination (28).

128. Goethe warns that “we should not try through experiments to directly prove something or to confirm a theory. For at this pass—the transition from experiment to judgment, from knowledge to application—lie in wait all our inner enemies: imaginative powers that lift us on our wings to heights, while letting us believe we have our feet on the ground” (“Experiment as Mediator” 20).

129. Porter demonstrates how textual archives provide an inductive database in Romanticism, substituting for reproducible experiments (62–64).

130. Kearney warns of the imagination’s “imminent demise” because postmodernism undermines the modernist belief in the image as an authentic expression (3). Among others, Jennifer Ford, Alan Richardson, Lisa Ann Robertson, Ute Berns, and Yasmin Solomonescu have written recently on the Romantic imagination, but, with the exception of Richardson, the term has become localized.

131. See also Markman, Klein, and Suhr.

CHAPTER 1: Imagining Dynamic Matter

1. Ault reminds us that Newton had “a deep intuition for the limits of a purely mechanical interpretation of nature” (Visionary Physics 8). As he shows, the possibilities of dynamism lurk within Newton’s system. Although Newton’s atoms are immutable particles, his fluxional calculus provides ambiguity (6).

2. Citations to Prometheus Unbound are from Reimam and Fraistat’s Shelley’s Poetry and Prose. Quotations from the preface will be cited by page numbers. Quotations from the poem will be cited by act; when relevant, scene; and then line number.


4. In his January 1844 Experimental Researches in Electricity, Faraday wrote, “The word atom, which can never be used without involving much that is purely hypothetical, is often intended to be used to express a simple fact; but good as the intention is, I have not yet found a mind that did habitually separate it from its accompanying temptations” (2: 285). Coleridge accuses the ancient Greek materialists responsible for the theory of atoms of at least four fictions: the atom itself being the first; the second being atoms of various figures; the third, round atoms consisting of elements of fire; and the last, fire as the principle of thinking. See PL 353.

5. Hanna reminds us that, for Kant, “every self-conscious human cognizer has direct veridical perceptual or observational access to some actual macrophysical dynamic material individual substances” (29). His overall thesis is that Kant’s metaphysics is his ethics and that Kant’s metaphysics is thoroughly anthropocentric and
practical. My inspirations here are Quentin Meillassoux, who argues that “the virtue of transcendentalism does not lie in rendering realism illusory, but in rendering it astonishing, i.e., apparently unthinkable, yet true, and hence eminently problematic” (27), and Rei Terada. Science, of course, works to make astonishment thinkable. I part company with Meillassoux when he seeks to get rid of Kantian correlationalism, because that goal obstructs rather than clarifies the Romantic project. That Meillassoux turns to an empirical object—the prehuman fossil—to take down Kant, who is interested in the conditions of knowledge that make knowledge possible, violates Kant’s premises. In Looking Away, Terada questions why appearance is associated with dissatisfaction, when appearance mandates reflexivity.

6. Just because something is thinkable does not entail it is really possible (J. Kim 39). Kant argues that things in and of themselves while unknowable are thinkable, and this gap perhaps provides the ground of what Richard Holmes calls wonder and Meillassoux names astonishment. This gap further complicates Shelley’s Platonism, where the imaginative is coextensive with the noumenal but does not directly get to it. In his Opus Postumum, Kant sought to overcome what he saw as the limits of the Metaphysical Foundations: “These furnish no specifically determined, empirical properties, and one can imagine no specific [forces], of which one could know whether they exist in nature” (OP 22: 282). M. Friedman shows how dynamism enabled Kant to envision a science of chemistry once all forces specific to chemical interactions were documented (Kant’s Metaphysical Foundations 60–61).

7. Janelle Schwartz recognizes how speculations concerning material nature carry irony, as “all discussions of materialism necessarily do” (43).

8. Janice Cauldwell’s concept of Romantic materialism, though it does not deal with dynamism, is helpful. She submits that “Romantic materialism accepted disjunctions between two ways of knowing: science and religion, and this called for an ‘interpretative method’ that toggled back and forth between imagination and empirical evidence” (1).

9. In his Philosophy of Material Nature, Kant defines thinking as “uniting representations in a consciousness” (305). Thinking then is proximate to the imagination’s unifications of the manifold of presentations but not identical to it.

10. I thank Adam Komisarik for helping me to articulate this position.

11. On the pervasive problem of thinking matter, see Yolton, who demonstrates how Locke and others had to take seriously the possibility of a matter that could think. Current forms of thinking about matter from the perspective of information—it from bit—and the turn to plant cognition give this debate renewed salience.

12. See Jane Bennett, Vibrant Matter: A Political Ecology of Things and the essays by various hands in Diane Coole and Samantha Frost, eds., New Materialisms. When vitalism claims that life is beyond the reach of naturalistic explanation, it mistakes current limitations for future ones. In Sweet Science, Amanda Jo Goldstein argues for a continuum between the physical and figuration in Romanticism; where she aligns herself with Lucretius, I turn to Kant.

13. Jacob suggests that biology took a turn toward force as well because it might account for how living matter changes form and moves (94).

14. Newton’s primitive particles bore no direct relation to chemical observables. By connecting the term “atom” to the “least particles of a chemical element,” John Dalton
enabled the properties of atoms to be inferred from chemical experiments (Thackray 39). One reason why dynamism took off in chemistry was Louis Lemery’s development of affinity, “a theory domain of chemical operations rather than of substances” (M. Kim 121).

15. Knight argues that ‘‘dynamical’’ about 1800 implied a view of the world in which phenomena were to be described in terms of forces” (“Physical Sciences” 60). J. Edwards highlights the epistemological difficulties with corpuscles (105). I thank Charis Anastopolous and Trevor Levere for their e-mail exchanges with me to help me grapple with the intricacies of the very vexed term “dynamism.” Under dynamism, forces can be added to matter or be matter; forces can be passive or active, mechanical or vital. The Romantic interest in matter as force allows them to make matter proximate to vitality. Jammer considers dynamics to have led to a dead end, but string theory, supersymmetry, and perhaps even the interactions of the Higgs boson may make its obituary premature. My physicist colleague Nathan Harshman cautions me that the Higgs does not qualify under dynamism because its interactions are about inertia, not acceleration, and no dynamic theory of movement is necessary because movement is a frame of reference problem. In the Romantic period, however, dynamism emphasized the forces of matter, and the symptom of forces was movement. Since the origin of this movement was often thought to be God, the Romantics could sideline the frame of reference problem, since to have one would be to impose limits on God. Harré elucidates the key differences between atomism and dynamism (12–15).

16. Isabelle Stengers reads Diderot’s egg, the one with the power to overthrow all theology, as the one forcing D’Alembert to accept that the practices producing his own conception of matter were irrelevant (“Wondering about Materialism” 378).

17. Kant initially postulates a “force-shell atom theory of matter” but rejects atomism in his 1786 Metaphysical Foundations. Knight argues that William Hyde Wollaston’s 1808 analysis of oxalates “forced the chemical world to take the atomic theory, or at least the law of multiple proportions seriously” but concedes that Wollaston allowed atomic weights to be treated as “mere mathematical ratios” (Atoms and Elements 23).

18. The locus classicus of the argument for an essential tension between Romanticism and consciousness is the essay collection of that title, edited by Harold Bloom.

19. References to Blake’s Four Zoas are to the Erdman standard edition, by the night, the Erdman page, and then the line numbers.

20. Somerville’s On the Connection of the Physical Sciences was inspired by these recently discovered unities, which “simplified the laws of nature” (preface). She would go on to insist that heat, light, magnetism, and electricity all referred to the same agent. Somerville knew Faraday and his work well.

21. John Yolton argues that when matter becomes force and acquires the ability to be the source of causality, “immaterialism had, one might be tempted to say, become a property of matter itself” (204).

22. Charles Altieri has recently suggested that “it is difficult not to conclude that shorn of its enabling metaphysical oppositions, materialism cannot do significant philosophical work but functions instead to mark a critic’s political allegiances” (80). Likewise, in “A Motion,” Marjorie Levinson argues that materiality too often substitutes for intellectual arguments. In order for my study of Romantic matter not to fall
into these traps, I must constantly ask what is the intellectual work that I want materialism do. The dynamism of matter in the Romantic period makes it an ally against tyranny, since control and power are ironized in a world of dynamic matter. Yet it does not undo that tyranny: for one, that irony needs to be perceived. For another, the action of matter is the necessary backdrop against which human action can be measured.

23. See Kramnick.

24. For an analysis of Newton’s ideas of force, see Jammer (chapter 7). He contends, “Force, for Newton, was a concept given a priori, intuitively, and ultimately in analogy to human muscular force” (124). Ault comments that Newton’s disciples interpreted his forces either physically or spiritually (Visionary Physics, 15). He also suggests that Newton’s admittedly hypothetical ether was an attempt to think about the dynamic and continuous forces.

25. Onno Oerlemans thinks about the ways in which Romanticism “transcends into materiality” (29), and I enlist her as an ally. Janet Radcliffe Richards reminds us that neither immateriality nor indeterminism offer free will. Indeterminism, she submits, offers no one responsibility (140). Although recent critics have underscored Romanticism’s dark side, Romantic scientists could be quite optimistic: hence, Davy highlighted that “the process of fusing & working with metals were the first phenomena that proved to human beings that they were not the impotent slaves of blind & unascertainable laws existing in their connected impressions. They exhibited to them the mightiness of their powers, they taught them that volition was the characteristic of man” (“Notebook on Education and On Nitric Oxide, circa 1800,” page 19).

26. Modiano notes that Coleridge saw as a key limit of Naturphilosophie the tendency to “ascribe physical causes to spiritual activities, that in their attempt to locate the one dynamic power at the root of all phenomena of nature, they confused ideal forces with material substances” (150). My point in Kant at least is that the insistence upon appearance prevents that very collapse, since one was not making ontological claims. The Romantic turn to imagination in order to conceptualize matter, moreover, helped to control anxieties about the denigration of spirit.

27. John Dalton likewise dismissed the idea of one kind of matter as imagination. “It has been imagined by some philosophers that all matter, however unlike, is probably the same thing . . . We ought, however to avail ourselves of every means to reduce the numbers of bodies or principles of this appearance as much as possible” (cited in Knight, Atoms and Elements 33).

28. Unlike Davy and Faraday, Schelling thought that intuition was “the highest element in our knowledge” (173). And unlike Kant, who thought forces were the basic concept, Schelling thought Kant’s dynamism was insufficiently dynamic because, by beginning with forces, Kant is beginning with something extended, rather than with the fundamental activities of nature itself (Beiser, German Idealism 531).

29. Schelling, for example, insists that the “natural laws of reciprocal attraction and repulsion” are an “assumption” (143).

30. Freud later based his concept of the id on the concept of physical energy, derived from force.

31. Key histories of matter in the Romantic period include J. Edwards; Riskin; Levere, Affinity; Kramnick; Harman; Modiano; Knight, Atoms and Elements; Thackray; M. Kim; Yolton; Ruston, Creating Romanticism; and Schofield, Mechanism. For a
playful juxtaposition of quantum mechanics to Romantic poetry, see Mark Lussier, *Romantic Dynamics*. I find suggestive his claim that Romantic poetry thematizes dynamism “to complexify purely mechanical visions of inner and outer phenomena, allowing the term to apply equally to the motion or movement of mind and matter” (16–17). Plotnitsky argues that Shelley had a complementary understanding of matter insofar as he thinks of it simultaneously as particle and wave. Grabo pointed out long ago that Shelley’s theory of matter seemed to be electrical and “difficult to reconcile with any conception of ‘solid’ matter” (141). For a suggestive reading of causality as aesthetic from the standpoint of object oriented ontology, see Morton. He argues that causality lies in the realm between objects.

32. For Kant, in order for human beings to be free, they must have access to an agency beyond pure mechanism, beyond the mere laws of physics. The laws of physics thereby form the necessary backdrop against which to measure human freedom.

33. Bensaude-Vincent underscores the complexities of atomism in chemistry (204–05). In his *Philosophical Lectures*, Coleridge wrote, “I do not look on Materialism, on the doctrine of atoms, as philosophy at all inasmuch as it is pure assumption” (106).

34. Haekel (*Soul*) shows how vitalism moves from political radicalism to orthodoxy in the period, and hence its relation to materialism is perforce complex.

35. Popper argues, “These marvelously imaginative and bold conjectures or ‘anticipations’ of ours are carefully and soberly controlled by systematic tests” (152–53).

36. Schelling argues that force “is a mere concept of the understanding, and hence something that cannot, directly, be any sort of object of intuition” (182).

37. The original French reads: “Mais, c’est la force (qui est la cause du mouvement) qui existe véritablement, ainsi outre hors de masse, de la figure et de leur changement (qui est le mouvement) il y a quelque autre chose dans la nature corporelle: savoir la force” (*Leibniz and Dynamics* 130). Engell notes that, unlike Spinoza, who “sabotaged the imagination because it assumed the static identity of all things as God,” Leibniz stressed the active discovering force of imagination (26).

38. See Donald Rutherford, 159–60. Jammer informs us that it is our concept of energy that Leibniz refers to as force (166).

39. Davy has “the Unknown” credit Boscovich for supposing “points [as] possessing weight and attractive and repulsive powers” (*Consolations* 9: 388).

40. Hankins notes Boscovich denied vis viva also because it smacked of Spinozism (202). Knight reminds us that Boscovich’s atom was thought to be too theoretical. By 1813, Davy was a fully converted Boscovichian (*Atoms and Elements* 39).

41. Levere cautions that Boscovich used the term “vis,” which Levere argues is “power,” not force (*Affinity* 13). Child translates “vis” as “force.”

42. Boscovich later writes, “I show that the law is nowhere exactly in conformity with a ratio of this sort, unless we add explanations that are merely imaginative” (13). “Imaginative” here brackets the claim as a form of explanation, not a form of ontology. In section 134, he again invokes the aid of geometry, asking his readers to “imagine something that is perfectly plane and continuous” (58).

43. I have consulted Kant’s *Metaphysische Anfangsgrunde der Naturwissenschaft* for the original German. Barry Gower argues that Kant made the dynamic theory of matter well known, at least among German scientists (321).

