Mind, Brain and the Elusive Soul

Human Systems of Cognitive Science and Religion

Mark Graves

Ashgate Science and Religion Series

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MIND, BRAIN AND THE ELUSIVE SOUL

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Human Systems of Cognitive Science and Religion

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CHAPTER 1

Mind

What does it mean to be a human person?

Quite a demanding question to address in one book. Many people, including myself, spend their whole lives attempting to answer that question. Do any of us really succeed? Can we do more than piece together a few fragments of living and hope our lives tell a story? Even if one does answer the question for oneself, how can that answer the question for more than the individual?

This book attempts to answer the question. Of course, it remains a partial answer. I weave together snippets I learned from academic work and religious experiences. Threads from computer science, biology, and spirituality depict an image of a human person that thinks and prays in faith. Academically, the book lays out aspects of cognitive science and religion, but an academic answer can only serve as a partial answer. One needs insight into the human person, and according to the early twentieth-century pragmatic philosopher of religion, Josiah Royce:

> Insight is knowledge that unites a certain breadth of range, a certain wealth of acquaintance together with a certain unity and coherence of grasp, and with a certain closeness of intimacy whereby the one who has insight is brought into near touch with the objects of his insight. To repeat: Insight is knowledge that makes us aware of the unity of many facts in one whole, and that at the same time brings us into intimate personal contact with these facts and with the whole wherein they are united. The three marks of insight are breadth of range, coherence and unity of view, and closeness of personal touch.[1]

No scholarly book provides intimate personal contact, and with a single author the breadth of range remains quite limited, but hopefully I will provide coherence and unity of view over a moderate range of topics that currently appear fragmented in the existing literature.

The insight comes at a cost. One might hope that after examining many partial answers, one could arrive at a single synthesized answer to the meaning of the human person, or at least for *a* human person, namely oneself. But this book systematically describes why no single coherent view of the person can be known or even exists. Understanding the complexity of the human person requires multiple coherent views that unify only in their relationship to each other. The topics of mind, brain, spirit, and soul do cohere in surprising yet unified ways, but one must surrender remnants of overly simplistic nineteenth-century science and overly romantic nineteenth-century religion to unify and cohere knowledge of the person with contemporary findings of

1 Josiah Royce, *The Sources of Religious Insight* (New York: C. Scribner’s Sons, 1912), pp. 5–6.

quantum mechanics, chaos theory, the Human Genome Project, neuropsychology, (post)modernism, and religious plurality.

In the twenty-first century, insight into the human person requires a new question: how does a human person become meaningful?

By shifting questions, one loses static categories of essence to gain dynamic processes of stability. Those stabilizing processes end only when a person's life ends, and thus the dynamic process of becoming underlies the static perception of being. If one searches for a fixed, static essence of the human person, one finds nothing. Slow-moving change results in the appearance of permanence, but only the different rates provide stability. The changes of civilizations and species over centuries and millennia provide stability to the individual life. The changes of a person over years and decades provide stability to a person's daily life. But, conversely, one defines oneself and thus gains "meaning" through the choices one makes in each daily decision. One's daily decisions define the decisions of one's entire life. The decisions of one's life define one's community, and the daily decisions of every person's life in community define what it means to be a human person.

Although one loses a static ground for one's individual life, each individual meaningfully defines an aspect of what it means to be human for all humanity, and with what we know from chaos theory, such as the "butterfly effect," even a very small change can have great impact, and each individual has the potential to significantly influence what it means to be a human person. Before I begin highlighting the individual threads of human cognitive science and religion beginning with the "mind," I close the introduction slightly apologetically, though perhaps appropriately, with a quote from Christian scripture:

> For those who want to save their life will lose it, and those who lose their life for my sake will save it. (Luke 9:24, NRSV)

Philosophy of Mind

What is meant by mind? Is mind a human characteristic, natural phenomena, or both? How do religious, philosophical, and theological perspectives on mind along with body and soul identify the human person?

The mind does not exist, at least not in isolation. Cognitive scientists may refer to the mind as embodied, and brain scientists have described many aspects of the mind as embodied in and through the brain.[2] The human mind exists embodied in one's brain and body and situated in a particular culture, but "mind" isolated from those relationships is an illusion based upon modern interpretations of the seventeenth-century philosopher René Descartes, who wrote of separation between mind (or soul) and body:

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2 Michael S. Gazzaniga, Richard B. Ivry, and G.R. Mangun, *Cognitive Neuroscience: The Biology of the Mind* (New York: Norton, 2nd edn, 2002); Francisco J. Varela, Evan Thompson, and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge, MA: MIT Press, 1991).

> If I had only ceased to think, although all the other objects which I had ever imagined had been in reality existent, I would have had no reason to believe that I existed; I thence concluded that I was a substance whose whole essence or nature consists only in thinking, and which, that it may exist, has need of no place, nor is dependent on any material thing; so that "I," that is to say, the mind by which I am what I am, is wholly distinct from the body, and is even more easily known than the latter, and is such, that although the latter were not, it would still continue to be all that it is.[3]

However, scientists and scholars now understand that thinking does depend upon a material thing, namely the brain, and that it also depends upon the categories that one learns from others in one's culture which one uses in framing and interpreting one's experience.

How does the human mind exist embodied through the brain and culturally situated?

When approached from the perspective of one's body, one discovers the brain. When approached from the perspective of one's experience and one's cultural interpretation of that experience, one discovers one's mind. In isolation, both remain incomplete descriptions. The brain by itself cannot explain mental activity, and the mind does not exist without a brain. Neither does culture or the mind exist independently of each other.

Mind–Body Problem

In his book *Mind: A Brief Introduction*, contemporary philosopher of mind John Searle examines the nature of the human mind. How does one give an account of humans as apparently conscious, mindful, free, rational, social, and political agents in a world where some interpret science as telling us reality consists entirely of mindless, meaningless, physical particles? What does it mean to be human, and how do we fit into the rest of the world? Philosophy of mind addresses these questions because mental phenomena form the bridge by which the individual connects with the rest of the world.[4]

In the modern era, philosophy of mind begins with the work of Descartes. In Descartes' doctrine of dualism, called "substance dualism," the world divides into two different kinds of substances or entities that can exist on their own: "mental substances" and "physical substances." Descartes believed that a substance has to have an essence or an essential trait to make it the kind of substance that it is. The essence of mind is consciousness or "thinking"; and the essence of body exists in being extended in three dimensions in physical space, which he called it "extension." (In Descartes' Latin terminology the distinction is between *res cogitans* and *res extensa*.) In the seventeenth century, Cartesian dualism seemed to divide up the territory between science and religion and partially diffused the apparent conflict between faith and reason by giving the material world to the scientists and the

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3 Rene Descartes, *Discourse on the Method of Rightly Conducting the Reason, and Seeking Truth in the Sciences* (1637), Part IV.

4 John R. Searle, *Mind: A Brief Introduction* (Oxford and New York: Oxford University Press, 2004), pp. 9–13.

mental world to the theologians. Minds were considered immortal souls and not a proper topic of scientific investigations, whereas bodies could be investigated by such sciences as biology and physics. For Descartes, each of us as a self is identical with his or her mind. A living human being is a composite entity, comprising both a mind and a body, but for each person the self, the object referred to by "I," is a mind that is somehow attached to the body. One knows both the existence and the contents of one's mind by a kind of immediate awareness, which Descartes summarizes in his famous sentence, *Cogito ergo sum*: "I think therefore I exist." Gilbert Ryle, a twentieth-century philosopher of mind, satirizes Descartes' view by calling it "the ghost in the machine." Each person is a ghost (one's mind) inhabiting a machine (one's body). For Descartes the "I" refers to one's mind, the mental substance that constitutes the essential me. Searle, Ryle and many others argue that Cartesian dualism is not a philosophically acceptable account of the nature of the mind, at least in part because of the arbitrary distinction between mind and body, and the lack of explanation as to how the two realms connect.[5]

If the mind is separate from physical objects, how do the mind and body affect each other? In philosophical terms: how can there be causal relations between the mental and the physical? For philosophers, it seems impossible that causal relations should exist between two completely different realms—the physical realm of extended material objects and the mental realm of mind. How does anything in the body cause anything in the mind? How does anything in the mind cause anything in the body? Yet every time one perceives, the world influences the mind; and every time one decides to act, the mind influences the world. For the dualist, two sets of problems occur: How can anything physical produce an effect inside one's mind or soul, which is nonphysical, and how can events in one's mind or soul affect the physical world. The inability to explain these causal relationships forms the "mind–body problem."[6]

Self, Intentionality, Free Will

For those who reject substance dualism, there is still a serious question left over: what exactly is the self?

Philosophy of mind explores several philosophical issues around the nature of the human person. What is the self, and how does it retain its identity over time and changes? The mind seems different from other physical objects. One's mind appears to make free choices and can think "about" a variety of real-world and imagined objects. If the mind is only a certain type of physical object, what makes it different from other objects that cannot be "about" something? What does it mean to decide anything?

The early twentieth-century American philosopher and early psychologist William James understood the self as the sum of all that one knows oneself to be and self-awareness as a stream. The self has two aspects: an "I" that experiences continuity and a "me" that is rooted in bodily existence and captures the sum total of

5 *Ibid.*, pp. 13–16.
6 *Ibid.*, pp. 17–18.

the perceived world claimed as part of the self. James considered three dimensions to the "me." These three dimensions of the "me" are sets of perceptions that filter how we sense the world. The three dimensions are:

1. *Material* "me" is my perception of my physical, body-centered world, such as body, clothes, home, and physical possessions with which I heavily identify.
2. *Social* "me" captures my role in interpersonal relationships, such as family and other people who matter to me.
3. *Spiritual* "me" includes the entire collection of my states of consciousness, such as my thoughts and feelings.

However, James's split between "I" and "me" does not adequately explain how the continuity and change connect in the self. What are the criteria by which one forms a personal identity? What exactly is the subject, an "I," to which one attributes these criteria? Contemporary studies of the brain indicate processing related to the self, but much work remains, especially with respect to subjectivity or consciousness.[7]

From a philosophical perspective, the mind–body problem relates to intentionality. *Intentionality* is a technical term used by philosophers to refer to the "capacity of the mind by which mental states refer to, or are about, or are of objects and states of affairs in the world other than themselves." If one has a thought, it is a thought about some object or state of affairs in the world. The same is true of beliefs, desires, hopes, fears, and perceptions. In each case the state refers beyond itself. Intending, in the ordinary sense in which one intends to do something, is another kind of intentionality among others. How can a mental state refer to or be about something beyond itself? Two related problems of intentionality include: How is intentionality possible at all? And given that it is possible: How is it that intentional states have the specific contents they do have?[8]

Another place the mind–body problem arises is the question of free will. One has experiences of deciding between alternatives or doing one thing, when one could have easily done something else. One takes these as indications of free will. But the question arises: does one genuinely have free will, or is it only an illusion? [9]

How does the physical give rise to the self, intentionality, and free will? When scientists examine the brain closely in a variety of experiments, they learn much about perception, learning, memory, action, planning, and certain other mental phenomena, but not as much about self, intentionality, or free will. What differs between mental phenomena best understood in terms of the brain and those that extend beyond the brain?

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7 *Ibid.*, pp. 280–81. S.J. Gillihan and M.J. Farah, "Is Self Special? A Critical Review of Evidence from Experimental Psychology and Cognitive Neuroscience," *Psychology Bulletin* 131(1) (2005): 76–97.

8 Searle, *Mind*, pp. 28–30 (28). As the book defines several technical terms in a variety of fields, some of which identify core concepts of the book and other which identify a peripheral topic, I distinguish via "quotes" terms only used in the current section and via *italics* terms that will occur in later chapters. Although for the uses later in this book, one can think of intentionality as simply the capacity of thought to be "about" something.

9 *Ibid.*, 23–25.

A better question than trying to locate mind within or outside of brain is: what provides meaning to the self and how do brain processes contribute? The prior question assumes the brain exists as a fixed structure, not a slowly changing process, and although that assumption leads to knowledge about perception in the brain, the knowledge cannot help one gain insight into all mental processes. By considering the brain in the human body and cultural context, one gains insight about self and deeper insight into perception.

Intentionality or "aboutness" captures Descartes' important observation that the mind, unlike a rock, can think about something else, and free will identifies that people make decisions. They each identify aspects about the mind—a certain type of abstract quality and ability to make decisions—that add meaning to the human person as does the sense of continuity ascribed to the subjective "I." I will revisit these aspects later in this chapter and throughout the book, and explain that addressing the mind–body problem requires recognizing the biological processing of the brain. Dead bodies do not have minds, and the mental depends upon biological processes, not just static biological structures.[10] However, reframing mind requires re-examining (and reinterpreting) the construct of "soul," and that requires examining the relationship between science and religion.