44. I have adopted Pollok’s translation here (“Fabricating a World” 97). Important
studies of Kant’s understanding of matter include essays by Pollok; M. Friedman; Watkins; Kitcher; Modiano; and Hanna. Key studies of Kant’s notion of the imagination include those by Makkreel; Kneller; and Schlutz. Kneller’s fine study, in particular, makes the case for Kant’s Romanticism. Modiano charts Coleridge’s ambivalence to Kant, and the poet lambasted Kant for having confused the unknown cause of the phenomenon with the phenomenon itself (156). Yet he praised Kant for “construction of matter by two powers” (157).

On Blake’s understanding of imagination as an inverse homology to Newton’s, see Ault. Like Blake, however, Newton was disturbed by the self-sufficiency of mechanism (Ault, Visionary Physics 8). Because of the immense practical success of Newton’s theories, his acolytes were not bothered by the theology underpinning them.

Coleridge links fantasia with the active powers of the mind and imagination with “passive perception” (BL 1: 99). Schlutz notes that for Kant, while Einbildungs-kraft stands in relation to our rational faculties, Phantasie produces its mental images involuntarily, thus making it outside reason (111). Yet by having the spontaneity of the production of images mirror laws of the development of thought, the imagination’s automaticity did not have to result in its exile from rationality. For this view, see Makkreel; and Mensch.

J. Edwards cautions that although the standard history of Kant’s positions with regard to matter assigns a clear break between the earlier corpuscular accounts of matter and the later dynamical accounts of it, force was always an important influence. See chapter 7. Thomas Reid dismissed “Epicurius’s atoms,” claiming they “dance about in emptiness” (Inquiry 31).

Pollok suggests, “One might wonder whether Kant’s dynamism and the basic forces it assumes involves at least as much ‘fantasy’ as mechanism with its conception of full and empty space” (“Fabricating a World” 97). I thank Konstantin Pollok for his e-mail exchanges with me about Kant’s theory of matter. I am grateful to Alex Burdfield for his insights into the nuances of Kant’s German.

Modiano reminds us that Coleridge accepted Kant’s argument that the fundamental forces could not be explained because they were beyond experience (155).

In the abstracts of his Friday Evening Discourses at the Royal Institution, Faraday sought to correct the public misapprehension that Brownian motion had proved vitalism: “Mr. Brown by no means intended to say or even had said, that the motion was an indication of vitality” (“Abstracts” F/13/F(2), page 72). Einstein was able to imagine Brownian motion as evidence for atoms. Since objects in a fluid have a jittery motion that could be seen, one could figure out how much motion there should be, and this would entail the size of the atoms (Feinberg 29).

Schofield briefly discusses the influence of Unitarianism on Priestley’s approach to matter (Enlightenment of Joseph Priestley 184).

The price paid for the loss of human free will is that human beings become an agent of the divine (Disquisitions 1:43). For Priestley, this is a bargain.

Priestley argues, “How unintelligibly are persons reduced to talk, when they quit the road of common sense, forming their systems not on facts and appearances, but from imagination” (Disquisitions 1: 78). Imagination is here aligned against common sense; somewhat surprising is that common sense includes attention to “appearances.” Ault suggests that Newton at least, since God worked through appear-
ances, does not deal with the possibility that God works through deception (25). Later, Priestley warns that giving scope to the imagination without restraint is dangerous (1: 119). Still later, he warns that “our ascribing impenetrability to matter might make us imagine, that we had some kind of idea of its substance, though this was fallacious” (1: 139). Engell reminds us that in Priestley’s Lectures on Oratory, the imagination “assumes a broader and more active role in ‘the internal agitation’ of the mind” (73). Jean-Jacques Rousseau insisted that “the word substance . . . is at bottom the greatest of abstractions” (256).

53. Coleridge’s response was to mock Priestley for having “striped matter of all its material properties; . . . when we expected to find a body, behold! We had nothing but its ghost! the apparition of a defunct substance!” (BL 1: 136). Yet Coleridge misses Priestley’s careful bracketing of ontological claims. On essentialism as a strategy, see Diana Fuss, Essentially Speaking.

54. See Pheng Cheah, who argues that deconstruction insists upon a materiality without matter because matter is equated with presence.

55. Ruston shows Davy’s interest in a material sublime (Creating Romanticism chapter 4). “For Coleridge, the imagination is . . . such [a] modifying principle and the process of sublimation is used to describe its power to transform” (155).

56. Levere (Affinity) cautions that Davy uses Newtonian corpuscles, but “these were frequently supplanted by all-pervasive forces without material centres” (29). Davy wrote to Coleridge that, despite his absence, “you will live with me . . . as an imagination winged with fire inspiring & rejoicing” (“Letters” March 1804). I thank Wahida Amin (Nas) for her help in deciphering Davy’s quite wretched handwriting.

57. Coleridge’s notes on these lectures are published in Notebooks (1: entry 1098).

58. Davy denounces individuals with “religious emotions . . . [who] imagine [them] sel[ves] to be the peculiar favorite of the Deity. The vivid appearances of the ideas and the wild and uncommon mode of their Association dispose him to believe them” (“Personal Notebooks” HD/13/E, page 10).

59. In Royal Institution “Personal Notebook” HD/13/E, Davy wrote a “Prospectus of a Work on the Laws of Corpuscular Motion,—or the Philosophy of Chemistry.” Here, although “corpuscular” would seem to undermine dynamism, he insists, “the laws of corpuscular motion . . . are of Attraction and repulsion” (page 27 of inverted pagination).

60. Golinski considers how Davy was able to use experiment as a lever to redefine the social relations between experimenter and audience, with the audience reduced to a passive role (Science as Public Culture 190–92).

61. How careful Davy was in making ontological claims can be seen in the ensuing remarks: “That chemical & electrical attraction belong to the same bodies is in favour of the idea that they are the same powers exerted under different circumstances but much stronger analogies are wanting to give to this opinion the character, even of a probable theory” (“Electrochemistry” 81).

62. Jonathan Smith quotes Davy’s statement that imagination is “merely the vivid but vague association of images with passion” while reason “associates images ‘according to facts observed in nature’” (79) and argues that his take on reason is “highly imaginative” (79).

63. He noted in his “Introductory Geological Lecture” that the “active imagination must rest somewhere” (Davy, Works 9:188).
64. Ruston points out that Davy imagined light, and its entrance into bodies, as the principle of “perception, thought, and happiness” (Creating Romanticism 164–65). At NASSR 2014, Jan Golinski argued that Davy was initially an enthusiast. In that same paper, however, he cautioned not to call Davy a scientist because “scientist” indicates a kind of professionalism Davy did not and could not, because he wanted to appear genteel, afford to have. In my introduction, I defend my use of the term “scientist.”

65. Ruston comments that “Davy would have had access to Kant’s work in Beddoes’s Library, and that Beddoes had written a review of Kant’s Critique of Judgment in the May 1796 the Monthly Magazine” (Creating Romanticism 149). Class details Nitsch’s London influence (chapter 1), especially how he shaped Kant so that his German rationality would fit in with British empiricism.

66. Davy notes that when colors are considered beautiful, the “generating imagination makes them hereditary” (Works 2: 116).

67. Davy often links the imagination and or fancy of others to error. See Davy, Works 4: 5, 14, 16, 216; for the “imaginary” existence of phlogiston, see 4: 29, 163, 166; for heat being imagined as a subtle fluid, 4: 100, 2: 21. The “fertile imagination” of Beccher is somewhat positive, but that is undermined by “conclusions too rapidly formed” (4: 21). De Saussure, too, is praised for having presented “the rare instance of a powerful imagination associated with the coolest judgment” (9: 103). For the errant imagination of the alchemists, see 5: 66. Admitting that he does not know the essence of matter, Davy writes, “Matter may ultimately be found to be the same in essence, differing only in the arrangements of its particles; the results of our operations must be considered as offering at best approximations only to the true knowledge of things” (4: 132).

68. For similar uses, see Davy, Works 3: 270, 275, 276, 286, and 302. Davy chided Kirwan because he “imagined” the partial decomposition of nitrate of ammonia (3: 52). Ruston shows in an 1831 letter how Davy used “imaginary fluids” to dismiss phlogiston and caloric (Creating Romanticism 163–64).

69. On how the voltaic pile enabled Davy to show his command over natural forces, and to escape the ridicule that came from his earlier experiments with nitrous oxide, see Golinksi, Science as Public Culture 203–18. Davy had to redefine Galvanism, away from its associations with mesmerism and French revolutionary hysteria, and toward rational analysis. Ruston argues that these experiments are about the control over pleasure (Creating Romanticism 167).

70. Patricia Fara suggests that Marcet may have informed Mary Shelley’s understanding of chemistry (“Educating Mary” 21–22).

71. Thanks to Frank James for guiding me through the Royal Institution Archives and for his many conversations with me about Faraday. I am further indebted to him for a careful reading of this chapter, which prevented many errors, and for his encouragement.

72. In a December 1829 letter, Faraday wrote to John Ayrton Paris, “My desire to escape from trade, which I thought vicious and selfish, and to enter into the service of Science, which I imagined made its pursuers amiable and liberal, induced me to take the bold step of writing to Sir H. Davy” (Correspondence 1: 497).

73. Daston and Galison note Faraday’s strenuous attempts to keep hypothesis and experimental evidence distinct, and they note that his diaries were written up at the end of each day (245).
74. In 1818, Faraday belonged to a self-help writing group, and Alice Jenkins makes
the case that Faraday was the author of this paper (26–28). Jenkins announced this
discovery in her 2008 book.

75. Sophie Forgan documents Faraday’s “principal appeal to the imagination, both
public and scientific” (63) in his Royal Institution Lectures.

76. Faraday had this to say about speculation: “Speculations—dangerous tempta-
tions generally avoid them—but a time to speculate as well as to refrain—all depends
on the temper of mind” (“Speculations” entry Friday, 19 January 1844). Disciplined
subjectivity, then, helps control speculation and make it useful. Similarly, Davy com-
ments, “To be attracted to mere speculation is to be directed by a dream. Knowledge
can only be acquired by the senses. Nature has no archetype in the human imagina-
tion” (“Electrochemistry” 101).

77. In Royal Institution MS F/13/F(2), the abstracts of Faraday’s Friday Evening
Lectures for 1826–61 note the follow-
ing: “Not asserting that a new power was con-
cerned [Faraday discusses Brownian motion]; not denying that the powers with which
were [sic] acquainted might not be sufficient to originate the motion; but thinking it
much more philosophical to acknowledge ignorance as to the mode of action in these
cases, and to suspend the judgment, than by the assumption of an opinion, which must
have been hypothetical, run the great risk of shackling the mind by the admission of
error for truth” (71).

78. I am indebted to Frank James for this explanation.

79. Faraday’s diaries are in fact his laboratory notebooks. Gooding acknowledges
Faraday’s “well-known distrust of imagination and hypothesis” (“Mechanics versus
Measurement” 5). My treatment shows that Faraday’s distrust applied when these
were extended beyond their proper reach. See also Experimental Researches 1: 142.

80. Recall Kant in CPR: “All determination in time presupposes something
persistent in perception” (B276).

81. Faraday is drawn to dynamism because it allows him to think in terms of
contiguous particles—he defines induction as “an action of contiguous particles”
(Experimental Researches Dec. 1837)—and because it helps him to account for mat-
ter’s shifting states.

82. Levere notes that Faraday does not clearly use force to distinguish “between
laws and powers innate to matter and laws or powers impressed on matter” (Affinity
101). Gooding provides the shrewdest analysis of Faraday’s use of force, and he notes
that Faraday does not distinguish between actual and potential force, ascribing this
failure to Faraday’s theology. Dear suggests that Faraday relied upon Newton’s claim
that since action at a distance was unintelligible, there had to be some physical
medium fulfilling the conditions of a line of force (Intelligibility 118).

83. I thank Frank James for telling me to pay attention to the shift between series 4
and 5. On Faraday’s knowledge of Boscovichean atomism, see James (“Reality or
Rhetoric?”). James argues that Davy might have been the source of Faraday’s acquain-
tance with Boscovich’s atomism (578–79). Faraday thought that Dalton’s atoms had
retarded science, but this led him to be read as firmly within Boscovich’s camp (584).
Even at the dawn of the twentieth century, physicists like Mach hoped to erect science
upon a phenomenalological base, without the “unnecessary hypothesis of atomism”
(Holton 33).
84. On the complications regarding the Faraday’s meaning of “contiguous,” see James, *Michael Faraday* 67.

85. Nersessian addresses when Faraday had a field concept and points out that scholars have disagreed because they are working with different notions of a field concept. She argues he must have had one by 1832 (182). Harman notes that Faraday introduced the term “magnetic field” in 1845, which was not clearly defined until Maxwell did so in 1865. Maxwell’s term meant “the mediation of the forces by the agency of the contiguous elements of the field existing in the space between separated electrified bodies” (72). Gooding shows the ways in which Faraday’s lines of force helped him to draw a picture of nature, one that “represented the expenditure of natural powers as processes obeying the intellectual principles of economy and conservation” (“Magnetic Curves” 188). Faraday did not invent “lines of force” and, in fact, in making lines a heuristic, drew from ways of mapping terrestrial fields and geometry (208).

86. For a similar use of “imagine,” see *Experimental Researches* 1: 56. Faraday also uses “imagine” when trying to think about where others have gone wrong. See *Experimental Researches* 2: 190, letter to Gay-Lussac.

87. Faraday alludes here to the homopolar disc, developed in 1831. Now called the Faraday disc in his honor, it showed the potential to generate electricity with magnetism.

88. To provide his audience with an idea of how powerful chemical affinity is, Faraday writes, “It may perhaps assist in impressing us with an idea of this power, if we were to imagine a change in the affinity of some one simple body with which we are acquainted. If, for instance, that of oxygene [sic] was exalted; combustion would then be more rapid and violent than at present; many bodies would burn which now do not” (“Lectures on Chemistry,” 108–09).

89. Faraday explains why the public thought he had taken Signor Nobili’s idea: “The circumstances of back date has caused many here who have heard of Nobili’s experiments by report only, to imagine his results were anterior to, instead of being dependent upon, mine” (*Experimental Researches* 1: 41n). Faraday’s work appeared later because of publication delays (James, *Michael Faraday* 60).

90. In a paper titled “Physical Lines of Force of Electricity,” Faraday again highlights his modesty: “With the electric force we have both the static and dynamic state. I use these words merely as names, without pretending to have a clear notion of the physical condition which they seem meaningly to imply” (*Experimental Researches* 3: 410). Morus explains that Faraday increasingly thought that electricity “should be regarded as a force occupying the space surrounding the conductors rather than as a fluid flowing through the conductors themselves” (96). In an exchange between Faraday and William Whewell in February 1852, Faraday sent Whewell a specimen of magnetic curves, asking for his input on what to call them. Whewell suggested the name “sphondyloid,” citing Jeremy Taylor’s remark that “the circles of Divine Providence turn themselves upon the affairs of the world” (James, *Correspondence* 4: 365). Faraday thanked Whewell, noting that his last letter was “curiously to the point in respect of Jeremy Taylor” (ibid.).

91. Dear argues that Faraday cannot specify what this condition of space is in any noncircular way (*Intelligibility* 118).
92. Faraday turns to the imagination once more in this paper: “I think the analogy with the voltaic battery so placed, is closer than with any case of static electric induction, because in the former instance the physical lines of electric force may be traced both through the battery and its surrounding medium, for they form continuous curves like those I have imagine within and without the magnet” (Experimental Researches 2: 424–25). Two points. One, analogy is a way of linking other kinds of evidence to this experiment. Two, continuity itself must be imagined, because the forces might work through action at a distance.

93. For Faraday’s speculation that radiation also produced physical lines of force, see his “Thoughts on Ray-vibrations” (Experimental Researches 3: 447–52). Here, he argued that the propagation of forces could be represented as vibrations in the lines of force.

94. Levere argues that Faraday was not very much influenced by Boscovich and could not read Latin (Affinity 99–102). Harman agrees and thinks Faraday to be far more closely aligned with Priestley (77).

95. “Lectures on Chemistry,” dated January 17, 1816, to August 19, 1818, Faraday wrote, “That the attraction of aggregation and chemical affinity are actually the same as the attraction of gravitation and electrical attraction I will not positively affirm but I believe they are and when I again have the honor of appearing before you, I shall give my reasons for such belief” (31). He later claims that the hypothesis of polarity is “of great service to the science, for it enables us to arrange a number of facts which before were insulated and to substitute order and regularity for complexity and confusion” (74).

96. Frank James cautions that Faraday’s religious views were not responsible for his rejection of atomism. He points out that Anglicans, Dissenters, and Roman Catholics all rejected atomism (“Optical Mode” 142). On Faraday’s Sandemanianism, see James, Michael Faraday 12–19; and Cantor.

97. Jenkins omits 5.5 pages of manuscript in her published version of the essay. In these pages, Faraday declares his epistemological modesty and situates the goals of the lecture within the context of the interests of the City Philosophical Society. I quote from the manuscript, and not her published version.

98. Faraday writes a second paper on the imagination. Here he claims that natural philosophy offers many opportunities for the imagination. “What a field for the imagination, (as well as Reason,) is exposed by the powers of the microscope, the telescope, and the discoveries in natural philosophy. How it wanders in the infinite divisibility of matter, or in the immensity of space; how can we restrain it in the contemplation of the heavenly bodies” (Jenkins 65).

99. Faraday opened his 1859 Juvenile Lectures with an illustration of force: he used a string attached to a piece of paper, and pulled on it (Forces 6–7). On July 23, 1826, he wrote to Edward Barnard, “I do feel for those who are oppressed either by real or imaginary evils, and I know the one to be as heavy as the other” (Correspondence 1: 419). Forces perhaps helped to explain how imaginary evils had real effects.

100. In a letter dated May 12–14, 1813, Faraday wrote to his friend Benjamin Abbott, “Till on a sudden as the dense light of the electric flash pervades t’horizon so struck the thought of Abbott through my soul” (Correspondence 1: 53).

101. Anyone attempting to trace Shelley’s interest in the physical sciences must begin with Grabo. In what follows, I develop the implications of some of his findings.
Hugh Roberts situates Shelley within chaos theory, arguing that his Lucretian understanding of matter helps resolve the long-standing debate about the relation of Shelley’s idealism to his skepticism. Marilyn Gaull offers a useful and crisp overview of Shelley’s interest in various sciences. King-Hele quotes Hogg’s recounting of Shelley’s exuberance with regard to science: “By chemical agency the philosopher may work a total change, and may transmute an unfruitful region into a land of exuberant plenty” (Shelley: His Thought and Work 160–61). For an analysis of Shelley’s notes on Davy, see Ruston, Shelley and Vitality 95–101.

The Pforzheimer Collection at the New York Public Library owns Shelley’s annotated copy of G. Gregory’s The Economy of Nature (Pforz 557R07), given to him in July 1810. To Gregory’s definition of matter in terms of extension, Shelley responds, “No one agrees on one definition of matter. By W. D., soul is matter because it is capable of extension but generally is also of sentient sensation” (1: 10). Gregory later names as a law that all matter is subject to laws of attraction and repulsion (1: 16) and dismisses the idea of impenetrability of matter on the grounds that bodies are porous; electricity passes through the densest of bodies and light passes through a variety of substances (1: 10–11). Thanks to Neil Fraistat for helping me suss out Shelley’s handwriting and faint pencil markings.

For studies that consider Shelley’s materialism, see Alan Richardson, Neural Sublime chapter 2; Ruston, Shelley and Vitality; and Roberts. To Gregory’s claim that “the electric matter is visible; whereas the very existence of a magnetic fluid is justly questionable” (1:53), Shelley retorts, “Why may we not as rationally question the existence of electric fluid. It causes certain effects as the magnet does capable of being the subject of our senses—the testimony of them is equally strong in one as in the other” (Pforz 557R 07, 1:53). See also Goldstein.

Even such a fine critic as Ruston perpetuates a divide between art and science by distinguishing “scientific exposition” from Shelley’s “creative use of science” (Shelley and Vitality 105).


Citations of this poem are from Reiman and Fraistat, and numbers refer to lines.

Perhaps because the histories of magic and chemistry were so entwined, chemical lecturers followed Priestley’s lead in linking chemistry to the sublime but “explicitly not to the mysterious or magical” (Golinski, Science as Public Culture 102).

Harré highlights the fact that in the late eighteenth century forces like electromagnetism made it difficult to retain atomism (13–15).

Tresch’s larger point is that since technology has been associated with modernity, Romanticism looks like a dead end. He thus demonstrates how Romantic technology contributes to the history of science.

In lines 313 and following, Shelley does threaten to strangle “cones and parallelograms and curves,” suggesting perhaps a tension between geometry and the creative imagination. However, Shelley will only strangle them if they once dare to
bother him. He concludes that section promising that “we’ll make our friendly philo-
sophic revel / outlast leafless time” (lines 319–20).

110. Albert Rupert Hall documents that, in the eighteenth century, cataloguers
were aware, if dismissive, of Newton’s manuscripts on alchemy (190). My point is that
his interest in alchemy was known.

111. For a deft reading of *Prometheus Unbound* within contemporary geological
theories, see Heringman. He argues for example that “the fossilized instruments of war
. . . appeal to geological stability to represent an end to violence” (*Romantic Science
71*). Yet this is to ignore the counter-spirit entailed within “ruin within ruin,” not to
mention that the passage ends with “abolished” and “no more” (lines 316 and 318).
Moreover, Shelley refers to these fossils as “prodigious shapes / huddled in grey
annihilation” (4: 300–301). I shall develop my reading of “shape” below.

112. According to Faraday’s 1816–18 “Lectures on Chemistry,” “Above gases we come
to Radiant matter, and here seem to have the utmost degree of tenuity possible, for
even the fanciful ethereal media can not be conceived to surpass it” (150). If Romanti-
cism understood heat, light, and ether as forms of radiant or imponderable matter, we
now would call these energy.

113. Frosch writes suggestively that, in this drama, “words are like things or physical
forces” (134). Less helpful is his claim that “Demogorgon serves as a gravitational force,
bringing the action down to an earthly level, modifying the transcendent trend of eros
and imagination with his own ethos of material process” (217).

Wilhelm Ritter, discoverer of ultraviolet radiation, thought that “light is the external
intuition of gravity, love the internal” (cited in Daston, “Fear and Loathing” 85). By
making love about the intuition of gravity, he makes it about the phenomenality of the
physical. In response to Gregory’s chapter on iron, Shelley notes in the margins: “Is
there not in nature a continual reorganization of whatever is decomposed?” (Pforz
557R 07 2:178).

Gregory warns against overreliance upon the imagination in accounting for theories
of magnetism. He argues, “I am not fond of indulging the imagination in its favorite
propensity to create invisible agents in order for the fabrication of plausible theories,
which some slight and causal experiment may shortly overturn . . . It is a trite remark,
that there are certain points at which the human faculties must stop in all our specu-
lations. This would be a dangerous tenet, if it promoted indolence, or discouraged our
ardour in the pursuit of natural knowledge by the only secure path, I mean that of
experiment; but it is a salutary maxim when applied to the imagination, and when it
only serves to restrain our ardour for fabricating systems, which have no other end but
to remove for a moment the uneasy but useful sensation of doubt and curiosity” (Pforz
557R 07, 153). Shelley underlines “doubt” twice and “useful” once, and in the right
margin submits, “Place a magnet underneath a sheet of paper on which iron filings
are spread. What explains the arrangement of these [illegible].”

114. Perhaps Shelley is thinking of Locke here because even Locke defined
“mentality . . . as a property of physical structures without being identical with those
structures, or without having the same nature as other properties of that structure”
(Yolton 200). Shelley’s teacher, Adam Walker, insisted that matter albeit inert “attracts
and is attracted” (5), and he highlights matter’s pores (4).

115. Attention to matter as force allows us to see that Shelley did not limit Pro-
metheus to the One Mind as Wasserman argued in *Shelley*, and matter as force grounds idealism and utopia.

116. Curran argues that Shelley syncretizes physics, pointing out that Orsted was on the cusp of proving a connection between electricity and magnetism. He also mentions Shelley’s reading of Volney, from which he learned that ether formed the matter of the stars (108). King-Hele suggests Adam Walker to be the source for Shelley’s idea that fire, light, heat, and electricity were one principle; Shelley was shrewd enough to reject Walker’s caloric and phlogiston (*Shelley: His Thought and Work* 166–67). Ruston reads the passage where Panthea describes herself as a drop of dew vaporizing as an allusion to the ability of all matter to change form into another, and this, in turn, speaks to a Lucretian understanding of matter as nothing being annihilated, only metamorphosed (*Shelley and Vitality* 113). Where Ruston distinguishes between an absence of love before the revolution and the growth of love after it (125), I underscore that the issue is not presence or absence but apprehension: a dynamic theory of matter demands the apprehension of force/love as the force that holds matter together.

117. Especially useful here is Ruston’s point that life as electricity allows Shelley to consider the gendered and political connotations of relationships (*Shelley and Vitality* 115). In an important essay on Shelley’s similes, Julie Carlson shows how love is like understanding and like imagination for the poet, and that simile does not predict the outcome of attachment in advance of the attachment (91–93).

118. In *Visions of Science*, Secord argues that Davy uses the form of dialogue to be everywhere and nowhere at once; the various characters all speak from positions Davy was known to have taken (37–41).

119. Rei Terada argues that we would “have no emotions if we were subjects” (*FT* 4): “Emotions require the death of the subject” (ibid.). She means by this to critique the notion of a subject who is driven by teleology, and, under that view, the emotions are importantly moments of self-difference. Shelley thinks about emotions like love as objective forces that must be subjectivized if they are to animate subjects. For Shelley, if emotions make the border between subject and object fungible, they convert subjects to forces in the world whose energies work in the world and give the subject a kind of open subjectivity.

120. In his *Hints Towards the Formation of a More Comprehensive Theory of Life* (*TOL*), Coleridge questions whether crystals, because they have a principle of organization, are necessarily not life. He insist one cannot presume the definition in advance.

121. Although Romantic science was later ridiculed for its reliance on symbols and on analogies, Evelleen Richards shows how these ambiguities were useful to science because it generated a fertile source of ideas and concepts (“Metaphorical Mystifications” 131). Davy of course thought about how judgment needed to preside over the application of analogy. Julie Carlson chides Bruhn for ignoring the affective dimensions of analogy (79–80) and insists upon how analogy enables potential alliances; my insistence on love as attractive force highlights the role of affect. See her “Like Love,” opening pages.

122. Goldstein is right that Shelley’s understanding of life at times allows it to be mechanical (*Sweet Science*). In act 4, Shelley repeatedly uses the term “unimagined” to describe a utopia in formation that exceeds our imagination, thus associating imagination with limit instead of with boundless transcendence.
123. Wiegand Brothers reminds us that Herschel was a professional musician before he turned to astronomy, suggesting that the arts and sciences were not then as far apart as they are now.

124. Amanda Jo Goldstein and Hugh Roberts thus situate Shelley within a neo-Lucretian swerve that makes necessity unpredictable. I thank her for sharing her Representations article with me before publication.

125. For an overview of Enlightenment debates surrounding what counts as an action, see Yolton (chapter 7). Is action merely mechanism? Is human action self-initiating or spontaneous action? Is human action merely godly movement? Does mind cause action, and if so, how does it engage with mechanism? The problem of mechanism continues today in the controversy surrounding Benjamin Libet and his claim that there is an activation of a neural mechanism that prepares the body for action roughly a third of a second before intention. Libet argues therefore that the only free will we have is to decide not to do something we have previously decided to do. Critics note that his choice of action, that of flexing the wrist or bending a finger, is not an action we ordinarily are conscious of, and thus the particular action is not representative of intentionality.

126. See Hogle 230. For a reading of the poem that sees it supporting life as an internal power, and therefore William Lawrence’s side of the Abernethy/Lawrence debate, see Ruston, Shelley and Vitality chapter 3. She argues that the furies show a misunderstanding of animal life, because they separate vitality from the soul (108).

127. Heilbron insists that Franklin did not discover conservation but that he was the first to exploit it fully (330).

128. On the soul in Romanticism as an entity that moves from an anthropological to an aesthetic object, see Haekel, Soul.