Science and Religion

Although many people find questions of the person best framed in philosophy, academically, others turn to religion to frame questions of existence, purpose, and meaning. Christian theologians draw upon both philosophy and the Christian tradition to frame and ask those questions.

Descartes drew insight from the ancient Greek philosopher Plato to separate mental from physical and provided independence for physical sciences from religious entanglement and persecution. However, now that physical sciences have progressed in physical and biological understanding of the person, they bump against the artificial separation created by Descartes. Apparent conflicts between mind and body, and also science and religion occur because of different presumptions. Reconciling those apparent conflicts requires re-examining historical philosophical frameworks in which they arose. Presuming a Cartesian split (i.e., after Descartes) between mind and body leads to a mind–body problem that need not occur in other philosophical systems. Presuming a Cartesian split between body and soul leads to conflict between science and religion that need not occur. I argue that re-examining the thought of Plato's student Aristotle can bridge the Cartesian gap between mind and body.

10 John R. Searle, *Minds, Brains, and Science* (Cambridge, MA: Harvard University Press, 1984).

Soul as Form of the Body

When people talk of "soul," they typically refer to a separate essence of a person that may or may not leave the body upon death. Although a disembodied soul remains very popular as a Christian belief, Christianity has consistently held to belief in the resurrection of the body. Saint Irenaeus of Lyon in the second century wrote against the heresies of the Gnostics, who believed in the elevation of spirit over matter. The Christian Scripture, Roman Catholic Church, Orthodox traditions, and the Protestant Reformers teach resurrection of the body, not a dualistic separation of the soul. However, by interpreting the soul as separate in a Platonic sense, the body as separate in a Cartesian sense, and "separation" in the sense of nineteenth-century physics of mechanisms, twenty-first-century European–American Christians (and those influenced by them) have lost the connection between body and soul that made resurrection central to early Christian belief.[11]

What ever happened to the Christian body? People often see science and religion as in conflict, especially in contemporary American culture. In a book on cognitive science and religion, one might suppose I would take one side of the conflict and dismiss the other, even if done respectfully and subtly. Although science and religion may prove challenging to reconcile in general, no intrinsic conflict exists between cognitive science and religion. The conflict occurs between cognitive scientists who forget they study cognition, not the physical brain, and Christians who forget they believe in resurrection of the body, that is, like Christ, not a disembodied soul. When one studies cognition in a Christian body, no conflict exists.[12]

Previous attempts to integrate science and religion on the soul often have occurred, such as by the medieval philosopher and theologian Thomas Aquinas who drew upon the Christian Bible; the influential fifth-century Christian, Augustine; the recently rediscovered works of Aristotle and Islamic commentaries brought back from the Crusades; and other sources to articulate what became the Roman Catholic position on the soul.[13] Thomas Aquinas' psychology addressed conflicts among his contemporaries between medieval science, philosophy, and religion with the reincorporation of Aristotle, but many of Aristotle's and Aquinas' presuppositions have been questioned and some shown incorrect, such as Aristotle's static universe (by Big Bang cosmology), the unchanging nature of species (by evolutionary biologists), and a priori metaphysics (by the eighteenth-century philosopher Immanuel Kant). Current findings in *cognitive neuroscience*, that is, brain scientists

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11 Joel B. Green, "Bodies—That Is, Human Lives: A Re-Examination of Human Nature in the Bible," in *Whatever Happened to the Soul? Scientific and Theological Portraits of Human Nature* (ed. Warren S. Brown, Nancey C. Murphy, and H. Newton Malony; Theology and the Sciences; Minneapolis, MN: Fortress Press, 1998), pp. 149–73.

12 Brown, Murphy, and Malony (eds), *Whatever Happened to the Soul?*; Nancey C. Murphy, *Bodies and Souls, or Spirited Bodies?* (Current Issues in Theology; Cambridge and New York: Cambridge University Press, 2006).

13 Thomas Aquinas, *Summa Theologica* I.75 (New York: Benziger Bros., 1947); available online at http://www.ccel.org/a/aquinas/summa/home.html (accessed 27 November 2007). For an overview, see Robert Edward Brennan, *Thomistic Psychology: A Philosophic Analysis of the Nature of Man* (New York: Macmillan, 1941).

studying cognition, and in social psychology call into question presuppositions of theology based on prior theories of the human person, such as having separate spiritual powers of will and reason, however other aspects of Aristotle and Aquinas reconcile the Platonic and Cartesian split between body and soul.[14]

Aristotle's teacher Plato provided the philosophical context for both Aristotle and Thomas Aquinas. *Platonic form*, or essence, occurred in the realm of Ideas that later Platonists by the second century associated with the mind of God. Aristotle and Aquinas define the soul as the substantial form of a living body.[15] For Aristotle, the *substantial form* is the first principle or act of a natural body, which together with primary matter (or pure potency) comprises a substantial being.[16] Thus a living body requires both a substantial form, which explains what kind of thing it is, and primary matter, which explains its potential for becoming something else. The soul informs the whole substance, and it is through the form that each part of the organized, living being exists.[17] The soul provides the radical source of activity by way of the powers of the soul.[18] For Aquinas, the powers of the human soul included nutrition, growth, and reproduction (like plants); sensation and appetites (like animals); and intellect and will. Rather than essence as Platonic form, essence requires both substantial form and primary matter, avoiding dualism and allowing the form to inform the person, but without all of its power, when separate from the body. (In Chapter 2, I reinterpret form as information that constrains possibilities of existence.)

This book examines the soul as a form of the body for four reasons.

1. A better understanding of the soul as the form of the body may help relate biological, cognitive and theological perspectives on the human person.
2. Scholars are reinterpreting Aristotle's form and causation, especially formal and final causation, to address self-organization and emergence in biological systems and that work may prove useful to understanding the human person.
3. Thomistic philosophy impacts on conservative Catholic thought which impacts on the remainder of Roman Catholicism which in turn impacts on the rest of Christianity and especially ecumenical dialogue and ethics.
4. Biblical literalists claim a separate soul at death but do not address how that soul could interact with the body (the critique of Cartesian dualism). Although Protestant fundamentalists do not draw on Aquinas, Aquinas provides a philosophically sophisticated understanding of the soul that addresses the biblical statements which the biblical literalists value.

As forms were static in substance, they could change, for example, as a seed grows into a tree, but they could not evolve. Evolutionary biology, quantum mechanics,

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14 For a thorough survey of the history of soul in Western thought, see Paul S. MacDonald, *History of the Concept of Mind: Speculations About Soul, Mind, and Spirit from Homer to Hume* (Aldershot and Burlington, VT: Ashgate, 2003).

15 Aristotle, *De Anima II* 1.412a20.

16 *Ibid.*, 412b5.

17 Aquinas, *Summa Theologica* I.76.8.

18 *Ibid.* I.5.5; I.80.1.

Big Bang cosmology, and now cognitive neuroscience have demonstrated the fundamental role of change in nature, but have they dismissed form?

Certainly the Platonic notion of form has no toehold in Western scientific thought (though it still has utility in art which captures and communicates the form). Aristotle saw the form as immanent in reality, not separate from it, but retained its fundamental static nature of "being" with change as secondary. But if form need not be static and pre-existent as Plato taught and Aristotle and Aquinas continued to believe, and instead describes the slowly changing or evolving patterns in natural phenomena, then science has falsified Platonic form and clarified Aristotelian form as the information-bearing content of natural systems (examined in Chapter 2).

Barbour's Typology of Science and Religion

Examining the relationships between human mind, spirit, body, and soul involves insights drawn from both science and religion. The eminent scientist–theologian Ian Barbour describes four relationships between science and religion, which I will use to relate cognitive science and religion: conflict, independence, dialogue, and integration.[19]

Conflict occurs between science and religion from the two perspectives of scientific materialism and biblical literalism. *Scientific materialists* believe "all phenomena will eventually be explained in terms of the actions of material components, which are the only effective causes in the world." Thus, science can explain everything and religion has no purpose. For example, Carl Sagan argues that nature replaces God as an object of reverence; Daniel Dennett defends a strong neo-Darwinist position that humans are the product of a mindless, purposeless process; sociobiologists such as E.O. Wilson argue that one can explain social sciences, including religion, completely in terms of the brain and evolution; Richard Dawkins claims nature uses chance and natural selection only and that God does not exist; and Patricia Churchland argues that neural activity sufficiently explains all mental activity, including philosophy and religion.[20]

Biblical literalists, on the other hand, hold as inerrant a literal interpretation of Scripture, and thus science is mistaken when it contradicts Scripture. Thus, science may be useful, but it is secondary. Biblical literalists argue against evolution and propose creationism which describes a literal reading of the Genesis creation story. Biblical literalists interpret passages such as "Before I formed you in the womb I

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19 Ian G. Barbour, *Religion and Science: Historical and Contemporary Issues* (San Francisco: HarperSanFrancisco, rev. edn, 1997). Scholars have subsequently refined Barbour's typology, such as introducing confirmation, consonance, or creative mutual interaction to replace integration.

20 *Ibid*., pp. 78–82, 243. Patricia Smith Churchland, *Brain-Wise: Studies in Neurophilosophy* (Cambridge, MA: MIT Press, 2002); Richard Dawkins, *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design* (New York: Norton, 1996); Richard Dawkins, *The God Delusion* (Boston: Houghton Mifflin Co., 2006); Daniel Clement Dennett, *Consciousness Explained* (Boston: Little, Brown and Co., 1991); Carl Sagan, *Cosmos* (New York: Random House, 1980); Edward O. Wilson, *Sociobiology: The New Synthesis* (Cambridge, MA: Belknap Press of Harvard University Press, 1975).

knew you" (Jer. 1:5) as indicating the existence of a person prior to the body, and they interpret passages such as "the dead were judged according to their works" (Rev. 20:12) as indicating the existence of a person after the death of the body.[21]

Conflict often occurs with the prioritizing of one field and devaluing the other, such as Churchland's claims that humanity reduces to neural activity, and the biblical literalists' interpretation of Bible passages about the person as indicating a soul or spirit separate from the body.

Independence avoids conflict between science and religion by viewing the two enterprises as independent and autonomous.[22] Each uses its own language and methods to attend each area of life and thought. Independence may function in some areas of science and religion—few church-going scientists struggle between routine experimental methods during the week and the content of liturgies on Sunday. However, independence fails to address issues where overlap between scientific and religious perspectives of the person occur, especially those issues around birth and death, including abortion, stem-cell use, patient-determined death, and removal of feeding tubes.

Dialogue portrays the relationship between science and religion as interacting with each other in conversation; the fields relate more closely than independence, but not as close as integration. Barbour identifies three diverse areas of dialogue. First, science raises "limit questions" or "boundary questions" that the methods of science do not answer, such as ethical issues, Karl Rahner's transcendence, and David Tracy's presuppositions of scientific inquiry. Second, science and religion have "methodological parallels" such as paradigms, the effect of the observer on an object of observation, Michael Polyani's personal participation of the knower in all knowledge, and the role of judgment, theory, and beliefs on observation. A third group describes the experience of a religious dimension in nature, such as Thoreau, more recently Matthew Fox's creation-centered spirituality, or many environmentalists. Dialogue around consciousness often brings together a variety of scientific and religious beliefs and perspectives, such as the Institute of Noetic Sciences, *Journal of Consciousness Studies*, the Center for Consciousness Studies, and various conferences on consciousness. Dialogue provides a forum for the exchange of ideas from each discipline. For example, John Polkinghorne presents religious and scientific perspectives on the end of the world—a topic neither field can definitively address alone.[23]

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21 Barbour, *Religion and Science*, pp. 82–4, 243–4.

22 *Ibid.*, p. 84

23 *Ibid.*, pp. 90–98; Matthew Fox, *Creation Spirituality: Liberating Gifts for the Peoples of the Earth* (San Francisco: HarperSanFrancisco, 1991); Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1958); J.C. Polkinghorne and Michael Welker, *The End of the World and the Ends of God: Science and Theology on Eschatology* (Theology for the Twenty-First Century; Harrisburg, PA: Trinity Press International, 2000); Karl Rahner, *Foundations of Christian Faith: An Introduction to the Idea of Christianity* (New York: Seabury Press, 1978); Henry David Thoreau, *Walden* (1854); David Tracy, *Plurality and Ambiguity: Hermeneutics, Religion, Hope* (San Francisco: Harper & Row, 1987); John Polkinghorne, *The God of Hope and the End of the World* (New Haven, CT: Yale University Press, 2003).