129. See my “John Keats and Some Versions of Materiality.”

130. Faraday rejects the shape of the atom as hard and fixed, instead adopting Boscovich’s argument that atoms are centers of force. The implication of this for shape is that atoms can now have different shapes according to the intensity of forces. See his January 1844 paper, published in his Experimental Researches (2: 292). See also his paper on ray-vibrations, when he claims to have given radiation “shape” (3: 452). Amanda Goldstein reads “shape” in the “Triumph” in relation to Lucretian chance encounters and entanglements among atoms, not making them figures of figures, but rather giving figures reality (“Growing Old Together” 73–76). Lucretian materialism offers the possibility of convergence between materialism and trope (63).

131. Schelling argues that matter originally had the property of elasticity and that it could be compressed ad infinitum, making “shape” an ideal referent for matter. See 189–90. Of course, Hegel used “shape,” or Gestalten, to describe the structures of consciousness in his Phenomenology, and key here is that this term is applied to both consciousness and material objects.

132. I agree with William Keach when he claims that Shelley “has to accept and work within the imperfections of ordinary language in order to realize . . . language’s potential” to generate thought, but I would add that the dynamic force of matter also helped to generate thought (47). Jacob highlights that, under preformation, “shape” indicates regularity. With epigenesis, “shape” becomes more mobile (57).

133. Cameron, following Grabo, suggested these lines borrow from Herschel’s idea
of the formation of solid matter out of nebulae (546). In the Romantic period Pierre Simon Laplace articulated the nebular hypothesis, arguing that the gaseous clouds rotate, collapse, and form planets. I had hoped to include material on Caroline Herschel, who discovered eight comets, but my sweeping through British Library MS Egerton 3761 did not find a single reference to “imagination” as a scientific entity.

134. O'Neill resists deconstruction on the grounds that it is about testing a linguistic theory and not about the imaginative testing of any one writer. Of course, it was never meant to test any one writer.

135. Cameron reminds us that Asia is another version of Venus, the goddess of love. Shelley compares her arrival to Botticelli’s Birth of Venus (509).

136. Sperry argues that liberation for Shelley is freedom from “inhibition and compulsion” (Shelley’s Major Verse 113).

137. Under my sense of Shelley’s dynamic physics, when Shelley refers to Jupiter’s “thought-executing ministers” (1: 387), he worries about the death of thought rather than framing the actions of ministers as the execution of thought. Under dynamism thought is action in another form.

138. Roberts shows how the Lucretian swerve introduces chaos into order, and thus Shelley’s interest in Lucretius enables Roberts to see how Shelley profits from simultaneous optimism and skepticism, order and disorder.

139. Demogorgon, for instance, thinks of heaven as “constellated wilderness” (IV.532), implying that even in heaven there is no order without destruction.

140. Wasserman helpfully suggests that Shelley’s rejection of dualism “must have driven him to reconsider the function of language, for he could no longer assume it to be an analysis of percepts into the components and relationships obtaining among their counterparts in an outside reality” (Shelley 267). Roberts suggests that Shelley’s desire to restore the unity of subject and object was fueled by his 1817 reading of Coleridge’s Biographia (95–104).

141. King-Hele’s reading of II.i.71–89 is worth recalling here. Panthea feels Prometheus’s love in her dream as if she were a drop of dew vaporizing under Prometheus’ beams. King-Hele notes rightly that Shelley focuses on the molecules of the droplets, which dance more vigorously upon vaporization (Shelley: His Thought and Work 177), though unfortunately he thinks this is sexual sublimation. It is simultaneously love and force.

142. Cf. my essay in Romanticism and the Emotions.

143. Sperry credits John Sewell Flagg for this insight (77, 214n15).

144. Ruston notes that there is sympathy between the emotional and physical in the body of the earth (Shelley and Vitality 124). I would add that that sympathy is awakened by the kiss, and that this sympathy verges on identity given love is a force of attraction. Leask argues that earth’s inorganic voice makes her resemble “the magnetic influence working on a diseased nervous system” (72–73).

CHAPTER 2: WILLIAM BLAKE AND THE NEUROLOGICAL IMAGINATION

1. Here, I think about how Romantic reductionism enabled traffic between the sciences and the arts. In science, of course, reductionism is generally a term of praise, signifying at minimum the work that science depends on to make objects subject to scientific procedures, and at maximum the deduction of properties, explanations, or
methods from one scientific domain to another. As reductionism crosses into the arts, it often indicates the loss of the human perspective, which, from the standpoint of science, is getting rid of the occult or of introspection or subjectivity. In his study of reductionism, Kandel argues that scientists “use reductionism to solve complex problems” while artists like Turner shift to abstraction to elicit “new perceptual and emotional response in the beholder” (Reductionism 6). For Kandel, scientific and artistic reductionism are analogous and therefore should be studied together. Though his is a rich study, his sense that scientific reductionism is not a negation of complexity does an end run around the fact that his work on memory and learning relies on his studies of sea slugs, chosen for the simplicity of their neural circuits. Stengers laments the fact that the “delegation” of matters to scientific experiment was labeled “reduction” in the science wars (Cosmopolitics II 213), and this use of reduction amounts to a denial of the creativity within experiment. For a defense of using metaphor between disciplines, see Kellert. To do so, he considers the ways in which science turns to metaphor, despite its protests against figuration, to guide the development of scientific hypotheses (113). Rose and Abi-Rached consider how neuroscience has “move[d] beyond reductionism as an explanatory tool, to address questions of complexity and emergence” (23), but I think this is too optimistic. At bottom, neuroscientists still search for a neural mechanism. Their interest in how neuroscience might lead to new forms of the subject (24) is worth consideration. Finally, Malabou argues that the “neuronal self” is the strength and weakness of current neuroscience: a strength because it is a new idea; a weakness because the continuity between the neuronal and mental is necessarily philosophical and epistemological, not scientific (56).

Blake does most often gender the nerves as male: he frequently modifies nerves with “his.” However, his female characters do manipulate the nerves: for instance, in Milton, plate 19, “she ties the knot of nervous fibres.” And Tharmas is ambiguously gendered. One should also acknowledge that both male and females are “regenerated.” See FZ N9 E 391: 205–10.

2. The line break is important. By ending the line after “unity,” it at first seems completely possible, only to be taken off the table at the start of the next line. References to Blake’s Four Zoas are to the Erdman standard edition, and typically I specify the night in question, the Erdman page, and then the line numbers.

3. Asma argues that heuristics are “experiential, probable, and approximate,” while deduction is algorithmic and produces certainty (71). Heuristics thus encourage feeling.

4. See Cunningham and Jardine, 8, 22. “For all the metaphysical differences between Naturphilosophie and the new natural sciences there is a striking commitment in the range of disciplines they sought to unite” (8). According to Edwin Clarke and L. S. Jacyna, “The nervous system provided a paradigmatic case for the vindication of Romantic principles,” meaning that the nervous system helped prove the unity of organic structure (43). Alan Richardson shows how Charles Bell was able to “preserve the soul” without “minimizing the claims of the body” (British Romanticism 31).

5. In Andrew Lincoln’s otherwise quite suggestive study of Blake’s The Four Zoas, he draws an analogy between Tharmas’s fall away from divine vision and the rise of the “scientific universe” of the seventeenth century and Baconian empiricism (72). I show, by contrast, that science has no necessary connection to the fall; Romantic neurology enabled science and imagination to coexist.
6. Rajan’s term (“Baudrillard and Deconstruction”).

7. Amanda Jo Goldstein argues that Blake’s “sweet science” is informed by Lucretian materialism, whereby figuration becomes a central means of empirical knowing and communication (Sweet Science 1–9). In this view, sweet science becomes Lucretian poetic sweetness, which allows the science not to seem so bitter. She reads Blake’s The First Book of Urizen as a critique of life as the power to self-organize (chapter 1) because that organization rarely leads to autonomy. My contextualization of Blake in terms of the neurology of the time suggests alternative paths through these debates. Rather than seeing Blake in terms of a hostility to life, I see him as distinguishing between two kinds of reductionism, the absolute reductionism of Urizen, which can yield only tyranny, and reductionism with a difference that demands pleasure.

8. See Wellmann, who argues that physiology in Romanticism put movement at its center, further ironizing Urizen’s backward desire for fixity (152–55).

9. Figlio shows how unity through “organization” enables scientific and philosophical thinkers to attach their diverse beliefs, and he calls attention to the metaphoricity of organization. Jacob allows us to see why it would become metaphorical: “By progressively replacing visible structure, organization provided a hidden foundation for the bare data of description, for the being as a whole and for its functioning” (83). Coleridge, of course, like John Hunter, wanted to consider life “independent of the organization,” thus hinting that the word “organization” could retain a materialist taint (Friend 1: 493n). On reductionism, see Nagel; and for a critique of Nagel’s resistance to ontology, see Schouten and de Jong. See also Changeux and Ricoeur. Robert Richardson notes that reduction to genes can quickly lead to intractable computations as there are more interactions among the genes (125). Eric Kandel argues that reductionism in science does “not necessarily imply analysis on a more limited scale . . . understanding discrete levels of meaning then paves the way for the exploration of broader questions—how these levels are organized and integrated to orchestrate a higher function” (In Search 5). In practice it often does, especially since those broader questions must perforce be more speculative and less scientific.

10. See Marjorie Levinson’s talk on why lyric poetry should be considered self-organizing systems (“Lyric”).

11. Owsei Temkin argues that “passions, instincts, thought and will could be studied as phenomena dependent upon our external and internal sensations, and, therefore, upon our biological organization” (“Materialism” 322). In Mind’s World, Alexander Schlutz sees the mind’s embodiment as a necessary threat to autonomy, but Romantic artists found numerous paths around this problem: one key way was to make embodiment a commitment so as not to be confined by then-current understandings of materiality. For how organization in Blake acquires political resonance, see Makdisi, Impossible History.

12. According to the Blake Concordance, this is the only use and form of “organize” in the poem. Massey’s remarks may no longer pertain: a review of issues of Neuron for 2015 shows an interest in neuron “ensembles,” “circuits,” and “populations” that acquire rhythms when they fire together.

13. Cuvier thought of living bodies as “furnaces, into which inert substances are successively thrown” (1: 5). If Blake’s furnaces are a play on this, their irony mounts.

14. Mark Bruhn turns to the work of Francisco Varela to think about how neuro-
phenomenology relies upon “autopoesis”: the idea that living systems have a unitary nature, a coherent wholeness, and “an autonomy that is brought forth by the system itself” (“Mind Out of Time” 424). Bruhn thinks about the imagination as “function of a global pattern” of the brain (428), thus turning to organization to enable autonomy. This version of autopoesis requires that the process be “operationally closed” (424). Chemero suggests a more open notion of autopoesis, one perhaps more in keeping with Blake. For an overview of new approaches to the imagination, see Alan Richardson’s “Reimagining the Romantic Imagination.” Isabelle Stengers argues that with reductionism, in practice, “no one dreams of requiring those ‘parts’ to actually bear witness to such obedience [of the same laws]” (Cosmopolitics II 209).

15. Eric Kandel suggests in In Search of Memory why neurons are so capacious: neurons are both chemical and electrical. With long-term memory, not only are new proteins synthesized, but also the number and strength of synaptic terminals can shift from 1,300 to 2,700 (213–16). There is also the number and variety of neurotransmitters to think about.


17. See philosopher David Chalmer’s TED talk on consciousness, where he argues that, to think about consciousness as scientific, one may need to risk two crazy ideas. The first is that consciousness is fundamental (a fundamental law), and the second is that consciousness is universal (an argument for panpsychism, which the Romantics found at least for a time attractive). One way to get to panpsychism is to think about consciousness in terms of information (i.e., it from bit). Jaegwon Kim argues that “emergence” is a bit of a dodge. Emergence identifies correlations, which are then not subject to further analysis: it identifies fundamental facts incapable of further reduction (97). This perhaps suggests the ideological work of fact.

18. Might one criticize Malabou’s “explosive plasticity” for also lacking precise requirements?

19. After recounting the main theories of how the nerves worked, John Abernethy thought the electrical explanation offered the most “probable account” because it could explain how “motions are transmitted from the tangible extremity to the brain” (Anatomical and Physiological Lectures 329). Probability throws a wrench into any deterministic conception of embodiment.

20. Clarke and Jacyna date the start of mechanical reductionism in neurology to the emergence of what they call the “organic physicist” in Germany in the mid-1850s.

21. This holds true even today: consider the current interest in brain waves, or growing curiosity about astrocytes, or the claustrum, which Francis Crick was working on when he died, or rich node neurons.

22. Helpfully, Connolly thinks about Burke as a precursor to Blake in terms of thinking about how the mental and physical interrelate (62–64). Matthew Green argues that Blake synthesized the work of the prophet and scientist; although his “mills” have been taken as destructive metaphors of empiricism, the mills do grind bread (12–13).

23. In 2000, neuroscientist Jean-Pierre Changeux published a series of exchanges with Paul Ricoeur on the brain and ethics. There, he warns against “the presumption of a priori ruptures in discourse . . . which pave the way to irrationality” (23).
24. Catherine Malabou argues that part of plasticity is apoptosis, or cell death: nervous connections that die to enable other nervous connections (19). By making death a form of plasticity, she seeks to resist neuroscience’s furthering of capitalism. In insisting upon an explosive plasticity that includes an annihilation of form, Malabou wrests plasticity from flexibility and functionalism. David Chalmers reminds us that “the language of a completed fundamental physics is not known” (Constructing the World 110), and thus even physicalism has its limits.

25. Shouten and de Jong question whether multiple realizability really is a problem, since the current success of neuroscience “presumes genuine continuity across individuals and even across species” (12).

26. In July 2017, Frank James and I discussed scientific modeling, and he cautioned me to be wary of imposing a current view of models upon the past. Though they may not have used the term “model” in this way, Romantic neurologists’ sense of the tenuousness of any embodiment given to the nerves made their versions of nerves representations, at least, if not models.

27. Rheinberger argues that models to be successful must “leave something to be desired”; the minute they approach certainty, one no longer needs them. Their representational relationship must remain fuzzy (8). Georges Rey argues that we do not know enough about philosophical physicalism; that is, we do not yet know enough to claim a “substantive, explanatory physicalism” (102). He continues, “At best, we have a sketch of a promising naturalistic research program: . . . [a] computer model’s version of materialism” (103).

28. Edelman and Tononi have developed an important tool to assess how a group of neurons might be connected to consciousness called the functional cluster index. This index measures the degree of interaction.

29. One of the main problems within literary criticism is the need to render literature bankrupt in advance: sexism, racism, classicism, humanism, colonialism, nationalism, heteronormativism, power. What work of literature can escape these combined charges?

30. Ernest Nagel recognizes an increased skepticism on the part of physicists as to a unified theory but comments that “nevertheless, that ideal continues to leaven current scientific speculation” (336). Reductionism, thus, disciplines the kinds of scientific speculation that are licensed. On the problem of reductionism, see Schouten and de Jong. Its editors note that reductionism in psychology is back in favor again (2). Nagel further warns that reductionism is always historically contingent: on the status of each science, on what forms of reduction each science will find of use for itself and generative of new kinds of experiments (358–64).

31. Gerald Edelman calls absolute reductionism in the form of reducing the human into a theory of molecular interactions “silly reductionism” (Bright Air 166); he notes that this was the failure of the Enlightenment. Catherine Malabou in Self and Emotional Life argues that neurobiology endorses an essence of subjectivity that has difference at its very core: “The subject is fundamentally, immediately, biologically a stranger to itself, which never encounters itself, which never touches itself” (Malabou and Johnston 34). She highlights the ways in which Damasio points to an autoaffection that is subjectively invisible.
32. Einstein worried about whether “God could have made the world in a different way; that is, whether the necessity of logical simplicity leaves any freedom at all” (cited in Holton xii).

33. Gerald Edelman thus pits the creativity of the imagination against reductionism to Newtonian physics, arguing that the imagination refutes such reductionism (Bright Air 170–71). Ricoeur worries that neuroscience, in extending the correlation between organization and function, does away with the need for representation, which he defines as the brain’s projections upon the world of “the representations it has organized” (90). Massey warns of the insuperable differences between scientific and humanistic methods, and highlights the humanist’s valuing of individual experience of the work of art (chapter 1). Barrett, in insisting upon the subjective differences entailed within the emotions while arguing that the emotions are how we regulate our body energy, suggests that the two approaches are not necessarily at odds.

34. Kleist’s Über das Marionettentheater, by contrast, marvels at mechanization, arguing that consciousness makes for more wooden dancing. It is worth recalling Kant’s remarks that there was not yet enough knowledge about mechanism to know whether it was the same as purposiveness.

35. Patricia Churchland rightly decries as hubris the idea that, just because one cannot imagine a solution, the solution cannot be explained at all (58).

36. See, for example, Churchland’s Touching a Nerve, chapter 2, where mechanism exculpates the scientist from lazy soul searching. She writes, “Faced with a degenerative disease, . . . we find that mysteries, perhaps hitherto comforting, become instead a wretched obstacle to understanding and hence to possible intervention” (28–29). The problem is that “mechanism” can be its own form of ignorance or mystery, shrouding ignorance under the idea of a mechanism. See also Stinson and Sullivan, who argue that even today neural mechanisms straddle different sciences and different species. So, for instance, they question whether Kandel’s work on sea slugs tells us much about human learning. Malabou critiques Damasio’s assumption of a continuum between the neuronal and the mental by showing the deep structures of transformation that he has not yet even begun to explain (62–72).

Self-organizing systems include traffic jams or bee colonies or the human circulatory system.

37. For an important overview, see G. Rousseau, NA; and Alan Richardson, British Romanticism, chapter 1. Ishizuka makes the useful point that Urizen’s webs are nervous, and he does so to challenge the equation of him with reason. He separates fiber medicine from the nerves, however, arguing that the nerves were a subset of fiber medicine. I do not see the discourse of the nerves making any kind of hard and fast distinction between fiber and nerve.

38. Even the elements of the brain are not fixed. Rose reminds us that brain proteins are highly unstable and break down: “The average half-life of a protein molecule in the brain is around fourteen days” (140). What does this mean for the materiality of the brain?

39. Manhood of course remains a problem: this intersubjectivity is gendered.

40. Andrew Piper argues that Romantic books were a form of networking, and thus they prefigure our current digital world rather than contrast it. He further turns to Goethe’s use of the body to make the book a technological prosthetic space (45–50).
Although never published, Blake’s *Four Zoas* arguably parallels a networked text environment with a nervous network.

41. Qualia is about the perception and simulation of subjective differences, which threaten to exceed function, and therefore resist reduction. Lisa Feldman Barrett may offer leads here. She defines emotions as our individual constructions of reality but recognizes that to have force in the world, they need “social reality,” which requires “collective intentionality” (134–38).

42. Bruce Wexler argues that social interaction is most important for brain development. See chapter 3 of *Brain and Culture*.

43. Since the relationship of the correlation to causality is always vexed, emergentism may more positively function as a kind of epistemological modesty or bracketing so long as it avoids ontological emergentism and the claim that the emerging complexities will never be known. Although the intentional and qualitative properties of our experience appear to be fundamentally incommensurate with brain matter, this appearance may only speak to the limits of what we can know through our senses. Ontological emergentism is best supported by the idea that complex interactions are more than the simple aggregates of the component parts.

44. Stengers reminds us that although “emergence” began as a weapon against reductionism, “any weapon can be used against its inventor” (*Cosmopolitics II* 209). Ultimately since emergence cannot be disentangled from questions of reductionism, she argues that we must reject thinking in terms of “a judge who has no need of a terrain because he knows ahead of time what that terrain has to say” (233).

45. Edelman and Tononi explore how the nervous system can be integrated and differentiated at the same time. Consciousness is experienced as unified (through “binding”) yet is subdivided into individual components (111–12). The subtitle of their study of consciousness is *How Matter Becomes Imagination*.

46. Though syneresis normally requires the elision of one of two contiguous vowels, it is a normal process in which a poet attends to the regularizing of a syllable count. See the *New Princeton Encyclopedia of Poetry and Poetics* (1993).

47. Schliefer argues that wholeness is a quality and function of discourse (xxii), locating the absolute in the tropes that gesture toward it.

48. Nagel cautions that “emergent” does not merely baptize our own ignorance (371). He uses the example of hydrogen and oxygen, whose individual properties do not predict the properties of water.

49. Derek Sankey comments that, “neurologically, we need other selves to become truly our self” (176–77). He overcomes the reduction of the self to neurons by thinking in terms of multiple levels that maintain autonomy. John Savarese argues that literary imagining is “a thoroughly social, outward directed activity” (439).

50. Gigante reminds us that “originally, the concept [of epigenesist] stood for a gradual, internally motivated process of morphogenesis, commencing from what might be called an epicenter” (7). In pointing radically to the external influence upon genetics, Changeux’s definition, I suggest, is more in keeping with Blake’s. Gigante is quite right to pit epigenesis against preformationism, but she limits epigenesis to “the capacity to deviate from given structures, to harness an internal formative power and branch off on its own during the developmental process” (121). The formative power is internal but very much shaped by the external.
51. Philosopher of science Ernest Nagel argues that reductionism is always temporally qualified even though it is rarely treated so: the reduction has to work with the science of the time (363). Ricoeur argues that “mental experience implies the corporeal, but in a sense that is irreducible to the objective bodies studied by the natural sciences” (Changeux and Ricoeur 15). Changeux responds that qualia have nothing to do with metaphysics, but rather with “an epigenetic signature stabilized in our patterns of cerebral organization” (18). Because Changeux allows for consciousness, Ricoeur does not see him as a “reductionist” (19). Nonetheless Changeux’s bent is toward the collapse of a dualism of discourses of body and mind, whereas Ricoeur’s is tilted toward an “agnosticism” toward such a collapse.

52. Schuchard notes that, on his visit to England in 1744, Swedenborg turned to a dream journal to encode “his political fears with psychoerotic explorations” (William Blake’s Sexual Path 77). The parallel is suggestive for The Four Zoas. James Hyde’s Bibliography of the Works of Swedenborg notes that the London Universal Society published a syllabus of eight pages, “proposals for printing by subscription, Emanuel Swedenborg’s Spiritual Diary” (631). I thank Marsha Keith Schuchard for suggesting that I take a look at this source. Peter Otto (“Drawing Lines”) argues that Swedenborg is the key to understanding sexuality in The Four Zoas.

53. Blake here anticipates the work of philosopher Evan Thompson, who criticizes the “standard neuroscience conception of the dream state as a form of delusional hallucination.” Instead, he argues that dreaming is a “kind of spontaneous imagination” (xxxvi). Thompson’s larger project is to think of the hypnagogic state, the state between waking and dreaming, as one that might give neuroscience unparalleled access to consciousness, especially consciousness that includes nonconscious cognition.

54. I am indebted here to a passage in Chemero (43). By radical embodiment, Chemero means to do away with the idea that the mind works through mental representations. He thus sees the environment as directly providing affordances, spurs to action. Chemero is helpful for understanding Blake insofar as the poet does not automatically distinguish between mental representations and embodiment: his imagination is modeled on a kind of electrical mental fire.

55. Thus, the important neurologist Robert Whytt wrote, “The influence of the mind over the body seems much greater than is commonly imagined, and it is not to be confined to voluntary motion, and has a prodigious effect upon such operations in animal economy as are most involuntary and of which we are not least conscious” (“Proposes” file 6). He argued that “different impressions on the thinking principle” alters the quantity and quality of the secretions (ibid.).

56. Alan Richardson notes that for Charles Bell “reductionism could be avoided without resort to a unified, conscious, transcendent subject; the soul could be preserved without minimizing the claims of the body” (British Romanticism 31).

57. For information about this work, signed by Blake, see John Windle’s Catalogue. Therein, Robert Essick and G. E. Bentley confirm this copy was Blake’s (1).

58. The neuroscientist Jaak Panksepp acknowledges Blake in his chapter “Energy is Delight” in Affective Neuroscience. Feeling energetic feels good, and thus emotion is tied to energy.

59. Finger credits Swedenborg with having “anticipated the birth of modern cortical localization theory” (29). Of course, these volumes, dated 1744, languished in
manuscript form until the Victorian period (1882), and thus Blake could not have read them. See Hyde 96–97. However, Blake and Catherine did attend the Swedenborgian church in 1789, and Blake annotated three of his theological works. On the church, see Schuchard, “Secret Masonic History.” In one of those works, Swedenborg compares his ideal conjugal love to the two hemispheres of the brain, covered with one meninges (Sketch 58). In another, Divine Love and Divine Wisdom, Swedenborg describes “innumerable substances and forms in the brain, in which every interior sense, which hath relation to the Understanding and the Will, resides” (35). He adds, “The principles of life are in no other place than where the beginnings of the [nervous] fibres are” (346). In Treatise on the Nature of Influx; or, Of the Intercourse of the Soul and Body, Swedenborg blames “ignorance of the offices and formation of the brain” for the idea that “perceptions and cogitations of the mind present themselves to us in organized forms” (52). I do not know whether any of Swedenborg’s followers in London had access to these manuscripts, but Swedenborg writes extensively on the brain in his 1795 True Christian Religion. He refers to the human brain as a “Form of Divine Truth and Divine Good” (242). I am arguing that Swedenborg’s writings on the brain offer a useful heuristic. On the vexed relationship between Swedenborg and Blake, see especially Otto, chapter 6, Blake’s Critique; and Schuchard, William Blake’s Sexual Path 78–79.

60. I am indebted here to Lauren Berlant, Cruel Optimism, 23–26.
61. Lincoln errs when he claims, “As the circle of destiny is woven into Enion’s web, faith becomes fatalism” (74). Enion tries to force the web to mean one thing, but, since the nerves are vital, they resist such impositions.
62. Blake may have derived this image from William Smith, MD. In Smith’s 1768 A Dissertation Upon the Nerves, he wrote, “The soul is placed by the Almighty in the sensorium of the brain; as a centre in a circle, the nerves are radii, proceeding from that centre” (60). Nicholas Culpeper spoke of the “nervous circle” of the diaphragm in his 1795 English Physician and Complete Herbal, thereby hinting at some kind of feedback mechanism. My point here is that although Bell’s use of the nervous circle is the most defined connection to a feedback mechanism, this way of thinking about the nerves was present in neurological discussions long before Bell. Ault suggests that in Night 4, “even the word ‘circle’ has disappeared from the text along with its binding power” (Narrative Unbound 163). As feedback mechanism, the circle’s binding power becomes more nuanced.
63. Could this have been an early example of brain plaque, now thought to be responsible for Alzheimer’s?
64. Lincoln calls attention to the polypus as a hydra, a lower life form. His point is that the image signals how materialism kills even the idea of redemption (246–47).
65. Blake revises the means through which Christ achieves human redemption. In FZ (N9 E391: 220–24), he writes:

Because the Lamb of God creates for himself a bride & wife
That we his Children evermore may live in Jerusalem
Which now descendeth out of heaven a City yet a Woman
Mother of myriads redeemd & born in her spiritual palaces
By a New Spiritual birth Regenerated from Death
Instead of highlighting Christ’s death, Blake here makes Christ’s gift the ability to have sex and give birth. In this way, joy replaces sorrow.

66. See Kreiter; and Gilpin.

67. From 1800 to 1803 when Blake was living in Felpham, he had access to William Hayley’s library. According to Munby, Hayley owned a copy of An Inquiry into the Nature and Origins of Mental Derangement (1798). In that work, Crichton writes, “If symptoms of hypochondriasis are alleviated, no delusion follows: from which it appears that the disease (delirium) is not permanently seated in the brain” (1: 192).

68. Lincoln intriguingly suggests that vales are symbols of faith “that must sustain the mind in the fallow periods between creative activity” (231). This complicates Vala, making her a symbol of faith on the cusp of delusion, so that faith must be questioning, not automatic.

69. Here, one should keep in mind Ngai’s point that envy is not necessarily about a lack in the subject feeling it but rather about a perception of inequality (126–27).

70. In Night 1, Blake recognizes that summer heat can make people vulnerable to delusion: “delude by summer’s heat they sport in enormous love” (E310: 9).