Barbour's fourth approach claims *integration* of the content of theology and the content of science. He describes three versions of integration: natural theology, theology of nature, and systematic synthesis. Natural theology begins with science and claims that the existence of God can be inferred from the evidence of design in nature. For example, Thomas Aquinas offered several arguments for a first cause; the Anthropic Principle in cosmology indicates a very narrow range of cosmological constants necessary for life and has been used to support arguments for "fine-tuning"; and Ilya Prigogine and Stuart Kauffman's works on self-organization provide a model for a patient God enabling the emergence of free creatures. A theology of nature begins with religious experience and reformulates traditional doctrines in light of science. Arthur Peacocke suggests God constrains the events of the world without violating its laws; John Polkinghorne and others have proposed that God communicates information to the world; and Teilhard de Chardin suggests a convergence of evolution of greater consciousness toward an "Omega Point."

A third version of integration occurs as *systematic synthesis* if both science and religion contribute to a coherent worldview elaborated in a comprehensive metaphysics. Although metaphysics occurs in the purview of philosophy rather than science or religion, it can serve as an arena of common reflection. Thomas Aquinas provides one such metaphysics, though Barbour argues that process philosophy holds more promise. (I discuss process and pragmatic metaphysics in Chapter 7).[24]

In both the dialogue and integration, Barbour suggests philosophy should mediate between science and religion.[25] In this book, I focus on integration and a systematic synthesis of aspects of the soul where both science and religion lay claim, namely the soul as it inhabits the body, and occasionally indicate other areas where fruitful dialogue might occur. The systematic synthesis requires a pluralistic worldview to understand the variety of relationships comprising the integrative soul. Although integration results in a coherent worldview, its comprehensive and unified metaphysics is intrinsically relational and requires a community of interpretations to comprehend. Specifically, I take a systems approach to science, a pragmatic approach to philosophy with neo-Aristotelian and process influences, and an anthropological approach to theology—terms the remainder of the book explains.

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24 Barbour, *Religion and Science*, pp. 98–105, 246–7; P.C.W. Davies, *The Mind of God: The Scientific Basis for a Rational World* (New York: Simon & Schuster, 1992); Freeman J. Dyson, *Disturbing the Universe* (New York: Harper & Row, 1979); Stuart A. Kauffman, *At Home in the Universe: The Search for Laws of Self-Organization and Complexity* (New York: Oxford University Press, 1995); Arthur Robert Peacocke, *Theology for a Scientific Age: Being and Becoming—Natural, Divine, and Human* (Minneapolis, MN: Fortress Press, enl. edn, 1993); I. Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (Toronto and New York: Bantam Books, 1984); Robert J. Russell, William R. Stoeger, and Francisco J. Ayala, *Evolutionary and Molecular Biology: Scientific Perspectives on Divine Action* (Scientific Perspectives on Divine Action, 3; Vatican City State and Berkeley, CA: Vatican Observatory, Center for Theology and the Natural Sciences, 1998); Pierre Teilhard de Chardin, *The Phenomenon of Man* (New York: Harper, 1959).

25 See for example, Robert J. Russell, *Fifty Years in Science and Religion: Ian G. Barbour and His Legacy* (Ashgate Science and Religion Series; Aldershot and Burlington, VT: Ashgate, 2004).

Creating a systematic synthesis involves finding coherence and unity in the methods and practices of scientists and theologians. In the desire to understand nature, scientists simplify what they study and run the danger of overly reducing the phenomena they study to impoverished parts. In the desire to understand aspects of faith, theologians attend to the ineffable and run the danger of under appreciating the filters and limitation imposed by the human mind.

Scientific Parsimony

A desire to understand the world drives science; and to understand the complexity of the world, scientists typically simplify it. Simpler explanations of nature tend to more accurately describe nature, in part because the human mind orients toward understanding nature. The medieval philosopher Occam stated what has become known as "Occam's razor," that one should strive for the simplest explanation: "Plurality should not be posited without necessity … One should not increase, beyond what is necessary, the number of entities required to explain anything."

Those who emphasize the science in science–religion interactions often value the proven benefit of simplicity in explanations. They view religious explanations as needlessly complicated because simpler explanations suffice to explain the observable phenomena. History has often shown that the simpler explanation proposed by those who value science has proven more accurate than the older ideas retained by religious authorities. Examples include Copernicus, Galileo, and Darwin. The emphasis of rationality over religion dates back to the Enlightenment and the eighteenth century, and led to what now appears as an overemphasis on rationality in the nineteenth century. However, at least four problems occur with the position that values the simplicity of science over religion.

The first problem involves misunderstanding simplicity. Science values simplicity, but explanational simplicity depends upon the presuppositions, theories, models, paradigms, and language used in the explanation. Scientific materialists and others who prioritize the value of physics to explain the natural world assume biology and other disciplines reduce to physics, though the simplest explanations of biology occur using the concepts and theories of the biologist, not the physicist. The word "reduce" means to make smaller, or in this case, to discover the primitive constructs; but "simplify" means to uncomplicate. Scientific materialists (and other "reductionists") confuse the two terms.[26]

A second problem occurs with oversimplification. Occam's razor suggests simplifying as much as possible, but no further. Sometimes people simplify too far and lose necessary aspects of what is studied, leading to impoverished categories inadequate to model the phenomena.[27]

A third problem happens when scientists ignore alternative principles. Simplicity describes an important principle in science, namely parsimony, though other principles are also important: accuracy, coherence, comprehensiveness, fertility,

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26 Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: Belknap Press, 1982), pp. 59, 62–3. I investigate reductionism in Chapter 3.

27 Examined further in Chapter 4.

applicability, and predictive power. For C.S. Peirce and other pragmatists (described in Chapter 7), the important principle is how the understanding of nature affects one's ability to use that knowledge in practice. A scientist does not value a simple explanation if it cannot be used to do more science.

A fourth problem arises from a category mistake. In a category mistake, one confuses a property of an entity with the whole, for example, confusing the buildings or faculty of a university with the whole university. In religion one may confuse beliefs about nature or reality as a whole and religious beliefs with some natural property. One may distinguish between religious beliefs that depend upon nature existing in a particular way and scientific models used to explain otherwise independent religious beliefs. Those who value religion over science often value tradition. Some traditions include beliefs that one can now identify as superstitious and discard. Other traditions use nature to help explain beliefs and often involve outdated science, and those explanations need revision, but the beliefs do not change. One should distinguish between invalidating religious beliefs that directly depend upon a particular theory of nature and a better understanding of religious beliefs because of a correction of scientific theories. For example, learning that the earth is round rather than flat invalidated the religious belief of four angels responsible for the four directions, while replacing the Ptolemaic model with Copernican views of the solar system led to a better understanding of humanity in the universe (our world is not the center), and only strengthened a belief in the beauty and majesty of creation. As scientists should have more current views of science than theologians (or anyone else), the updating of religious beliefs involving nature based on recent findings in science is part of a necessary interaction between disciplines, not an invalidation of religion. Similarly, new newspaper stories on scientific findings describe corrections in the presuppositions used in older newspaper stories about science, but they do not invalidate journalism.

Conflict, in Ian Barbour's typology, occurs when non-scientists use terms such as consciousness and quantum mechanics, but ignore the analytical aspects of science. Thus for integration to occur between science and theology on the human person, theology must work within the analytical framework presumed by all current sciences. But, science must also acknowledge an aspect of religion.

Religious Ineffable Possibility

A desire to participate in something more than the individual helps to drive a person's involvement in religion. The twentieth-century theologian Paul Tillich calls a person's faith a person's ultimate concern, and the twentieth-century Roman Catholic theologian Karl Rahner refers to divinity as mystery. Religious language is often limited by the ineffability of concepts such as a God, transcendence, ultimate concern, and mystery, and a commitment to religion in the science–religion dialogue often includes a commitment to ineffability. Although mystics have often tried to describe the ineffable, they also claim those descriptions prove lacking. Theology itself requires a balance similar to the dialectic between science and religion leading to synthesis. In the theologians' desire to understand God's relationships they must constantly reaffirm human inability to understand God. However, God could very well desire humans to know God more fully, and only our limitation within the relationship causes the appearance of ineffability. The commitment to ineffability as a characteristic of God and spirituality likely has roots in the nineteenth-century romantic turn to the self as a reaction against the overly rational movement that had grown after the Enlightenment. A mistaken commitment to ineffability as a characteristic of God's nature, rather than a commitment to God revealing Godself to humanity, leads to conflict with science's desire to understand the world.[28]

Developing a unified view of the human person requires honoring both sciences' commitment to understanding the world using the simplest framework possible and religion's commitment to something greater than the natural world. Although science requires a pluralistic view of the person, acknowledging the possibility of the "super" natural religion helps unify them. Scientific explanation and faith are compatible, complementary, and interdependent.

As this book explores in depth later, pragmatic philosophy provides a framework for capturing both the actual entities existing in the world, their general configurations, and the real possibilities, which are not yet actualized (Chapter 7). For example, human blood carries oxygen through the body by binding it to iron in the protein complex *hemoglobin*. The four proteins that comprise the protein complex hemoglobin organize in precise configuration to carry iron molecules between them; however, hemoglobin does not contain iron and thus a reductionist account of hemoglobin could only describe an empty space in the middle of the hemoglobin polypeptide and cannot capture the role that iron plays in filling that space (Chapter 4). Pragmatism describes both the proteins of hemoglobin and the real possibility that iron would fit in their natural configuration. Likewise, the person is constituted such that its material relationships may be understood by science, but the person as a whole cannot be fully understood without reference to religion in general and the soul in particular. Examining the actual relationships constituting the person requires a plurality of theories and methods, but incorporating the real possibilities inherent in those relationships allows for a systematic synthesis and unity of view. The soul, from a natural perspective, appears as an empty space, but without acknowledging the relationships of the soul, the self cannot be fully understood. One may best understand the self by examining the organization of the body in its social, cultural, and spiritual context from a rigorous scientific perspective, and the soul as the apparent empty space within the constraining relationships that enable real possibility (Chapter 8).

The twentieth-century American writer and Roman Catholic monk Thomas Merton has written extensively on the experience of ineffability. Merton describes the apparent emptiness as a fullness of mystery that positively transcends our perceptions. For Merton, the Christian's "true self" finds God in and through simple daily experiences and contact with others. He contrasts the true self with a "false self" rooted in psychological misperceptions and created of egocentric desires that separate the person from God in an illusionary, self-proclaimed autonomy.

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28 Rahner, *Foundations of Christian Faith*; Paul Tillich, *Dynamics of Faith* (New York: Harper, 1956); Claude Welch, *Protestant Thought in the Nineteenth Century* (New Haven: Yale University Press, 1972).

Relinquishing the perceptions of the objective self to which the false self is attached releases the illusions. Individuality asserts itself in humility. The true self is hidden in (or towards) the mystery and is not knowable; in a way similar to how God is unknowable. Merton writes: "Our reality, our true self, is hidden in what appears to us to be nothingness and void … the way to reality is the way of humility which brings us to reject the illusory self and accept the 'empty' self that is 'nothing' in our own eyes and in the eyes of [others], but is our true reality in the eyes of God."[29]

Similarly, Paul Tillich, in his discussion of the Christian doctrine of creation from nothing (*creatio ex nihilo*), distinguishes between the absolute negation of being (*ouk on*) and a relative negation of being (*me on*). In Tillich's theology, out of emptiness, God created a space of infinite possibility before creating the existing world. Similarly, a person's creation of the self occurs in a place of possibility. Tillich writes: "being a creature means both to be rooted in the creative ground of divine life and to actualize one's self through freedom."[30]

Similar themes of possibility also occur in science. In biology, a "totipotent" stem cell has the potential to become any type of cell, but it does not yet act as a particular cell. In physics, while a classical vacuum is empty, a quiescent quantum field has no existing particles, but has the possibility of particles coming into existence.

This book occurs in the tension between science's need to simplify and religion's need to leave open worlds of possibility. Although new options for dialogue between science and theology have become available, prior lessons about dialogue and integration still apply. Philosophy has proven a useful tool for dialogue and integration between science and theology, and the dialogue between cognitive science and religion needs a comparable tool. Luckily, cognitive science provides such a framework with its integration of psychology, neuroscience, and philosophy.

Cognitive Science and Religion

Cognitive Science

In the 1970s, several researchers recognized that different disciplines studied the "representational and computational capacities of the mind and their structural and functional representation on the brain," however few researchers knew much of the results from other disciplines. The Sloan Foundation commissioned a study to organize the research results; initiate an autonomous science of cognition, called *cognitive science*; and highlight areas of promising research (as the foundation had recently done for neuroscience to improve dialogue among brain researchers). Several

29 Thomas Merton, *New Seeds of Contemplation* (Norfolk, CT: New Directions, 1962), p. 281. In Chapter 8, I draw on Merton to describe the orientation of the soul toward either the true or false self.

30 Paul Tillich, *Systematic Theology* (Chicago: University of Chicago Press, 1951), vol. 1, p. 256.

prominent researchers met and discovered several interactions between philosophy, artificial intelligence, neuroscience, philosophy, linguistics, and anthropology.[31]

Since then, investigators have expanded the social perspective from anthropology to include other social sciences; located artificial intelligence within the broader discipline of computer science; and expanded the interactions between the six disciplines to explore most, if not all, pair-wise combinations of fields. Several projects have incorporated three or more of the disciplines, and although cognitive scientists typically choose methods only from their "home" discipline, the topics have become more integrated.[32]

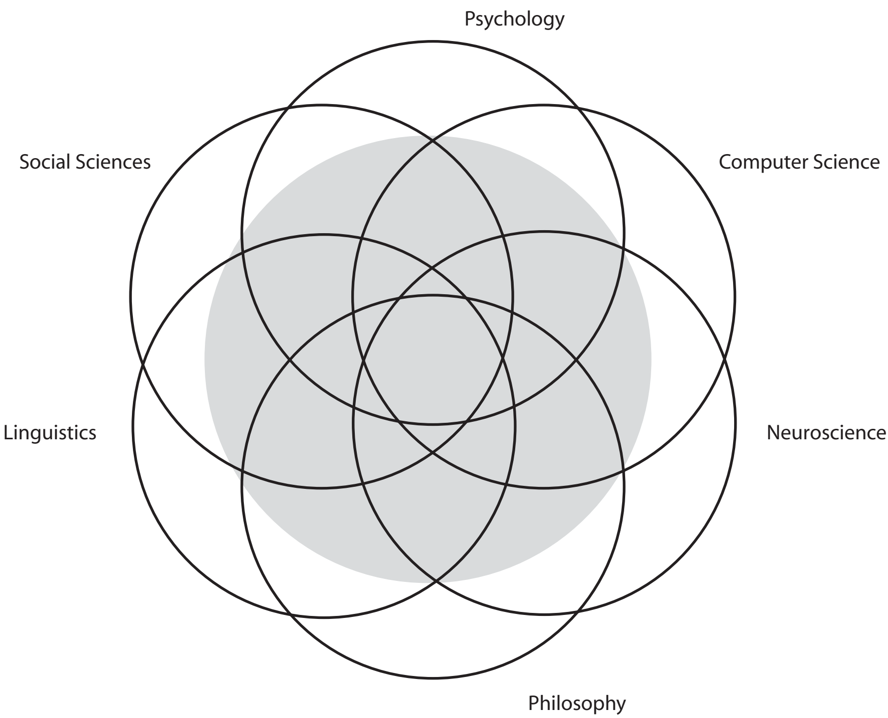

Figure 1.1 Overlap of six disciplines in cognitive science

Figure 1.1 illustrates the six disciplines of cognitive science, some of their pair-wise and more-complex relationships, and highlights the area of overlap called cognitive science. Although a two-dimensional figure cannot illustrate all combinations among the six disciplines, the salient features of the shaded region indicating cognitive science include a small region where all the disciplines overlap;

31 Howard Gardner, *The Mind's New Science: A History of the Cognitive Revolution* (New York: Basic Books, 1985); Samuel J. Keyser, George A. Miller, and Edward Walker, *Cognitive Science in 1978* (New York: Sloan Foundation, 1978).

32 George A. Miller, "The Cognitive Revolution: A Historical Perspective," *Trends in Cognitive Science* 7(3) (2003): 141–4.

various combinations of three, four and five disciplines; some, but not all, of the topics studied by two disciplines; and none of the topics only studied by one discipline.

Cognitive scientists study the mind in the area where these academic disciplines overlap. Cognitive science—as the interdisciplinary study of mind drawing upon psychology, computer science, neuroscience, philosophy, linguistics, and the social sciences—explores the relationship between a person's mind and brain in its embodied, biological, and cultural context.

Before a brief survey of each of the cognitive disciplines, I comment on the scope of the term "cognition" or "cognitive science." The eighteenth-century philosopher Immanuel Kant argued for three irreducible faculties of mind: knowledge, feeling, and desire. That categorization tends to separate cognition, emotion, and motivation. However, a clearer understanding of mind informed by neuroscience suggests those faculties are highly interdependent and thus a broader understanding of cognitive science would include study of emotion and motivation. I use the term in the broader sense, though I recognize some authors use it in the narrower sense.

Psychologists study a person's mental processes and behavior. Mental processes include a person's cognition, emotion, and motivation. Research psychologists focus on areas such as human development, personality, social relations, abnormal functions, or models of cognition. *Cognitive psychology* refers to the modeling of mental processing typically from an information-processing perspective, such as perception, categorization, memory, problem solving, and learning. Historically, cognitive psychology drew from advances in artificial intelligence, and many of its topics and some of its methods occur in the area of overlap between psychology and computer science. Within psychology, cognitive science primarily draws from the field of cognitive psychology, though practitioners in cognitive psychology tend to emphasize behavioral experiments on human subjects, such as reaction time, while a cognitive scientist would tend to emphasize computational models of the mental processes underlying those behaviors.[33]

Computer scientists study the theoretical foundations of computation or information processing, typically as implemented on actual, simulated, or mathematically modeled computer systems. To compute (from the Latin for "to reckon together") requires the ability to represent abstractions of the real world, such as numbers or symbols, thus one can consider computer science (as well as cognitive science and other sciences of information) as a theoretical science as opposed to an empirical science. Fields in computer science include theoretical computer science, operating systems, databases, programming languages, networking, scientific computing, and artificial intelligence. Cognitive science typically incorporates *artificial intelligence* from computer science which refers to the development of computers (or other artificial, non-natural machines) to exhibit intelligent behavior where "intelligent" remains elusive and incompletely defined. Methods from computer science used in cognitive science include writing programs to model mental processing or

33 Due to limitations of space, I only discuss those aspects of the cognitive disciplines and philosophical methods which are relevant to my argument. See Gardner, *The Mind's New Science* for a historical perspective; for a more recent overview, see Paul Thagard, *Mind: Introduction to Cognitive Science* (Cambridge, MA: MIT Press, 2nd edn, 2005).

experimentally test human subjects. In the next chapter, I draw upon the historical foundations of computer science in systems theory and cybernetics to suggest a more general modeling framework.

Neuroscience refers to all the sciences studying the nervous system and brain. Some disciplines occur within medicine and biology such as, neurology, the branch of medicine concerned with the nervous system, and neurobiology, the study of the cellular and molecular biology of the nervous system. In particular, *cognitive neuroscience* focuses on how the brain enables mental activity. Other sub-disciplines of neuroscience also interact with other disciplines of cognitive science. Neuropsychologists study the relationship between behavior and brain function. Computational neuroscientists develop programs to simulate neural activity for study by neuroscientists and others, and in computer science, connectionist models provide a computational model similar to the associative networks of the brain. Philosophy has long explored the mind and has focused in particular on the mind–brain problem and more recently on neural correlates of consciousness. Neurolinguistics studies the relationship between language and the brain. Although anthropology does not have a single field that studies the brain, biological anthropologists investigate the evolution of the human brain and mental capabilities, and medical anthropologists explore the cultural aspects of health, illness, and health care. In Chapter 6, I draw upon cognitive neuroscience and the application of systems theory to neurobiology and neuropsychology to examine perception, memory, learning, and decision-making.

Philosophy as a discipline originated with the ancient Greeks, significantly Plato and Aristotle, and refers to the systematic, critical, rational thought about thought, action, and reality. Fields include metaphysics (study of reality), ontology (study of being), epistemology (study of knowledge), ethics, logic, philosophy of mind, philosophy of nature, and aesthetics (study of beauty and form). Cognitive science typically includes philosophy of mind from philosophy. The method chosen by a philosopher depends upon a school of thought, jointly developed by historical communities of philosophers who share interpretations of earlier philosophers' writings. Schools include analytic philosophy, logical positivism, pragmatism, and continental philosophy. Minor schools described later include process philosophy and Thomistic philosophy.

Linguists study language and its structure, meaning, and use. Linguistics began with the scholar from India, Panini (eighth to fifth century BCE), who described Sanskrit grammar and much later influenced Ferdinand de Saussure, a founder of modern (Western, twentieth-century) linguistics. Although linguists study individual languages in their cultural and historical context, the comparison between languages provides insight into the general structure, meaning, and use of language. Its fields include syntax (grammatical structure), semantics (meaning), and pragmatics (use of utterances in communicative acts). *Semiotics* (or semiology) generalizes human language to any medium or sense modality and examines the process of meaning formation through an organism's apprehension of the world through signs. Cognitive linguistics examines the mental processes of human language, either its syntax or how human language and thought interact in determining meaning. Cognitive science primarily draws from the study of how language and thought interact to determine meaning in cognitive science, and I use semiotics (from the tradition of C.S. Peirce) to examine meaning.

In cognitive science, social sciences initially included anthropology and especially the study of culture in cultural anthropology. More recently, researchers in education and sociology have become included in cognitive science as have certain economists and political scientists. An early classic cognitive science study occurred in linguistics and anthropology in the work of Brent Berlin and Paul Kay who examined over a hundred languages for color terms (hues) and found only 11 basic colors in very specific combinations.[34]

Interactions between these six disciplines form cognitive science, but although those interactions have led to fruitful research, the cognitive-science area itself has not formed a coherent field of study. Although the lack of methods across the cognitive disciplines has limited its cohesiveness, I suggest that an additional discipline, if incorporated, would cause a coherent and unified field of study to emerge.

Incorporating Religion

Religion already interacts with four of the six cognitive disciplines of philosophy, social science, linguistics, and psychology—through theology, religious studies, biblical studies, and religion and psychology, respectively. Ancient philosophers, such as Plato and Aristotle, did not separate their love and study of truth from religion, and not until the Enlightenment could one conceive of philosophy as separate from religion. Religious studies has explored comparative approaches to religion using the methodologies of cultural anthropology, sociology, and other social sciences.[35] Linguistics, like philosophy, grew as a secular discipline out of roots in religious traditions dealing with sacred texts and their translations, and initial efforts in modern philosophy and linguistics attended to creating separations from their religious roots or—some might argue—chains, though interactions continue in philosophy of religion and hermeneutics. Modern psychology finds its roots in Freud and Jung, each with views of religion, and William James's *Varieties of Religious Experience*, and modern psychology distinguishes itself from religious views of the person yet continues to interact with religion in pastoral counseling and psychology of religion.

In addition to interactions between religion and the four cognitive disciplines of philosophy, social science, linguistics, and psychology, those interactions are expanding to develop critical models of a person's mind, brain, and spirit incorporating neuroscience and computer science. In particular, neuroscience provides a biological foundation for examining the individual and social aspects of religious experience,

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34 Brent Berlin and Paul Kay, *Basic Color Terms: Their Universality and Evolution* (Berkeley: University of California Press, 1969).

35 The new fields "cognitive science of religion" and "scientific study of religion" typically grow out of the social sciences, and use the methods from social science. However, only using methods from social science to study cognition misses the significant contributions available from the other cognitive disciplines.

interpretation, and practice; and computer science provides powerful models and contemporary metaphors through systems theory and artificial intelligence.[36]

Figure 1.2 shows the addition of religion as a seventh discipline in cognitive science. By expanding interactions between religion and the other cognitive disciplines, not only do more fruitful combinations appear, but also, I argue, a coherent field of study appears at the center where all the disciplines can contribute to study cognition in the information processing and systematic organization of the whole person—currently conceived as separate body, mind, and spirit.