Chapter 3: The Physiological Imagination

1. Peterfreund shows how Coleridge develops his ideas of energy with Saumarez’s help (109–11). Coleridge’s interest in physiology was sustained. Speaking of imagination later in his Logic, Coleridge warns that “a delusion might result, and in many cases necessarily would result, if the knowledge supplied by anatomy or physiology were wanting” (135). Schlutz argues that Coleridge turned to religion “to overcome conflictual models of the relation between reason and imagination” (216). I show how complex this struggle was because religion left epistemological questions of its own.

2. Early on in the Biographia, Coleridge insists that even the wildest odes have a logic (1: 9). Barrell argues that Coleridge’s famous definition works to sublimate fiery political rhetoric surrounding imagination (epilogue), and I would suggest that physiology gave him tools to try to do so.

3. Thus Kant’s Philosophy of Material Nature (1783) begins with the question of whether “such a thing as metaphysics itself is at all possible” (1). There he also stipulates, “The imagination may perhaps be forgiven for occasional vagaries and for not keeping carefully within the limits of experience, since it gains life and vigor by such flights and since it is always easier to moderate its boldness than to stimulate its languor” (317). If boldness leads to error, it also indicates vitality, and the problem with vitality is that it is more difficult to stimulate than to contain.

4. Alice Snyder argues that the vitalism controversy raised the issue of the value of hypothesis itself (20). While Einstein thinks of laws as deeply imaginative, Stengers critiques physical laws insofar as they defy ecological thought and rely on states, which falsely abstract dynamic phenomena (Cosmopolitics I 87–97).

5. Marilyn Butler’s preface to Frankenstein claims that Mary Shelley worries about how a principle of life lacks experimental consequences and “yields nothing” (Frankenstein xix). As Coleridge recognizes, however, if phenomena can legitimately be correlated to principles, the principles can have scientific weight.

6. In-text citations to Coleridge’s Philosophical Lectures are to Coburn’s edition unless otherwise noted. Physician John Gregory submitted, “The imagination, like
every thing in nature, is subjected to general and fixt laws, which can only be discov-
ered by experience . . . It requires the talents of a person of the most enlarged knowl-
edge of Mankind, to reduce its laws to any kind of system” (Comparative View 2: 98).
Of course, one man’s natural laws could be another’s hooey. Recall William James’s
review of Charles Darwin: “The only ‘law’ under which the greater mass of the facts
the author has brought together can be grouped seems to be that of Caprice” (cited in
Müller-Wille and Rheinberger v).

7. Jaegwon Kim shows how today’s brain science makes correlations more robust by
insisting upon their lawlike-ness. The correlation between mind and brain “must have
lawful regularity and therefore are not just co-occurrences” (J. Kim 92). During Roman-
ticism, by contrast, the gap between correlation and identity, partly thanks to Hume,
was the engine of skepticism. In Diotima’s Children, Beiser argues that Baumgarten
is able to see sensation as having both subjective and objective aspects because “they are
a fact about me, because they are my states of awareness, and because they represent
nature from my standpoint” (141). These remarks may shed light on Coleridge’s stance
to sensation.

8. Mitchell shows how Coleridge’s approach to life followed Hunter, in requiring a
fundamental shift in mind-set from life as thing to principle (90–92).

9. Schelling allows scientists to have genius. As Robert Richards notes, genius is
possible on the condition that the “creative scientific act initially comprehended a
whole [system].” Genius in scientific creativity could also be inferred when the individ-
ual “formulates ideas that he could not have understood fully” (Conception 163–64).
Science as collaborative process would inevitably extend the range of any useful idea.

10. Robert Richards reminds us that Kant stipulated genius as the “talent which
gives rules to art.” Yet, since that talent belongs to nature, it is nature that gives the
rules to art (Conception 70). This formulation further suggested that physical deter-
minism and human freedom were mutually possible (ibid.), even as it reminded his
audience that both art and science ultimately needed to align with human cognitive
powers. The problem is that although “the biologist judges an organism to be purposive
according to a specific plan of which he can become aware, . . . the art critic
judges the painting to be purposive, but cannot specify the plan or rules by which the
beauty has been produced” (71).

11. Vickers helpfully situates Coleridge’s use of opium within the context of the
main physiological theories surrounding it; as he makes clear, every therapy required
the testing of theories of what opium actually did to the body (chapters 4 and 5).

12. Kant writes, “Reason is tremendously concerned not to abandon the mecha-
nism nature [employs] in its products, and not to pass over it in explaining them, since
without mechanism we cannot gain insight into the nature of things” (CJ 411).

13. See Pamela Edwards, The Statesman’s Science, especially chapter 5. She argues
that Coleridge distinguishes between the material moral world and the ideal moral law,
in order to provide fixed principles that he defined as assertions one ought to make
(116). Material and ideal, however, operate less as binary opposition and more as con-
tinuum. She also helpfully suggests that, for Coleridge, Christian moral law was not
provable by experiment or concept (116).

14. Pamela Edwards argues that a transcendental idea was for Coleridge not
possible without an embodiment in the world; whether idea referred to thing or merely
 correlated to a thing is another question. Coleridge submits in his Philosophical
 Lectures that even a “perfect theory” “can never produce more than probability”
 (359–60).
 15. Criticism thus has ironically never taken seriously enough the provisional status
 of the imagination and its objects. Class shows that one of Kant’s key mediators in
 Britain, F. A. Nitsch, argued that “our notion of free will is not contradictory or
 imaginary” (42).
 16. Coleridge understands facts as being based on laws of human nature such as the
 fact that we have a conscience. In defining fancy as “a mode of memory, emancipated
 from the order of time and space” but nonetheless beholden to “the law of association”
 from whence it receives all its materials, Coleridge made even fancy part of science.
 To wit, he insisted that it was “modified by that empirical phenomenon of the will”
 (BL 1: 305).
 17. See John Gordon’s chapter “Doctor Wordsworth.”
 18. An important work that labors to subject imagination to science is Samuel
 Hibbert’s Sketches of the Philosophy of Apparitions (1824). Hibbert dismisses all meta-
 physical accounts of apparitions, including the existence of a faculty called Phantasia.
 Instead, he argues that “apparitions are nothing more than ideas, or the recollected
 images of the mind, which have been rendered as vivid as actual impressions” (61).
 He then applies Humphry Davy’s nitrous oxide experiments to hypothesize that a
 physical change in the blood is the reason why these images get elevated over real
 images (67–69).
 19. Coleridge praises Saumarez for his “masterly force of reasoning, . . . the
 copiousness of his induction,” and especially for having “(in my opinion) subverted
 the tyranny of the mechanic system in physiology” (BL 1: 163).
 20. I. A. Richards is worth recalling here. Speaking about how Coleridge draws
 the line between fancy and imagination, Richards remarks, “The importance and the
 persistence of the purpose, and the utility of the distinction, establish the line, and it
 has no other establishment” (76).
 Here he acknowledges how “external evidence” acquires force “from previous
 speculative convictions or presumptions” (ibid). Stabler reminds us of the primacy
 Priestley put on speculation, though even he thought that speculation without
 experiment was “the bane of true philosophy” (181).
 22. Good historical overviews of physiology include Cunningham; Rothschuh;
 Temkin (all entries); Larson; Jacob; Schofield (Mechanism, chapter 9); Jacyna; Beiser;
 Lenoir; Richards (Conception); G. Rousseau (NA); Gigante; and R. Mitchell. Lenoir
 argues that Kant’s take on purposiveness influenced physiology, while Beiser and
 Richards argue that most physiologists rendered purposiveness into an actual cause.
 How God is imagined to be present in the universe is the subject of Amos Funken-
 stein’s brilliant Theology and the Scientific Imagination. On speculation and science,
 see Robert C. Stauffer, who shows how Orsted, on the one hand, speculated about a
 unity of forces and, on the other hand, recognized that the theory of unity demanded
 all the more rigorous experiments to prove them.
When dealing with the “wild Imaginations” of the geologists, Coleridge himself linked “Fancies, Hypotheses, wild Imaginations . . . , even as Women of suspicious virtue are the first to cry out W— —; for they themselves can be acquitted of wild Imaginations on no other plea, than that their hypotheses are too wild even to be imagined” (CL 4: 804).

23. Kant labeled “the distinction between truth and hypothesis, and the bounds of the reliability of the latter” as “constitut[ing] the physiological doctrine of method” (PMN 308).

24. To successfully cure speech impediments, Thelwall argues the imagination is key: “Interest . . . the imagination; leave nothing obscure or unaccounted for; . . . give him a system on which he can see and feel that he may depend” (59).

25. Pamela Edwards highlights that Coleridge believed mankind to be fallen, and the cause of the fall was a “diseased will,” further raising the stakes of physiology (119).

26. The influential teacher of physiology William Cullen noted that physiology encompassed mind and body.

27. John Gregory, by contrast, linked theory and genius/imagination to their mutual detriment: “Men begin to be weary of theories which lead to no useful consequences, and have no foundation but in the imagination of ingenious Men” (Comparative View 1: 123).

28. Robert Whytt insisted that only persons of very sensible nervous systems could be affected violently “by force of imagination” (“Proposes”). He later argued that “nervous diseases occasioned by strong impressions on the mind are often prevented, lessened, or cured by exciting other sensations or passions of a superior force . . . Epileptic fits are prevented by whipping” (file 5). Whytt named sympathy the general principle of all the activities of the body, and, as Neil Vickers notes, gave sympathy an Enlightenment pedigree by making it a “mechanical principle” (27).

29. On mesmerism and tractorism, see Harrington; Winter; and Delbourgo (both entries) especially. Harrington calls attention to how mesmerism replaces Christian demonic possession with Newtonian animal magnetism (42).

30. See Bender 288–89. Bender considers how eighteenth-century novels range within the “domain of experience governed by experiment” (288). In the period, experiment could not govern, because it was associated with mere empiricism and the dirty work of one’s hands. Bender, working through Dear, argues that experiment made knowledge “contextual, specific, and historical” (289), and I would add simply that these criteria could be a strength or weakness. The Romantic insistence upon feeling allows us to ask to what extent is reproducibility paradoxically about the feeling of conviction: that moment within experience when one senses the experiment has been reproduced.

31. Noel Jackson highlights Lord Kames’s interest in how the ideal experience of imagination enables a kind of shared virtual experience. See Science and Sensation 85–86.

32. Volta and Galvani began what we now understand to be electrophysiology, but the science of electrophysiology could not be fully in place until the invention of electrometers that could detect the electricity of nerves.

33. See Alan Richardson, British Romanticism and the Sciences of the Mind.

34. See Science and Spirituality: The Volatile Connection.
35. In his “Preface on the Law of Life,” Coleridge wrote, “Many of the worst errors
and bewilderments in the History of Physiology have arisen, and still rise, from mis-
taking this Ens logicum for an Ens reale, a somewhat existing out of the mind” (SWF
1: 575).

36. Holton argues that “hypotheses can never be altogether purged of their origin
in the fallible human imagination” (118). Beiser argues that the need to police a hard
and fast line between Naturphilosophie as a corrupt metaphysics and Kant has had
the unfortunate effect of “exagerrate[ing] the speculative and a priori dimension of
Naturphilosophie, as if it had no concern with observation and experiment, while it
downplays the metaphysical interests of those engaged in observation and experiment”
(“Kant and Naturphilosophie” 10). I would add that, crucially, in Romantic science
metaphysics and experiment were not yet framed as an either/or, but this did not mean
that then scientists did not have to justify their metaphysics.

37. Coleridge objected to how Malthus tried to make a physical limitation the
ground of a moral problem, which was for him an “immorality” (P. Edwards 139).

38. Coleridge classified Bacon and himself as Platonists (P. Edwards 142).

39. Vickers suggests that Coleridge’s and Wedgwood’s and Darwin’s experimental
failures had a silver lining: these men could present themselves as the very pinnacles
of scientific eminence insofar as they were scientific visionaries, “more sublimely
insightful than experimentalists” elsewhere (121). Steinle argues that experiments were
not necessarily theoretically driven in the period and thus could be more speculative
and exploratory.

40. In Creating Romanticism, Ruston relies on Wordsworth’s use of fact to distin-
guish science from poetry (7–8). My introduction argues why facts cannot serve this
function. Here Coleridge and Saumarez seek to elevate science beyond mere facts.
Although Levere claims that “facts were one refuge from the thinking disease,” I show
how Coleridge would never have assented to that claim. Levere’s suggestion that “the
subordination of metaphysics to a practical goal” was another refuge (Poetry Realized
39) makes more sense.

41. P. Edwards suggests that for Coleridge, “personal” referred not to an atomistic
individualism but rather to the obligations of the personal will to the civic common-
wealth (114). In this instance, Coleridge may be alluding to the obligations between
individual experiment and experiment as a collective enterprise.

42. See Mensch, who argues that Kant turns to organicism as a heuristic for thought
because it allowed him to get away from preformed rules that would put an end to free
thought. Rules could then arise epigenetically (10–13).

43. Jonathan Smith points out that those wanting to raise the prestige of hypothesis
had to struggle with Bacon’s and Newton’s hostilities toward it. They thus recontextual-
ized this resistance, showing how their practices obviated their denigration of it, or
insisted that Bacon and Newton only decried certain kinds of hypotheses (28–29).

44. Daston and Galison tend to stress imagination as a coquette of pleasure (224).
They are right that “vanity seduced natural philosophers into abandoning reality for
systems wrought by their own imaginations” (224). Nonetheless, the inculcation of
modesty and the idea that hypothesis has no business tangling with the physical nature
of things made it possible to think about how to discipline imagination into scientifi-
cally useful forms. Orsted makes clear the tightrope that hypothesis (read: imagination)
walks in the period: “As a tentative hypothesis, such a bold conjecture may be tolerated as it might lead to the discovery of what was previously unknown even though it should be regarded as misleading” (“Introduction to General Physics” 299).

45. Reid further argues that hypotheses tend to bias the impartial scientist. Moreover, although simplicity is what allows one hypothesis to triumph over another, Reid insists that nature is complex (Laudan 90–91). The stranger in Humphry Davy’s *Consolations in Travel* once again links imagination and hypothesis when he tells Onuphrio, “I beg you to consider the views I have been developing as merely hypothetical, one of the many resting places that may be taken by the imagination” (9: 295).