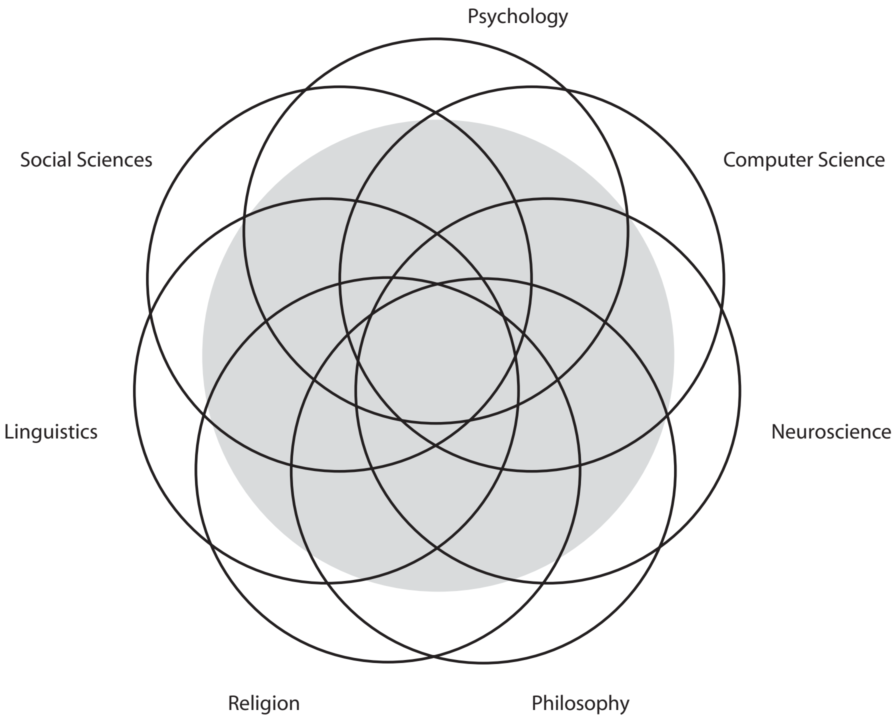

Figure 1.2 Overlap of seven disciplines in cognitive science and religion

Until the 1990s a lack of scientific understanding on how the brain worked limited conversations between science and religion on the topic of the self or soul. Although neuropsychology, the study of patients with brain injury, animal experiments, and examination of brain structure under a microscope provided perspectives on the brain, no one knew enough to begin developing an integrated scientific framework of how the brain works. But beginning in the 1990s with improved non-invasive technology to examine the functioning brain, early progress in the Human Genome Project, and the NIH (National Institutes of Health) Decade of the Brain research

36 For a survey of several research areas in theology and cognitive science and a readable introduction see Gregory R. Peterson, *Minding God: Theology and the Cognitive Sciences* (Minneapolis, MN: Fortress Press, 2003).

initiative,[37] progress in the study of the brain in neuroscience and human cognitive neuroscience began providing an integrated scientific framework that could be used for dialogue and integration with religious perspectives.

As science provides new, interdisciplinary theories of how the person's mind is embodied, connects those theories to neuroscience, and replaces older philosophical and psychological theories of the mind with theories grounded in neurobiology, new opportunities arise for theology to more closely connect aspects of *theological anthropology*, that is, theological study of the human person, to the cognitive sciences. Although some theological theories may prove invalid, other theories may receive evidence from science and can then interact with science to integrate a person's spiritual nature and religious experiences into scientific theories. A theological theory of the soul as the form of the body, which science appeared to dismiss, may prove a fertile basis to adapt for a coherent, complete, and accurate understanding of the person.

Neuroscientists have recently begun providing detailed, biological frameworks of a person's characteristics traditionally attributed to a person's soul or spirit—such as moral decision-making, personality, reasoning, consciousness, and emotional health. Neuroscience has progressed sufficiently since the 1990s to enable explorations of religion by neuroscientists,[38] explorations of neuroscience by religious scholars,[39] and fruitful interactions between neuroscientists and religious scholars.[40]

Computer science contributes a systems approach to the person that influences other cognitive disciplines, and that approach may increase critical methods for religious scholarship but needs to incorporate important spiritual qualities of a person to avoid what otherwise might become dispassionate reductionist models. Computer scientists have explored religious themes, especially within artificial intelligence. Noreen Herzfeld examines the relationship between the Christian belief that humans were created in God's image and the human desire to build artificial intelligent systems in our image. Anne Foerst uses her work in robotics to highlight conflicts between work in artificial intelligence and Christianity.[41]

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37 http://www.loc.gov/loc/brain/ (accessed 27 November 2007).

38 Andrew B. Newberg, Eugene G. D'Aquili, and Vince Rause, *Why God Won't Go Away: Brain Science and the Biology of Belief* (New York: Ballantine Books, 2001); Andrew B. Newberg and Mark Robert Waldman, *Why We Believe What We Believe: Uncovering Our Biological Need for Meaning, Spirituality, and Truth* (New York: Free Press, 2006); Michael S. Gazzaniga, *The Ethical Brain* (New York: Dana Press, 2005).

39 Kelly Bulkeley, *The Wondering Brain: Thinking About Religion with and Beyond Cognitive Neuroscience* (New York: Routledge, 2004).

40 Brown, Murphy, and Malony (eds), *Whatever Happened to the Soul?*; Robert J. Russell *et al.*, *Neuroscience and the Person: Scientific Perspectives on Divine Action* (Berkeley: Vatican Observatory Foundation, Center for Theology and the Natural Sciences, 2002); Kelly Bulkeley, *Soul, Psyche, Brain: New Directions in the Study of Religion and Brain–Mind Science* (New York: Palgrave Macmillan, 2005).

41 Anne Foerst, *God in the Machine: What Robots Teach Us About Humanity and God* (New York: Dutton, 2004); Noreen L. Herzfeld, *In Our Image: Artificial Intelligence and the Human Spirit* (Theology and the Sciences; Minneapolis, MN: Fortress Press, 2002).

When cognitive science draws upon computer science, it draws upon artificial intelligence, algorithms, and systems. Much of what contemporary philosophers draw from computer science in philosophy of mind has roots in general systems theory and cybernetics. In this book, I highlight aspects of systems used in computer science and present them in a way to facilitate their use by other cognitive disciplines. I then show how one can use a systems view of the person for insight into religious understandings of the person.

Typically in computer science one wants to draw upon the most recent research, not revisit its roots. However, before one can incorporate the real "computer science" into the study of cognition, one needs to separate the computational methods from their default philosophical interpretations, such as logical positivism and instrumentalism, and from the remnants of nineteenth-century rationalism. Although it may appear a step backwards when later in the book I use philosophers from the early 1900s to interpret theories from the 1940s, I actually am making progress in the field by eliminating presumed theories from the 1700s and 1800s.

In drawing from seven, large, complex disciplines several of which themselves have an interdisciplinary component, I select a combination of approaches that unify and cohere with each other. Other combinations might also work, but many potential combinations do not cohere, even among predominant views in each discipline. In particular, I focus on topics of self, mind, decision-making, memory, and learning from psychology; systems theory from computer science; emergence and form from a pragmatist perspective in philosophy of nature with some application of metaphysics; systems neurobiology in neuroscience; semiotics in linguistics; the organization of communities and sociology of knowledge in social sciences; and from religion, the human soul.

Coherence and Unity of View

To summarize, four of the six cognitive disciplines have histories of interacting with religion as long as those disciplines have existed. Those studying neuroscience and religion have interacted academically since about the 1990s, but that dialogue is growing rapidly. Only preliminary interactions between computer science and religion have occurred, and that has occurred within artificial intelligence. As far as I know, this book presents the first scholarly attempt to relate religion and computer science other than artificial intelligence. Drawing upon systems theory and recent advances in neuroscience, I select the philosophical school of American pragmatism to explore religious views of the person as that appears the most applicable for studying those new developments and their relevance for cognitive science and religion.[42]

Although cognitive scientists have begun to understand the importance of affective, motivational, social, and cultural aspects of the mind (or cognition), they typically have not yet acknowledged the importance of spiritual or religious aspects

42 Cf. Bulkeley, *The Wondering Brain*. Bulkeley, beginning with social science and comparable recent advances in neurosciences, uses continental philosophy to explore similar religious views of the person.

of the person. However, Christian theologians from Augustine and Thomas Aquinas to Sören Kierkegaard, Hans Kung and Paul Tillich have emphasized the importance of the religious context to understand the human person, and Buddhist psychology has long recognized the significant role of mind. The mind involves religious feelings, goals, desires, and motivations of the individual as well as communities in religious practices and rituals. Religious scholarship contributes to cognitive understanding of one's value, purpose, aesthetics, ethics, and belief. Likewise, one cannot understand the cognitive aspects of faith, wisdom, loyalty, or ultimate concern, for example, without understanding how the human mind functions. If one takes both religion and cognitive science seriously as contemporary academic disciplines, then the findings of theologians and religious scholars must be incorporated into cognitive science. That integration can occur weakly or strongly. In a weak type of integration, one notices the significant aspects of religious constructs in cognition, such as faith, ethical reasoning, or religious experience. In a strong type of integration, one recognizes that one cannot understand the human person without understanding the person in relationship to God, as many theologians argue. Rather than just add yet another discipline to the cognitive-science mix, cognitive science and religion forms a more coherent field of study than the attempt to understand how one thinks while excluding what one believes. Only when one examines cognitive and spiritual aspects of the self in relationship to the other can either be fully understood.

The unity and coherence of cognitive science and religion organizes the approach to cognition and spirituality presented in the remainder of the book. Within computer science, information theory underlies the modeling of relationships as constraints; systems theory organizes the networks of physical, biological, psychological, and social/cultural relationships constituting the human person; and cybernetics describes the function of those systems. Within philosophy, pragmatic philosophy categorizes the possible, actual, and general relationships to describe the real possibility inherent in relationships of emergence and dynamic forms. Within psychology, the concepts of mind, self, perception, learning, memory, and decision-making capture mental processing in thinking and spirituality. Within linguistics, semiotics describes the relationship between the mind and nature (the "aboutness" or intentionality of mind) and also the relationships between the relationships intrinsic to mind and nature themselves. Within social science, the pragmatist Josiah Royce describes the formation of communities through individuals interpreting each other's minds (Chapter 5). Within neuroscience, the biological processes of synaptic plasticity and long-term potentiation (described in Chapter 6) underlie the psychological processes of memory and learning. However, the broad range of topics just mentioned—modeling systems of relationships as constraints; categorizing real possibility in dynamic forms; relationship between individuals as community; and using semiotics to relate natural and mental relationships, especially learning, memory, and decision-making and their underlying biological basis in the brain—might not unify. But they do unify, and like the five blind people each trying to describe an elephant by touching one part, they unify by each providing a perspective on religion's contribution—the human soul.

Although the remainder of the book explains the terms, there is a correlation between systems, dynamic forms, and communities, which each describe the whole.

The whole consists of components that enable the shift of the whole over time, and for the human mind, those gradual shifts occur through processes of learning, memory, and decision-making. Semiotics and the informational capacity of the soul capture the connection between the whole person and the variety of parts that relate to constitute the person.

Mind, Self, and Nature

What is one's self?

Although "person" is an older term dating back to Greek and Latin words, the first-person "self" is a relatively recent word. Descartes assumed a thinking self as the first principle of his philosophy, and Kant distinguished between the phenomenal self, which can be known, and the noumenal self, which can only be inferred. For the early nineteenth-century philosopher Hegel, the self as a whole was revealed through differentiating the self from the non-self in a dialectic process of synthesis, and one reaches self-consciousness by self-externalization. William James understood the self as the sum of all that one knows oneself to be and self-awareness as a stream with two aspects: an "I" that experiences continuity and a "me" that is rooted in bodily existence. For twentieth-century psychologists including self psychologists and object-relations theorists such as Heinz Kohut or D.W. Winnicott, the self is understood to develop in the context of interpersonal relationships.

I use "self" as a psychological concept that refers to the person with which one identifies. With exceptions in some psychological disorders, every human adult has a concept of themselves—albeit incomplete. That concept forms from one's experience and other conceptual knowledge gained about people in general. One's personal concept of self exists as one of many concepts represented by the brain yet forms the nexus of a person's experience as *that* person's subjective experience. The concept of a person's self defines the meaning of that person to that person. Although possible to become caught in an apparently circular definition of self and subjectivity, considering the person in a broader context of society and the world facilitates meaningful definition.[43]

Philosophers and cognitive scientists recognize the apparent disconnection between mind (and the realm of ideas, language, and thought) and the body (and the realm of the physical world, including the biological processes of the brain). However, one can overcome that limiting conception of mind and brain by incorporating two contexts in which they occur: a person's social, linguistic and cultural context of mind and the effect of biological evolution on the brain.