46. Reid is a precursor of Popper, though of course Reid is influenced by Hume’s “problem of induction.”

47. Class reads the *Biographia* as Coleridge’s attempt to define himself as a Kantian genius who did not need learning but rather imbibed the truth spontaneously (chapter 6). In highlighting Kant’s reception as a radical in England, she shows how Coleridge helped transform Kant’s and his own reputation into a conservative.

48. Knight argues that Davy thought hypotheses had heuristic value. The problem with atomic theory for Davy is that it could not offer candidates for truth (*Atoms and Elements* 31).

49. Levere records that in Coleridge’s scrofula essay, he ridicules the notion of an improved hypothesis when “fancy has been made more active than reason” (*Poetry Realized* 46).

50. Cairns Craig explains that association has received a bum’s rap. He argues that “association may be the fundamental principle of the human mind but it does not remain the same in its operations through time: it is a self-enhancing, self-developing process which necessarily grows in complexity as long as the mind is able to recollect and reactivate past experiences” (16).

51. As Nancy Goslee recognizes, Shelley’s statement that “the deep truth is imageless” is not a denial of the image’s powers but rather “a denial of their claims to an absolute transcendent authority that would . . . deny human creativity” (2–3).

52. Coleridge later writes in *Logic*, speaking of the images of imagination, “The several sciences of hydrostatics, aerology, crystallography, and chemistry, preceded and accompanied by a knowledge of pure mathematics, may be all required in order to legitimate judgment on a single phenomenon, i.e., before the image can be safely declared to possess objective reality—before it can be received with safety as a fact of experience” (135).

53. Timothy Lenoir has noted that the physiology of the time used a variety of teleological arguments, but what they have in common is a recognition of “the special status of biological phenomena and their ultimate irreducibility to physics and chemistry” (9). One strand connected sensibility and irritability to Newtonian forces, but this had the unfortunate effect of reducing physiology to blind forces (ibid.). Another strand dictated that vitalism was an emergent property of biological organization. A third strand, inspired by Aristotle, argues that the universe is fundamentally biological (10).

54. Hence, he stipulates that “intelligence” or “self-consciousness is not a kind of being, but a kind of knowing, and that too the highest and farthest that exists for us” (*BL*
1: 285). Earlier Coleridge toed the Kantian line when he insisted, “We learn all things by occasion of experience; but the very facts so learnt force us inward on the antecedents, that must be pre-supposed in order to render experience itself possible” (1: 142).

55. Timothy Lenoir argues for the influence of what he calls teleo-mechanism during the Romantic period, which intertwined cause and effect so as to make them inextricable from one another. I think Blumenbach eventually gets there, but here he resists it.

56. Empirical evidence is rarely self-evident. Blumenbach must make a case for Bildungstrieb and then show us where and how to look for it. Levere argues that the Bildungstrieb virtually became a model for the imagination, “raising questions about the relation between imitation and imagination” (Poetry Realized 37).

57. Coleridge borrows from Hume the idea of the self as a vantage point from which to see relationality (THN 310).

58. Though Robert Mitchell argues that Coleridge’s “individuation” is about “emergence, rather than of distinction” (92), my point is that since emergence for Coleridge requires the will, the two will not stay distinct.

59. Barth on Coleridge and miracles and laws is helpful here. He argues that Coleridge did not want miracles to flout natural laws, and yet he wanted laws to be a divine sign that excited wonder (120–21).

60. Scholarly consensus is that Coleridge disagrees with Kant’s thing-in-itself, adopting Schelling’s skepticism of it. That may be true, but it leaps over much nuance. The passage cited in the Biographia is thus: “In spite therefore of his own declarations, I could never believe, it was possible for him [Kant] to have meant no more by his Noumenon, or thing in itself, than his mere words express; or that his own conception he confined the whole plastic power to the forms of the intellect, leaving for the external cause, for the material of our sensations, a matter without form, which is doubtless inconceivable” (1: 155). First, there are several errors here. Kant insists that things exist, only that we cannot know more than about their form. If appearances are real, it is not clear that Kant is invoking matter without form. Second, Kant analogizes from the ways we process experience the purpose for causality so that there can be some correspondence between subjective and objective, but this is a regulative use of a concept, not a constitutive one. Third, Coleridge is talking about his belief, and thus the standards of argument are not scientific demonstration. Yet my focus here is on what physiology tells him about scientific knowledge and the role of imagination, which must always be about more than mere belief. At very least, Coleridge recognizes that imagination requires some correspondence between the subjective and objective, and that the advantage of thinking about things in and of themselves is that it becomes more difficult to smuggle in qualitas occulta. Finally, when Coleridge discusses Schelling, he frames their relationship as a “coincidence,” which again resists identity (1: 160). His motivations are partly to defer the charge of plagiarism and the possibility of “an identity of thought” (1: 161), but plagiarism does not explain it entirely, given his patterns of denying identity throughout. Susan Lawrence argues that although scientists may have personally believed in immaterial souls and spirits, they frowned upon appeals to mind and soul within science, and they nonetheless carried on with experiments (330–31).
61. Coleridge comments that Kant in his moral philosophy “was permitted to assume a higher ground (the autonomy of the will) as a POSTULATE,” and thus he sees himself as following in Kant’s footsteps on this specific issue (BL 1: 154).

62. Hanna argues that Kant recognizes how the freedom of the will cannot be scientifically known, but that he ensures its logical consistency with the “true synthetic a priori position which says that the total mechanical system of inert macrophysical material bodies in phenomenal nature . . . have deterministic temporally antecedent nomologically sufficient causes” (23). For Coleridge, if something cannot be scientifically proven, it does not escape the requirements of logic.

63. On Coleridge’s division between natural objects and idealism, see Perry, chapter 2. As Perry astutely recognizes, Coleridge mocked himself for his proclivity for retreating from external sense (49). He thus saw the value of the integrity of the otherness of things.

64. Where Barth and others read Coleridge’s “primary imagination” in terms of “a sacramental encounter with the mystery of the infinite” (144), I stress performativity and modesty.

65. He will also credit the “system of natural philosophy” with the unity of the absolute, “which is at once causa sui et effectus . . . in the absolute identity of subject and object, which it calls nature, and which in its highest power is nothing else but self-conscious will or intelligence” (BL 1: 285). Whatever unity ensues is the product of discipline, system. Note too that Coleridge insists that this unity is “called” nature.

66. Peter Dear reminds us in The Intelligibility of Nature that science was preceded by natural philosophy, and the goal of natural philosophy was understanding. During the seventeenth and eighteenth centuries, Dear shows, instrumentality was coupled to the goal of understanding within natural philosophy (9–11).

67. Thus although Trevor Levere argues that for Coleridge “the law of the thing constituted its being and was the ground of its reality” (Poetry Realized 100), such designation would not allow Coleridge to distinguish between merely imagined laws and laws that could be corroborated somehow.

68. Coleridge’s response to Richard Hooker’s claim that “the assurance of what we believe by the Word of God, is not to us so certain as that which we perceive by Sense” is telling here. Coleridge argues, “God refers to our sensible experience to aid our will by the vividness of sensible impressions, and 2nd to aid our understanding of the truths revealed—not to increase the conviction of their certainty, when they have been understood” (CM 2: 1133). In turning away from thinking about sensible experience as a form of conviction and in moving sensible experience toward understanding, Coleridge makes space for free will because sensible experience is the work of understanding.

69. See Solomon.

70. P. Edwards argues that Kant thought that reason was hidden under the curtain of phenomena (146). She adds that “the Coleridgean Idea was a living, active thing in itself, something which formed and shaped the material world of phenomena” (ibid.). I would argue that, for Coleridge, reason understands that scientific proof must deal with the gap between phenomena and things, and that reasoned proof is not the same as experimental proof. Moreover, to have a useful idea of what the imagination can do,
Coleridge must refuse minting concepts as things, as this version of the Coleridgean idea can too easily do, or else physiology would constantly be smuggling in the imagination’s phantoms.

**Chapter 4: Obstetrics and Embryology**

1. It is worth recalling Veecher’s perceptive comment that Mary Shelley’s feminism was complicated by the fact that she saw “passivity as a trait essential to womanhood itself” (181). That means her feminism was also self-directed. See also Ruston on Romantic creation (*Creating Romanticism* 97–131). Where Ruston distinguishes imitation from reproduction, I consider how scientific theories of reproduction smuggled mimesis back in. For a feminist reading of the tension between procreation and creativity, see Susan Friedman. Huet argues that Romanticism invests in the idea of a single creator and appropriates monstrosity as a metaphor for the unique. She then argues Romantic criticism replicates “the very structure of monstrosity” insofar as it avoids the question of Percy Shelley’s involvement (159). I argue below that Mary Shelley’s take on the Romantic imagination was far more critical. Lee Edelman satirizes futurity’s reliance upon reproduction to model the future, but of course reproduction is creative in its recombinations of genetic material.

2. François Jacob captures the complexities of reproduction when he states that in “a mutation, there are causes which modify a chemical radical, break a chromosome, invert a segment of nucleic acid. But in no case can there be a correlation between cause and the effect of the mutation” (3). But Jacob tells a different story about the history of reproduction, perhaps because he is eager to isolate how generation became reproduction and thus could be studied as a science. He argues that, before the eighteenth century, reproduction was seen as individual creation, a kind of divine engendering. At the end of the eighteenth century, there was a shift to seeing generation as reproduction, and reproduction is defined as a mechanical procedure that science can get a hold of. Müller-Wille and Rheinberger comment about Jacob’s claim of a shift that “such creative acts did not have to presuppose a necessarily supernatural *creatio ex-nihilo*” (16). They add, “Yet whatever way one wants to understand creation, it is a concept that does not leave room for a distinction between hereditary transmission and individual development” (16). Development and inheritance thus were not two separate strands of research as they have become with the rise of genetics, which speaks to why I have linked them here. The current rise of epigenetics will once again bring these strands of research into consilience. But within Jacob’s narrative of a clear break between the episteme of creation and the episteme of reproduction lies generative crossings that come to light when one looks at how imagination is talked about as both mental conception and generation. Erasmus Darwin in *Temple of Nature* has a long note on hereditary diseases, in which he argues that asexual reproduction is much more likely to produce disease. Here, Darwin has anticipated the value of genetic differences. He ascribes the cause of hereditary diseases of sexual reproduction to excess drink. Choosing the most beautiful persons and ingenious minds will help improve sexual progeny (additional notes 52).

3. In Nancy Yousef’s study of Romantic autonomy, she highlights how philosophical accounts of mind abstract social contingencies while character develops out of
interactions with others. The issue of autonomy is complicated within embryology because, from the time of Aristotle through to Harvey and beyond, the embryo is considered autonomous, once procreated, “endowed with the capacity to nourish and fashion itself out of the materials provided by the maternal body” (Müller-Wille and Rheinberger 24–25). Yet, according to Keown, deliberate abortions were not generally prosecuted, because meaningful life did not occur until the moment of quickening, when the fetus’s movements could be felt.

4. I thank my colleague, Sarah Marsh, for this suggestion. Golinski argues that Priestley engaged in “literary exposition” designed to make his experiments reproducible (Science as Public Culture 77–82). Goethe discusses experimental reproducibility in his 1792 essay on experiment as mediator.

5. The midwife Jane Sharp associated the imagination with sexual desire: it “raised the yard” (21) and “stirs the clitoris” (37). Thus, without it, generation could not occur.

6. Murphy-Lawless demonstrates how the rationality of the man-midwife could be self-protective. One strategy was to make its errors a consequence of female labor as opposed to possible malpractice (86). She highlights the ways in which “obstetric knowledge” was a problematic construct in itself (194). Adrian Wilson argues that the replacement of female midwives by men-midwives in Hanoverian Britain can be explained neither by arguments of fashion nor by arguments about the forceps (Making of Man-Midwifery).

7. References to Frankenstein are to Marilyn Butler’s Oxford edition of the 1818 text. Butler’s edition lists the substantive changes to the 1831 edition, but in an appendix at the back.

8. Roe suggests that German embryologists like Blumenbach, Kant, and von Baer simply assumed organization and moved the discussion away from the source of organization. Embryology is so important because it is when genotype is expressed as phenotype.

9. According to Churchill, in 1819 von Baer repeated Pander’s observations on the chick, identified the notochord as a primary structure, and recognized that Pander’s primitive ridges were really neural folds that eventually marked the spinal column (5).

10. Vasbinder argues that Shelley models the monster’s development on Hartley, and in particular on his suggestion that cognitive development starts with sensation, moves to imagination, then to ambition, and finally to pleasure and pain (40–43). When Bonnet evaluates hypotheses surrounding generation, he “préfère un système dont la raison et l’imagination s’accommodent également” (3: 55).

11. Wellmann criticizes Roe for emplotting the history of embryology along a trajectory where problems are solved around 1800 (91–93). Instead, she argues that rhythm steps in to work through issues that were emphatically not solved. In her view, rhythm does the work of showing how the theory of development informed development itself.

12. I am indebted here to Roe and Pinto-Correia. The way in which the labors of female parturition was framed needs further examination. Galvani, for example, studied the anatomy of the uterus, emphasizing its nervous connections, endowing it with nervous sensibility rather than with mere brute muscular irritation. Female parturition was thus connected to mind. Haller mistakenly assumed that, since the yolk of the egg preexisted in the hen, that the embryo too preexisted (First Lines of Physiology 2: 206–07).
13. Malebranche argued when contemplating animalcules or little atoms, “The imagination is lost and confused at so incredible a littleness; it cannot catch the vanishing parts, nor take hold of them, as being too little to be grasp’d by it” (14). In this view, since the imagination is powerless to operate at the scale of many of the primary objects of generation, our ideas of them must derive from reason. As he outlines emboîtement, he contrasts the “finite and shallow [human] imagination” against the greatness of divine power: our failure to be able to imagine emboîtement speaks to the frailty of our powers (15).

14. By the end of the eighteenth century, Gasking notes that “preformationism was little more than a power to determine subsequent development” (167). In Alexander Crichton’s 1792 translation of Blumenbach’s An Essay on Generation, preformation has become “evolution” (5).