Expanding cognitive science in these two directions strengthens its foundation in the social sciences and neuroscience. Societies have a reality to them that influences

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43 For self as conceptual knowledge see John F. Kihlstrom and Stanley B. Klein, "The Self as a Knowledge Structure," in *Handbook of Social Cognition* (ed. Robert S. Wyer and Thomas K. Srull; Hillsdale, NJ: L. Erlbaum Associates, 1994), vol. 1, pp. 153–208. For a survey of the self's distribution across brain systems see Gillihan and Farah, "Is Self Special?"

the individuals that comprise them. Without locating the brain in its biological context—as a highly distributed and interconnected process adapted to specific functions—one overly limits the platform upon which mental activity occurs.

A person's concept of self depends upon that person's mind, and that person's mind depends upon a person's broader social context. If one takes an individualistic view of the person, one slips into a nihilistic spiral as the mind has no definition outside the person. However, allowing for definition of the self as a social construct, one gains the possibility of a communal foundation for subjectivity. Without the concept of other, the concept of self has no meaning.

Social Mind

George Herbert Mead studied under William James and Josiah Royce at Harvard and originated social psychology, as detailed in his posthumous *Mind, Self, and Society.* For Mead, interaction within a group or community creates the self. The group precedes and enables the emergence of the individual self. Social interaction creates the self by communicating meaning to the emerging self through symbolic linguistic acts. The individual social self creates itself initially through appropriation of the community's shared values and ideals. As the self emerges, it interiorizes the social environment in which it lives. The developing self may shift itself or reform the institutions which give it initial shape. Mead envisaged the transformation of the self in society as a dialogue between what he called the "I" and the "me" which function as dimensions of the emerging social self. Mead defined his "I" and "me" in response to William James as follows: "The 'I' is the response of the organism to the attitudes of others; and the 'me' is the organized set of attitudes of others which one assumes. The attitudes of others constitute the organized 'me', and then one reacts toward that as an 'I'."[44]

Mead proposed a social-psychological construct of the human self, and distinguished between the self and its body. While the self has itself as an object, the body does not. The reflexive character of the human self makes it simultaneously into both a subject and an object. As a subject it has itself for a conscious object. The human self, then, experiences itself as having and using its body at the same time that it experiences itself as more than just a body. Social communication creates self-awareness, and the significant signs of language structure social communication. [45]

Language not only creates the human mind, it also creates the human self who has a mind. Mead put it this way:

> The self is not so much a substance as a process in which the conversation of gestures has been internalized within an organic form. This process does not exist for itself, but

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44 George Herbert Mead, *Mind, Self and Society from the Standpoint of a Social Behaviorist* (Chicago: University of Chicago Press, 1962), p. 175. For an appreciation of Mead, I am indebted to Donald L. Gelpi, *The Gracing of Human Experience: Rethinking the Relationship between Nature and Grace* (Collegeville, MN: Liturgical Press, 2001), pp. 234, 238, 240.

45 Mead, *Mind, Self and Society*, pp. 112–78; cited by Gelpi, *The Gracing of Human Experience*, pp. 239–41.

> is simply a phase of the whole social organization of which the individual is a part. The organization of the social act has been imported into the organism and becomes then the mind of the individual.[46]

For Mead, the term "mind" designates the way in which one organizes one's meaningful responses to one's physical and social world. Social interchange creates the human mind and shapes the modality of its existential response to its world. Consciousness exemplifies a functional, relational reality, not a substantial one, and it engages neurological activity, but consciousness cannot be located in the brain, because human thinking always engages the person in its environmental rootedness and social relationships.[47]

Language depends upon the relationship between people that speak the language, and also their relationships to those who spoke the language before them and directly or indirectly passed the language on to them. Language, thought, and self each depend upon the relationship a person has with others. Modern linguists have recognized the relationship between thought and language. The twentieth-century American linguists Benjamin Whorf and Edward Sapir hypothesize that the structure of a particular language influences the habitual thought of its speakers.[48] A more general understanding of language occurs in the study of signs, or semiotics.

Society influences the construction of the mind, and human society occurs in a natural world that influences the people comprising the societies. From an evolutionary perspective, one would expect the nervous system to adapt to increase the survival of the organism and thus the brain and rest of the nervous system would provide a clue to the structures of nature.[49] In that case "mind" would be not only a human characteristic, but also a natural phenomenon.

Mind and Nature

In what way does nature influence the relationships of the mind?

Nature has a quality that many scholars describe as relational. Since the work of Immanuel Kant in the eighteenth century, scholars have begun to realize that one cannot know reality directly, but only through one's senses, and those senses distort reality by emphasizing one aspect over others. One approach (as described in Chapter 7) is to consider the most likely metaphor for reality and test that hypothesis using

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46 Mead, *Mind, Self and Society*, p. 178.

47 Gelpi, *The Gracing of Human Experience*, pp. 239, 241.

48 The contemporary cognitive linguist George Lakoff argues for the important role of metaphor in structuring thought, and the computer scientist Jerome Feldman has developed a computational theory of language rooted in a biological foundation for metaphor. George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind* (Chicago: University of Chicago Press, 1987); Jerome A. Feldman, *From Molecule to Metaphor: A Neural Theory of Language* (Cambridge, MA: MIT Press, 2006).

49 If one prefers (for non-scientific reasons) to believe in aspects of the human person created by God, other than through evolution, then hopefully a non-cruel God would create those structures to minimize pain and suffering, rather than confuse and overwhelm.

scientific evidence as it becomes available. Hopefully, a good hypothesis will gain evidence and perhaps suggest fruitful avenues for further scientific investigation. However, that approach presumes that reality is not only relational, but that it is rational, and rational in a way that humans can understand. Although that poses a significant problem for philosophy in general, scientists can focus on understanding the aspects of reality that humans can understand and leave the non-understandable aspects to other scholars.

The founder of pragmatic philosophy, Charles S. Peirce, wrote in response to Darwin's evolution and against the lack of realism in nineteenth-century, Cambridge, Mass., transcendentalist intellectual thought, and he believed that nature had a rational, logical quality he called "mind-like." Some confusion exists over Peirce's use of "mind." He did not imply that nature had a consciousness or acted with volition, but believed humans attempt to understand nature using what the human mind can conceive. Science and religion both depend upon nature having a structure that humans can understand. One might imagine the alternative as pure chaos in which random processes prevent any discernable patterns from occurring.

According to Peirce, every thought is a sign that interprets a prior sign. These signs provide a structure to interpret information in the relationships comprising them. Peirce developed several organizations of signs; the simplest organization of Peirce's semiotics consists of three kinds of relations to objects in signs: icon, index, and symbol.[50] An *icon* signifies by resembling its object like a painting or a map. It possesses a quality that resembles or duplicates those of the object. An *index* represents its object through an existential connection between itself and the object. For example, a fingerprint not only resembles the ridges of a fingertip, it signifies the existence of a particular finger. An index may also signify by physical action (action and reaction), such as a thermometer or weathervane. A *symbol* represents its object through a convention that governs how the symbol will be used. For example, the word "cat" is connected to an animal through conventional English usage, and thus one can categorize human language as "symbolic language."[51]

A "relationship" itself cannot be defined descriptively; one cannot "know" reality directly. However, one can use one of Peirce's insights to redefine "meaning" and capture the aspects of reality and relationship as we understand them. Peirce argued that if an aspect of reality has no conceivable practical effect, then it has no meaning. Thus, meaning can only refer to what one can conceive (under any circumstances, at any time). Although that may appear limited to some, if his *pragmatic* argument holds true, then that is the best we can ever do, and humans can only ever know what we can possibly ever know. If one finds that limitation acceptable, and I expect

50 Peirce also developed taxonomies of signs into 10 groups and 64 groups, but he did not complete his overall semiotic project.

51 Kelly A. Parker, *The Continuity of Peirce's Thought* (Nashville: Vanderbilt University Press, 1998), pp. 156–7. A more complete organization considers the category of the "interpretant" and sign itself (described in Chapter 7). Note, Paul Tillich and Carl Jung define symbol and sign differently from Peirce: for them, a symbol partakes of the reality to which it points and a sign simply points to it.

many scientists do, then one can use pragmatism as a philosophical foundation for science.[52]

However, there remain in science vestiges of *essentialism*, which holds that things in nature have an "essence" which one cannot know directly, and *nominalism*, which argues that one cannot know anything of reality, but only name concepts one imagines exist. No scientist (who spend their life investigating the empirical) wants to hold those philosophical positions of essentialism or nominalism, but those positions hide beneath the surface and skew one's interpretation of scientists' investigation of nature.[53]

In the pragmatic hypothesis that I describe in this book, nature consists of relationships that change over time where some relationships change more slowly than others and provide the appearance of stability. Although one cannot know the relationships of reality directly, one can observe an aspect of how they conceivably could exist by investigating the effects of their change over time and appearance of stability in nature. Although scientists have invented many tools to examine the relationships of nature, one natural tool has also developed to explore those relationships—namely, the mind itself.

The anthropologist and systems thinker Gregory Bateson examined human mind across cultures and described six criteria of natural processes he believed were captured in mental processing:[54]

1. A mind is an aggregate of interacting parts or components. Mental processing occurs as a sequence of interactions between parts. The parts themselves, such as atoms, do not form minds, but their interactions lead to the appearance of complex processes.
2. The interaction between parts of mind is triggered by difference, and difference is a non-substantial phenomenon not located in space or time. Although in the material world, one can talk of "cause" as an event of some force or impact, in the realm of ideas, it requires a relationship between two spatial or temporal components to activate a third component, and that relationships is one of difference or change. For Bateson, *information* consists of "differences that make a difference."
3. Mental process requires collateral energy. Although mental processes are triggered by difference, that difference is not energy and usually contains no energy. But the processes (from which the differences occur) require energy.
4. Mental process requires circular (or more complex) chains of determination. For survival, an entity resists change. The resisting of change requires not only collateral energy, but some type of circular flow of information. That flow of differences that make a difference provides an internal stability that

52 Karl Popper used pragmatism to develop his notion of "falsifiability" in science, which philosophers of science have since criticized, but that indicates a pragmatic need to revise a pragmatic approach to philosophy of science, not a repudiation of the approach.

53 Described further in Chapter 7.

54 Gregory Bateson, *Mind and Nature: A Necessary Unity* (New York: Dutton, 1979), pp. 85–119 (92).

allows the system to respond to external changes. (Cybernetics studies these feedback mechanisms.)
5. In mental process, the effects of difference are to be regarded as transforms (i.e., coded versions) of events which preceded them. The rules of such transformation must be comparatively stable (i.e., more stable than the content) but are themselves subject to transformation.
6. The description and classification of these processes of transformation disclose a hierarchy of logical types immanent in the phenomena.

These criteria of mental process occur in the natural world, and for survival, an organism with a mind learns to represent these relations and their processes. Humans and other animals make decisions to survive and thrive in the natural world.[55]

What relationships in the natural world do human minds attempt to represent in order to make decisions about their behaviors?

Consider any major life decision: who to marry, what career to pursue, where to live. When in time and where in the brain is that decision made exactly? Although one may locate small decisions in time and location, larger decisions are distributed over time and space. With whom one spends one's life depends upon decisions one made years earlier, decisions one's parents and other ancestors made, genetic factors that influence one's temperament and attraction to others. One cannot locate that decision and the mental factors that influence it solely in the brain of one person at one moment in time. The mind expands broadly—the decisions one makes, what one thinks about, and the mind itself transcend one's self and occurs in a cultural and spiritual context. For both social and natural reasons, mind—and its change and decision-making—result from processes more broad than the individual. The next chapter explores the relational processing of mind and nature in terms of information and systems.

To summarize: cognitive science and religion examine the human mind using methods from seven academic disciplines. It forms a coherent field only through the incorporation of the category of soul from religion which connects otherwise incompatible perspectives on the person. Those perspectives remain incompatible because they describe phenomena on different "levels" of human existence, as explained in Chapter 3, namely the biological level and the psychological level (referring to all aspects of the individual mind). By expanding the biological foundation of mind to recognize the slowly shifting processes in adaptation to the relationships of the natural world, and by expanding the individualistic conception of mind to include the social and cultural formation of mind, one can recognize additional levels of human activity and existence—each of which constitutes a coherent description of the human person. Chapters 3 and 5 will also identify two

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55 In philosophy of science, the view that mind (and brain) adapted to understand the world is called "evolutionary epistemology." In particular, according to Bradie's categorization, the view here corresponds to evolutionary epistemology of mechanism, i.e., that the brain evolved. Michael Bradie, "Assessing Evolutionary Epistemology," *Biology and Philosophy* 1 (1986): 401–459; Donald T. Campbell, "Evolutionary Epistemology," in *The Philosophy of Karl Popper* (ed. Paul Arthur Schilpp; La Salle, IL: Open Court, 1974), pp. 412–63.

additional levels of subatomic interactions and transcendent spirituality that also inform human existence, but frequently are not considered in study of cognition.