15. In Atkinson’s rhetorical analysis of the Royal Society’s Philosophical Transactions, he finds a reliance and centering on authors in the seventeenth and eighteenth centuries. Joseph Banks, in particular, sought to protect the society against the non-genteel (30–31). In the nineteenth century, he finds a move toward nonnarrative, scientific objects and more abstraction.

16. Youngquist argues that humanity is not conferred until one participates in civil society (54).

17. Maienschein submits that science alone cannot define when a meaningful life begins (10). On the legal history of abortion, see Keown. Keown argues that Lord Ellenborough’s act of 1803 criminalized pre-quickening abortions but made them into lesser crimes. Regular medical practitioners sought to downplay the common emphasis on quickening as the start of life.

18. John Hunter, for example, supposed that the “foetus in utero . . . does not sleep and has no sensation” (John Hunter’s Lectures from Mr Cline’s Notes, 1, 2).

19. In Humphry Davy’s Royal Institution “Notebook on Education and On Nitric Oxide, circa 1800,” he argues that the “perceptive existence of the infant” dates back to the feelings in the womb. “The spark of life has been kindled by a number of feelings perceived during the mysterious formation of organs” (3). In this view, the moment when life acquires dignity has been blurred. Musing on her own poverty in 1830, Shelley quotes Thomas Jefferson Hogg’s observation that one might as well “be a cabbage as poor” (Journals 516). She thus was acutely aware of the precarity of dignity.

20. Janice Cauldwell reads Frankenstein as a critique of materialist conceptions of sympathy within the medicine of the time, whereby sympathy is automatic and mechanical and predicated on identity. She suggests the gap between the monster’s ugly body and transcendent mind comments on how Romantic medicine struggled to find ways to allow mind and body to work together and to transform sympathy into an active engagement with difference (42). See her chapter 2.

21. A. Wilson argues that William Hunter sought not dogmatic rules but rather to regulate his practice as midwife according to careful observation (561). Hunter credited Haller’s observation on the congenital hernia for having “struck [his] imagination” (“William Hunter” 72). Haller’s observations helped Hunter to understand the descent of the testicle in the male fetus.

22. According to the patient daybook of surgeon George Furnivall, now at Cambridge University Library, Mary Shelley consulted with him on September 3, 13, 14 and
October 10, 1817, when she had another tonic, and again on May 10, 1819, when she had two ivory nipple shields, twelve teats, and three bottles sent to Rome. Her total account bill was nine pounds. On September 3, 1817, she ordered two shields and two teats, and on September 14 of that year, she had a tonic prescribed (204).

23. On the tenuous position of Scottish men-midwives, see Cody, chapter 6. “It was their ability to step back from the female reproductive body and objectively determine delivery strategy while empathizing with fears and pains of mothers . . . that made them superior attendants to traditional female midwives” (152).

24. My reading of how men-midwives feminized the imagination in order to exert authority over it is in keeping with Barbara Johnson’s insight that femininity is monstrous when it embodies contradiction (25), and thus Shelley represents “feminine contradiction from the point of view of its repression . . . in the gap between the angels of domesticity and an uncompleted monsteress” (ibid.).

25. Holmes (327–28) and Mellor argue for the centrality of Aldini’s experiments electrifying the heads of dead criminals. Holmes suggests Victor is modeled after the German physiologist Johann Ritter. For a study of how male poets like Pope turn to childbirth metaphors to spark revulsion, see Castle. In Romanticism, the rampant associations of imagination with nerves made the body no longer a necessary source of disgust. If the imagination were physiological, it had effects in the world. Castle also credits neoclassical poetics with an interest in aesthetic purposiveness (201–02), but that was perfectly in keeping with organic function. As she recognizes, in Romanticism, the association of creativity with birth becomes more celebrational.

26. In general, preformationist theories presented the embryo as if it were formed by only one parent, and so there was precedent for this hypothesis.

27. Here again facts cannot stand on their own because they are “assumed.”

28. For the anti-vivisection debates, see Guerrini.

29. For an astute reading of the gap between domestic ideology and the representation of domestic mothers in eighteenth century novels, see Francus. She asks why it was then so difficult to represent a domesticated mother and argues that the ideology tried to call the ideal into being and thus motherhood was itself monstrous (14–16). With regard to Frankenstein, Francus argues that Victor is the monstrous mother (44).

30. In a section of his Autobiography called “My Private Life,” von Baer confesses that he “never felt the slightest temptation to plan a short story, novelette, or still less, plan a novel or drama. Does that constitute proof of a lack of imagination?” (304). Von Baer defends himself from that charge. “But to take something swiftly shaped by the imagination, to hold it fast, slowly elaborate on it dress it in choice words . . . this has always seemed to me the most frightful slavery; that is, unless one intends to present a scientifically conceived opinion in a spirited, graphic and convincing manner” (305). Imagination has a role in science but a limited one: to provide a swift, albeit persuasive, delineation of a scientific opinion. Von Baer thinks the danger of being too beholden to imagination is a kind of slavery.

31. Caspar Wolff discovered that the intestinal tract and the nervous system share the same origin and commented, “This very marvelous analogy—not imagined, but based on secure observations—between parts that are so very different in their nature deserves the attention of the physiologist to the greatest degree” (cited in Wellmann 106). Wellmann notes that Wolff helped make embryology into a science by defining
development as a sequence that is governed by law and variable, filled with repetitions, but of nonidentical processes (107).

32. Devin Griffiths argues that what Darwin means by “rational analogy” is the conscious formalization of unconscious intuitions into conscious patterns (“Intuitions” 654).

33. Hanson thus argues that Shelley here considers “the potentially destructive power of an inadequate uterine environment” (49), and she proceeds to call attention to the darkness of the lab as the paucity of the environment. Are closed wombs not dark? Despite the fact that the monster is the size of an adult and does not grow physically, she connects Victor to epigenesis. I disagree and shall specify why below.

34. Bonnet submitted that the hypothesis of emboîtement startled the imagination without scaring reason (accablent l’imagination sans effrayer la raison) (Considerations 1: 2). In his later work, Essai Analytiques sur la Faculté de L’Ame, Bonnet granted imagination only the powers of reproducing ideas; moreover, “l’ordre dans lequel les Objets les auront faire naître, determinera celui dans lequel l’imagination les reproduira” (131). Imagination reproduces ideas in the order experienced and thus poses little threat to reason. Gasking notes that Haller objected to Buffon’s theory of organic molecules because it relied upon universal geometric patterns that could not account for the range of diversity (88, 108).

35. See Buffon’s Histoire Naturelle 2: 36.

36. In his long footnote arguing for the existence of the spontaneous vitality of microscopic animals, Darwin refutes Hill without naming him. He writes, “To suppose the eggs of the former microscopic animals to float in the atmosphere . . . is contrary to apparent nature” (TN 141).

37. Buffon writes, “On peut nous dire que cette expression, moule intérieur, paroit d’abord renfermer deux idées contradictoires, que celle du moule ne peut se rapporter qu’à la surface, & que celle de l’inérieur doit ici avoir rapport à la masse” (Histoire Naturelle 2: 35).

38. Goldstein argues that Darwin’s filament “is endowed not with self-organizing power but, like Blake’s malleable worms, with an exquisite, passive voice receptivity to influence” (Sweet Science 56). While Darwin does elaborate on the filament’s receptivity to stimuli, he also repeatedly calls it living and associates it with the nerves. I suggest then that susceptibility to influence does not cancel out self-organization, especially since responsiveness to stimuli is part of what it means to be living. Rather, the problem is a fantasy of life as a form of autonomy, in much the same way that political autonomy is a fantasy that ignores our social embeddedness.

39. Paula Feldman and Diana Scott-Kilvert, the editors of Mary Shelley’s journals, stipulate that Shelley was attended by the Clarke brothers. Shelley notes that she is visited by “Dr. Clarke.” John had been Mary Wollstonecraft’s obstetrician and was called in too late after she had contracted puerperal fever. Charles would later insist on the dangers of contamination through dissection and recommend the washing of hands, both of which might have saved Shelley’s mother. John retired in 1815 and died in August of that year, making it more likely that Charles attended Shelley in February of that year. Still, it must have been haunting for Shelley to be attended by either John or Charles. See Munk’s Roll of the Members of the Royal College of Physicians. John Clarke, Mary Wollstonecraft’s obstetrician, wrote one of the first studies of children’s diseases. In it,
he argued, “Information does not come by intuition or inspiration—the laws of nature, in health and disease, must be attentively studied in order to be well understood, and the life of any man, with every advantage of great experience and acute observation, is too short to admit of his adding much new matter to the general stock” (Commentaries 36). Clarke thus pleads for the institutional collection of information.

40. John Haughton warned of the need to distinguish between “life and action. Action is not life but only the effect of life” (“Physiology” 5).

41. Blumenbach warned that the living principle was “not to be imagined as belonging to dead matter” (Essay 61). The origins of life remain a problem. In trying to come up with an evolutionary account for consciousness, Antonio Damasio argues that single-cell organisms have “proto-feeling,” and that the neuron, as a special kind of cell that influences the behavior of other cells, develops somehow from single-cell organisms (273–74).

42. One strain of Frankenstein scholarship dismisses the science in the novel as pseudoscience (Vasbinder, Knoepflmacher), but the lines between these are more nuanced. Another strain identifies who Victor is supposed to represent (Holmes, Mellor). Peterfreund helpfully suggests that Paracelsus makes clear that natural knowledge is related to self-knowledge (“Composing”).

43. Bewell (“Issue”) argues that obstetricians granted power to the female imagination so that it can create monsters. Obstetricians of the Romantic period had largely debunked this idea, but that does not mean it simply disappeared. One question thus becomes, how does science change belief, and can it do so only insofar as it makes its truths felt?

44. Compare to Malebranche, who argued in Treatise Concerning the Search After Truth that the soul has three ways of perceiving: by the senses, by the imagination, and by intellect. “Now what she perceives by the senses affects her much, and takes up all her application; what she knows by imagination touches her less pathetically . . . the reason which may be given for this, is, that the senses represent the objects as present, the imagination represents them as absent” (43). Sharp argued that discontent disturbed imagination, which should be “pure in the act of conception” (110).

45. Vasbinder notes Paracelsus’s interest in the homunculus, which he understands to be an artificial man cultured in sealed glass (47). I am thinking of the homunculus in terms of the problem of Cartesianism, the brain that needs a little man with a brain to direct it. In an 1831 journal entry, Shelley wrote, “L’Ame n’en jouit qu’en passant—et sait bien qu’elle n’est pas tranquille que, par un tour d’imagination qu’il faudrait qu’elle conservat mais qui la gêne trop—de façon qu’elle en revient toujours a l’état qu’il lui est plus commode qui est d’être agitée [sic]” (Journals 514). Surrounded by ne que, the imagination only temporarily tricks the soul. Contrast her very careful bracketing of the imagination with Victor’s inability to bracket. Holton shows how the scientific imagination has oscillated from Dionysian to Apollonian poles (chapter 3).

46. Ludmilla Jordanova situates the novel within the decline of the “idiom of scientific heroism” (60), which provides another context for thinking about the imagination’s role in science. Victor very much wants to place himself in that heroic role and to be worshipped. Victor’s faults can also be chalked up to the fact that science was hardly collaborative then, as those who studied nature often worked alone (63).

47. Pinto-Correia shows that Paracelsus, one of Victor’s heroes, was a supporter of
preformationism and argues that he was the originator of the concept of emboîtement (33–35). He thought a perfect human embryo could be produced from male semen.

48. For a sustained reading of Darwin’s Temple as striving for organic happiness, see Janelle Schwartz (34–70). “Lacking any true experiential base, Darwin effectively manufactures one out of the analogue between nature enclosed under glass and the one that generates . . . swarms” (54).

49. In “The Rise of Classical Descriptive Embryology,” Frederick Churchill argues that the early embryologists’ theories of development betrayed a commitment to “a metaphysics of the organic and inorganic worlds, to a system of causation in mundane affairs, and to the structure of the cosmos itself” (1).

50. When Lavoisier showed respiration to be a form of combustion, Promethean covers inspiration. And when Cuvier called the organism a “furnace . . . to which dead substances are transported successively, there to combine together . . . and to escape one day and once more to become subject to the laws of dead nature” (cited in Jacob 91), he not only brought death and life together, but he also extended the range of the meanings of Promethean.

51. Yousef argues that the monster refutes Rousseau’s theory that man is naturally solitary (155).

52. On Darwin and the Eleusinian mysteries, see Primer; and Priestman. Friedman reminds us that Demeter’s “physical capacity to give birth serves as a paradigm of all origins” (53). See also Schwartz, who shows how Darwin turns to myth to secure what empiricism cannot (48–63).

53. Yousef connects the monster’s awakening to Locke and Rousseau, and notes that, in making the monster feel aloneness, Shelley refutes the doctrine of no innate ideas (152–54).

54. Yousef argues that Shelley thinks autonomy is an “artificial theoretical starting point for human development” (155). She also highlights that Locke misses the possibility that someone else’s experience might be different (154).

55. Cody writes that in the seventeenth century it was possible to find an accommodating female midwife who would suggest abortifacients. Society worried about women colluding with one another against men.

56. For Yousef, the monster’s size allows him to be “fantastically exempt from this state of infant dependency” (155). Evelleen Richards comments that “the majority of abnormalities or monstrosities were . . . to be attributed to an arrest of development, so that the organism remained fixed into one of those stages through which it ordinarily passed in the normal course of development” (“Political Anatomy” 380). This view allowed monsters to conform to natural laws as opposed to breaking them.

57. In Youngquist’s reading, the fault lies with the fact that he doesn’t have a proper normal body (48–52). More suggestive, I think, is that the monster’s bent on death develops the dark side of the history of medicine (55).

58. William Lawrence argued that “identity or similarity of cause can only be inferred from identity or resemblance of effect” (Introduction 171). My point is that how to make the comparisons useful was an open project.

59. The imagination thus might be considered partly in light of what N. Katherine Hayles has called the “cognitive nonconscious.” Her examples include termite mounds, algorithms that compose music, and how a grand chess master perceives
checkmate. The analogies this kind of cognition exploits are automatic, a product of neural mechanisms. Yet, despite this origin, it is ultimately how consciousness makes use of the nonconscious cognitions that lends value, and here that use is rightfully understood as creativity or science.