The next chapter describes mathematical, computational, and philosophical constructs for modeling the relationships of nature at each level, and Chapter 4 describes how the systems at one level emerge from the lower levels and inform them. However each level of human existence by itself remains incomplete. To unify the plurality of perspectives that inform the human person, requires acknowledging the constellation of informing relationships across all levels, in other words, the form of the person, namely the human soul.

CHAPTER 2

Systems Theory

> The self is a relation that relates itself to itself or is the relation's relating itself to itself in the relation; the self is not the relation but is the relation's relating itself to itself. —Søren Kierkegaard

Introduction

The personal or religious claim that everything is interrelated would provoke dispute in few (if any) arenas. But a scientist must ask the question: how is everything interrelated?

In a modern, European, North American worldview—that for lack of a better term I will call "Western"—deeply influenced by monotheistic religion, some people search for a "theory of everything." I claim no such theory exists. If by "theory" one means a real theory with logical structure and inference, rather than a collection of idiosyncratic ideas and an interesting story to connect them, then no theory of everything exists, because reality does not have one logically consistent story. Instead, I argue reality has multiple logically consistent stories in which each describes only part of reality.

Part of the problem occurs in logic itself. Gödel's Incompleteness Theorem states that any consistent theory that describes the natural numbers must be incomplete, where the natural numbers are the whole numbers 1, 2, 3, . . . The difficulty occurs because most interesting logics describe a potentially infinite collection, and thus according to the theorem, must be incomplete. Even when the theory does not directly use logic, the presumption of an infinite collection still holds. A psychological theory might state that under certain conditions, a person behaves in a particular way a certain percentage of the time. Although only a finite number of people actually exist at any time, the theory describes a potentially infinite collection of people. Alternatively, the theory would by definition have to reach some arbitrary limit—such as 6,536,215,106 people—and no longer hold, and no good scientist would introduce such an arbitrary limit.

Part of the limitation of logic to describe reality occurs in the nature of reality. Even though the universe appears finite, it operates in a potentially infinite way. When an electron orbits an atom, it will continue doing so forever, unless something else interferes. The something that interferes may also operate in a potentially infinite way, and those potential infinities interact in complex ways, which I will refer to later as emergent, that require another level of potentially infinite theories to describe. The universe does not introduce arbitrary limits, either.

On the other hand, some postmodern scholars argue for a radical plurality, where no common ground exists. People construct ideas socially using language and those ideas may prove useful to society, but have no direct connection to reality. But, extreme social constructivism directly contradicts science as done by scientists, and appears to only undermine its own foundations. I argue social constructivism provides another partial perspective on reality.

As described in the previous chapter, reality has a structure that Peirce, Bateson, and others describe as "mind-like." The neurophysiologist Paul Glimcher defines the natural function of the nervous system as decision-making and describes models of emergent social interaction in terms of game theory. Using economics and equilibrium points in ecological systems, he describes how one can model emergent properties of a social (ecological) system in terms of probabilities and game theory.[1]

Neuroscientists understand the human mind does not function as an indivisible whole, but that different functions are distributed over various regions of the brain. As detailed later in this book, the brain has a highly relational, interconnected structure, where the processing and functions vary depending upon the region of the brain, biochemicals present, and environmental factors. Similarly, reality has a highly relational, interconnected structure, and the processing and function vary depending upon a variety of factors.

Systems theory provides a framework for representing the multiple logically consistent stories that make up reality. Using systems theory, one can examine the relationships of mind, reality, and the human person. One socially constructs a model of reality in one's mind by making decisions using the human brain and receiving feedback through one's body. Although a popular metaphor today is "the mind as computer," when computer scientists talk about computers, they use the language of systems.

Systems Theory

Systems theory examines the complexity and interdependence of relationships between the regularly interacting parts or activities that form a whole, using information and decision-making/control concepts. Systems theory argues that despite the complexity or diversity of phenomena, their organization can be described by general laws, concepts and principles that are independent of the specific domain.[2] By uncovering general laws, one could analyze and solve problems in any domain, pertaining to any type of system.

Systems theory was developed beginning in the 1940s with the work of Ludwig von Bertalanffy on general systems theory alongside Norbert Wiener's cybernetics, Claude Shannon's information theory, and John von Neumann's game theory—all of which influenced each other and the development of computer science.

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1 Paul W. Glimcher, *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics* (Cambridge, MA: MIT Press, 2003), pp. 148, 175.

2 Ludwig von Bertalanffy, *Perspectives on General System Theory: Scientific-Philosophical Studies* (The International Library of Systems Theory and Philosophy; New York: G. Braziller, 1975), p. 37.

Systems theory has applications in biology, computer science, family systems theory in psychology, engineering systems, organization theory in business, and so on, and I use it to describe the relationships defining the human person.

General systems theorists attempted to model natural phenomena as relationships between components, typically mathematical relationships, and cyberneticists attempted to model the decision-making and mental processing of human thought, especially in the hope to develop artificially intelligent machines.

General Systems Theory Research

Systems theory focuses on the relationships of entities to model highly related entities. The original developers of systems theory hoped that mathematics might provide a common language to model the domain-independent laws, concepts, and principles across disciplines, but even von Bertalanffy speculated that other theories, such as graph theory or information theory, might provide alternate approaches to classical mathematics. Researchers have developed several general systems theories since von Bertalanffy's general systems theory to examine different aspects of systems as general abstractions, including network organization, process and feedback, and energy flow, and, with respect to the domain studied, storage.[3] Jay Forrester's Systems Dynamics simplifies systems to stocks and flows to analyze feedback in business and broader social systems.[4] James Miller's Living Systems Theory emphasizes hierarchical organization of biological subsystems, identifying 20 sub-systems, such as ingestor, converter, digester, that function over eight levels of organization and complexity from single cells to supranational organization.[5] Howard T. Odum models ecological and other living systems as the energy flow of components and processing.[6] Ervin Laszlo developed a holistic systems theory based on dynamic self-regulating systems.[7]

More recently, Len Troncale's SSP model (Systems of Systems Processing) enables comparison of systems-linking propositions of over 80 systems processes observed in many complex systems.[8] Processes used in this book (and explained

3 For a recent overview, see Lars Skyttner, *General Systems Theory: Perspectives, Problems, Practice* (Singapore and River Edge, NJ: World Scientific, 2nd edn, 2006).

4 Jay Wright Forrester, *Industrial Dynamics* (Cambridge, MA: MIT Press, 1961); Jay Wright Forrester, *Urban Dynamics* (Cambridge, MA: MIT Press, 1969); Jay Wright Forrester, *World Dynamics* (Cambridge, MA: Wright-Allen Press, 1971); Jay Wright Forrester, *Collected Papers of Jay W. Forrester* (Cambridge, MA: Wright-Allen Press, 1975).

5 James Grier Miller, Keith Talbot, and National Public Radio (US), *Living Systems* (sound recording; Washington, DC: National Public Radio, 1979).

6 Howard T. Odum, *Howard T. Odum Center for Wetlands at University of Florida*; available from http://www.cfw.ufl.edu/ (accessed 1 October 2006).

7 Ervin Laszlo, *The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences* (New York: G. Braziller, 1972); Ervin Laszlo, *The Systems View of the World: A Holistic Vision for Our Time* (Advances in Systems Theory, Complexity, and the Human Sciences; Cresskill, NJ: Hampton Press, 1996).

8 Len Troncale, *Systems Science Praxis* (Ponoma, CA: California State Polytechnic University, 2006).

later in context) include: attractors, boundary conditions, emergence, equilibrium, evolutionary processes, feedback, hierarchical structure, information flow, morphodynamics, network dynamics, phases, potential spaces or fields, restructuring rules, self-organizing processes, and stability processes.

Computer scientists and biologists have explored systems within those disciplines that emphasize the significance of modularity and emergence in dynamic processing, which will prove relevant to modeling human systems. Herbert Simon showed that a modular architecture of complexity resulted in increased survivability when each module had at least a limited stability.[9] Ilya Prigogine and his colleagues demonstrate the emergence of order through amplified, bifurcating fluctuations in non-linear thermodynamic systems.[10] Stuart Kauffman argues that networks near the edge of chaos appear best able to coordinate complex activities.[11] He also argues that an autonomous agent requires the ability to perform at least one thermodynamic work cycle.[12] Current work in the field also includes systems analysis[13] and object-oriented analysis and design.[14]

Cybernetics

Norbert Wiener coined the term *cybernetics* to refer to "the science of control and communication in the animal and machine" from the Greek *kybernetes* (helmsman, governor, navigator, pilot, or rudder). Wiener examined teleological mechanisms (from Greek *telos* meaning end, purpose, or goal) where the thing studied self-regulates through circular feedback mechanisms, such as thermostats or steam-engine governors. Cybernetics focuses on the function and behavior of a system in maintaining certain conditions near a goal. Like a pilot steering a ship toward a port, the system controls itself, responding dynamically to environmental changes. Systems studied now include social and ecological systems in addition to human, animal, or engineered ones. In all systems, a governor samples the flow of information, detects difference from expected values, adjusts the behavior of the system, which results in a new detectable difference, and the process repeats.

In cybernetic systems, circularity exists from the governor that controls the system to the effector, which changes the system's relationship with the environment, and the detector, which extracts values from the environment, and passes that information

9 Herbert Alexander Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 1969).

10 I. Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (Toronto and New York: Bantam Books, 1984).

11 Stuart A. Kauffman, *At Home in the Universe: The Search for Laws of Self-Organization and Complexity* (New York: Oxford University Press, 1995), p. 26.

12 Stuart A. Kauffman, *Investigations* (Oxford and New York: Oxford University Press, 2000), p. 4.

13 Jeffrey A. Hoffer, Joey F. George, and Joseph S. Valacich, *Modern Systems Analysis and Design* (Upper Saddle River, NJ: Pearson Prentice Hall, 4th edn, 2004).

14 Grady Booch, *Object-Oriented Analysis and Design with Applications* (The Benjamin/Cummings Series in Object-Oriented Software Engineering; Redwood City, CA: Benjamin/Cummings Pub. Co., 2nd edn, 1994).

as inputs back to the governor. In an engineered system these components typically remain distinct, but in natural systems the controller may be distributed over other parts of the system.

Gregory Bateson's systems theory examines the pattern that connects nature in an intelligible structure. In the intelligible structure of nature (described in Chapter 1), process occurs through difference. Some of those differences make a difference. In a cybernetic system the governor or controller responds not to the external world but to differences between the external world and some value. Bateson's natural "mental" systems respond to difference not with respect to a fixed value, but to an aspect that emerges from the system as a whole as it interacts with the environment.

Object-Oriented Analysis

General systems theory originally focused more on the structure of systems and their models, and cybernetics focused more on how systems function, operate, and communicate, but because the structure and function of a system cannot be understood in isolation, systems theory and cybernetics are now viewed as two facets of a single approach.[15] Object-oriented analysis uses a systems approach to create a representation of a natural or engineered entity that one can model on a computer.

In object-oriented analysis, one models each natural or engineered entity as an "object," and in the design phase, one uses programming-language structures to create a computational model of what was analyzed. An *object* consists of a collection of attributes or relations between entities (its structure) and methods that the entity can perform (its function). In programming languages, objects also have *encapsulation*, which ensures that attributes are only changed through the programs coupled to the object, called "methods," and not directly changed by another object. An *attribute* may have as a value either an atomic (primitive and undefined) value or another object. Objects with identical structure and function (though possibly different values) define a type, typically called a *class*.[16]

For example, a person modeled as an object would have attributes with atomic values, such as name, eye color, height, weight, and so on; relational attributes referring to other objects, such as parents, siblings, children, employer, friends, and so on; and methods that typically depend upon the application being analyzed or designed, such as, checking out library books, registering for classes, communicating a message to another person, and so on. From an Aristotelian perspective, more general object "methods" for a person include that a person eats food, grows, procreates with another person, moves around in the world through senses and appetites, and thinks.

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15 F. Heylighen, C. Joslyn, and V. Turchin, 'What Are Cybernetics and Systems Science?' *Principia Cybernetica* (14 January 2000); available from http://pespmc1.vub.ac.be/CYBSWHAT.html (accessed 25 April 2005).

16 Objects also have *inheritance*, where attributes and methods are shared, but inheritance is not relevant for the current study. Technically, the given definition of an object without inheritance actually defines an abstract data type. In terms of linguistic type–token distinction, a class is the type and objects are the tokens.

In object-oriented programming, objects encapsulate aspects of the data and program logic by presenting a well-defined "interface" with which other objects interact. Such interfaces protect the internal content of an object while allowing overall change within the system, increasing system stability and facilitating long-term system management.

In a retail-sales application program, for example, one object would calculate sales tax, and all other objects that needed that functionality would request answers from methods on the "sales-tax-calculation" object. The benefit of object-oriented programming occurs when the sales-tax rate changes. The programmer would make changes localized to the sales-tax-calculation object which would not interfere with other objects in the system, insuring that the system did not fail because of the change.

Object-oriented analysis and design typically works well in engineering applications, but for many areas of science, the restricted structure of attributes cannot adequately model the network of relationships inherent in complex systems. Researchers have developed additional modeling frameworks to address this requirement including object-relational models and graph models. By modeling the relations explicitly—rather than implicitly as attribute values—one can also define additional higher-order logical relations that constrain the applicability of the base relations. For example, one could define siblings as two people with at least one shared parent (a statement that one cannot declare explicitly in a pure object system).

Although objects are insufficient to model human systems, they easily capture simpler aspects of systems, and two concepts from object-oriented analysis and design will periodically reappear later, namely the concept of class—a collection of objects with identical structure and function, but possibly different values—and encapsulation—which hides some information and creates an interface (or boundary) by which other objects interact with the defined object.

To further develop the systems approach used in the remainder of the book, the following sections describe a philosophical interpretation of systems as dynamic forms, a logical perspective on relationships as constraints, and a particular graph modeling framework to capture the structure of the relationships in which a system participates.

Philosophical Form

Systems model the relationships of natural, engineered, or mental entities, and form describes the arrangement of those relationships and how they give rise to the whole. Consider the knitting or crocheting of yarn into a garment or weaving of threads into a tapestry. Several relationships come together into a pattern, such as stitches, and without those relationships, one would only have threads. With each stitch or row, the product emerges. The finished work has properties that one cannot reduce to the linear yarn or thread—size, texture, patterns of color, image. After completion, the whole has stability that does not depend upon its material. One can repair a hole with other yarn or thread.

The philosophical category of form captures the unchanging aspect of what otherwise is in flux. A garment, tapestry, sculpture, painting, bridge, or building has a form that does not depend solely on its materials. The materials and shape of those materials can slowly change and the form remains the same. In terms of objects, form captures the interface that encapsulates the hidden information that can change, while the object remains the same. In a living organism, historically, the form of a plant or animal specifies what remains unchanged from seed to birth through stages of life to death. The matter constituting an organism changes over a lifespan as does the arrangement of relationships, but the form identifies the continuity.

Although artists and architects learn about and work with form, scientists and engineers do not typically have that complete concept. However as form identifies the information in a changing system of relationships, the work of scientists directly involves the study of natural forms and engineering involves designing artificial forms which are then built.

The contemporary scholar Alejandro Garcia-Rivera proposes a thought experiment: if it were technologically possible to create a perfect copy of a work of art, what would be its difference from the original. For example, if one could create a "material hologram" of Michelangelo's statue of David, would it be a beautiful work of art? Garcia-Rivera proposes that there is "something" whose presence does not allow for reproduction. Classically, that something is its aesthetic form.[17]

Garcia-Rivera's thought experiment also illuminates the importance of "history" to a form. In late antiquity, the neo-Platonic intellectual inquiry into the nature of beauty and creative making (*poesis*) incorporated the maker, the thing made, and the activity of making. The activity of creative making (*energeia*) differs between Michelangelo and the "material hologram," and thus the form differs. The makers also differ, but Garcia-Rivera points out that if a copy of David were made by Michelangelo's friend and contemporary Raphael, one would still find that "copy" valuable.

Because of the variety of ways in which "form" has been used, and its centrality to understanding human systems, I will characterize form from the perspective of philosophical aesthetics, where it has been most studied, and summarize important aspects of that characterization afterward.

Characterizations of Form

Form arose as a philosophical construct to provide resolution to the dialectic between being and becoming: which is more fundamental—stability or change?

The ancient Greek philosopher Heraclitus (Ephesus, fifth to sixth century BCE) observed that everything exists in flux like a river. One cannot step twice in the same river, for the waters always flow on. "In the same rivers we step and we do not step. We are and are not." Yet, "by changing it rests."[18]

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17 Alex Garcia-Rivera, *The Community of the Beautiful: A Theological Aesthetics* (Collegeville, MN: Liturgical Press, 1999), pp. 65–74.

18 Heraclitus, *Fragments* 41, 81, 83, in Milton C. Nahm, *Selections from Early Greek Philosophy* (New York: Prentice-Hall, 1968), pp. 62–77.

For the ancient Greek philosopher Parmenides, either something exists or it does not exist. As there is no possibility between existence and non-existence, change does not occur and is an illusion. Everything is fixed.

Plato resolved the dialectic through the use of forms, which he apparently believed were "more real" than the physical world we perceive. Aristotle denied the reality of a separate form, but defined a substance as a necessary combination of form, called "substantial form," and a precursor to matter, called "primary matter." With the relative importance of form in Hellenistic philosophy, the controversy between being and becoming resolved with stability as more fundamental than change. Aristotle proposed "accidental form" as a description of the state a substance happens to be in. For example, "clay" has a substantial form that distinguishes it from concrete or wood and a piece of clay has an accidental form namely being shaped as a ball or a square or a horse.

The role of form in understanding nature declined in the Western Enlightenment. However, the stability of existence was still presumed to be an aspect of reality. In the twentieth century, physicists discovered that the physical universe was in constant flux. Some physicists began looking to Eastern philosophies for a replacement to crumbling Western metaphysics, while some philosophers, such as Whitehead, Heidegger, and Nietzsche, began revising Western philosophy to accommodate the new scientific findings.

Wladyslaw Tatarkiewicz, in his book *A History of Six Ideas*, describes several meanings of "form." The English word "form" derives from the Latin *forma*, which translates two different Greek words: *morphe*, which refers primarily to visible forms, and *idea*, which refers to conceptual forms.

Although Tatarkiewicz describes form primarily as it relates to *aesthetics*, the study of beauty, a brief review of the history of the concept illustrates a variety of meanings in the concept's 2500-year-old history. Tatarkiewicz describes eleven senses of form in aesthetics but only his five major senses are significant for this investigation. Tatarkiewicz' first three concepts of form (A) arrangement, (B) appearance, and (C) contour arose within aesthetics, and the next two concepts of form (D) substantial form and (E) a priori form arose within general philosophy.

Form A refers to an *arrangement of parts.* Form A unites or melds elements, components or parts into a whole. The correlates of form A are components, elements, parts, colors in painting, and sounds in music. Form A is an abstraction; a work of art is never just an arrangement but consists of parts in a certain arrangement. For example, the form of a portico is the arrangement of its columns; the form of a melody is the order of its sounds. The ancient Greeks designated beauty as the arrangement or proportion of parts: commensurability for visible beauty, such as works of architecture and sculpture, and consonance for audible beauty, such as musical works. For example, strings produce harmonious sounds when their length corresponds to simple numerical ratios, such as one to two (octave) or two to three (fifth). A temple portico is perfect if its height, width and the arrangement of columns are computed according to the accepted module (in Doric temples, architects assumed five to eight as the correct ratio of the width of the columns to the spaces between).[19]

In Tatarkiewicz' survey of the history of form A, he describes it as (1) a general arrangement; (2) a correct, beautiful, harmonious arrangement; and (3) an arrangement which is rational, regular, and expressible in numbers. In his analysis, he distinguishes a new sub-sense of form A (any arrangement) for a *harmonious or regular arrangement* (form A1). Another sub-sense of form A is the term "*structure*," which Tatarkiewicz calls form A2. Form A2 designates only "non-adventitious forms shaped on the outside by inner forces," such as biological and geological structures. Literary art also uses sub-sense A2 to express the intent that literary works have forms which arise due to natural laws and processes rather than arbitrarily.[20]

From an information-theoretic perspective, form A refers to an arrangement or pattern of elements. In physics and other mathematically grounded sciences, mathematical functions may describe the arrangement of the elements. In biology, the arrangement of amino acids in a protein would refer to its form A. Form A1 occurs in the physics of music, but also describes what biologists call "the beauty of DNA"—the regular arrangement of nucleotides in a double helix as well as the harmonious utilization of that arrangement in biological process. Form A2 refers to a variety of biological structures, such as the branching of limbs in a tree, the branching of blood vessels in an animal, or the location of limbs on an insect.

Form B refers to the *appearance* of things or what is *directly given to the senses.* Tatarkiewicz contrasts it with content, import or meaning as its correlative. For example, the sound of words in poetry is its form, and their meaning its content.[21]

Form B, in contrast to form A, is given to the senses and thus by definition concrete. While abstract painters stress form as arrangement (A), impressionist painters stress form as appearance (B). In the thirteenth century, Saint Bonaventure noted a distinction between an arrangement (form A) enclosed by line and the external appearance (form B) or beauty of a thing.[22]

As described in Chapter 7, Peirce grounds his metaphysics in phenomenology, the study of direct experience. Form B occurs in the biology of vision processing as the separately characterized constructs of color, shape, motion, and so on combine in the brain prior to their influence by higher, cognitive regions. In technology, the arrangement of pixels on a television or computer monitor would comprise the form A of the screen while the activated pixels would comprise the form B of the image. The form differs from the elements (liquid crystal diodes) and content (photons emitted by the diodes).

Form C refers to the boundary or *contour* of an object. It informs matter or material as its opposite and correlative. Form C is synonymous with contour, figure,

19 Wladyslaw Tatarkiewicz, *A History of Six Ideas: An Essay in Aesthetics* (Hingham, MA: Kluwer Boston, 1980), pp. 220, 222.

20 *Ibid.*, pp. 227–8.

21 *Ibid.*, pp. 220–21.

22 *Ibid.*, pp. 221, 228.

and shape, or, in three dimensions, surface and solid. It is applied in the visual arts to the works of architects, sculptors, and painters.[23]

Form C resembles form B as used in everyday speech, but form B takes in both contour and color, while form C takes in only contour. If form B is a natural concept in poetics, form C is the natural one for the visual arts, which are concerned with spatial forms.[24]

In object-oriented analysis, contour refers to the boundary of the object and helps determine where encapsulation can occur. In cognitive science, contour occurs primarily in the study of vision and computer vision, though it could provide a useful tool for describing the boundary conditions and basins of phase space, described later in this chapter. Contour also describes the empty space that occurs in some of the emergent systems discussed in this book. As described in Chapter 4, the contour of the internal space created by the four proteins in hemoglobin provides a place for the possible transport of iron molecules. The boundaries of the empty space relate the existing aspects of a person's form to the constitutive absence necessary for some emerging systems of the body, and together these existent and constitutively absent relationships form the soul.

According to Tatarkiewicz, antiquity particularly valued form A*,* the Renaissance favored form C, and the twentieth century stresses form B.[25] In a garment or tapestry, form A refers to the pattern, form B refers to the appearance, and form C refers to its outline. In a computer program, form A refers to its algorithm, form B refers to its user interface (or for internal programs, its application program interface), and form C refers to its functional scope (and for object-oriented programs, what attributes and methods are encapsulated). In biology, form A describes the arrangement of proteins in a metabolic cycle, form B describes the appearance of crystalline materials and melatonin and other proteins that reflect light, form C refers to the contour of the surface of a drop of water, the outer boundary of slime mold or a cell wall.

Tatarkiewicz' next two definitions of form occurred within philosophy.

Form D refers to the *substantial form* invented by Aristotle and means the *conceptual essence* of an object. Another Aristotelian term for form D is "entelechy." The opposites and correlates of form D are the accidental features of objects. Aristotle regarded form as the essence of a thing, as its necessary and non-adventitious component: "By form I mean the essence of each thing." He also identified form with action, energy, and purpose, that is, with the active element of existence.[26]

As mentioned in Chapter 1, form is used for Aristotle's substantial form derived from Plato's "Ideas." Plato's translators into Latin used the term form, and they were followed in this by some of his translators into the modem languages. Tatarkiewicz states that translating "idea" by "form" is justified to some extent, because in everyday Greek *idea* meant appearance or shape (form B) but Plato then introduced a different meaning. Because the translators retained the original meaning of "idea",

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23 *Ibid.*, pp. 221, 233.

24 *Ibid.*

25 *Ibid.*, p. 234.

26 *Ibid.*, pp. 221, 234. Aristotle, *Metaphysics* 1032b1; see also 1050b2; 1041b8; 1034a43.

and selected "form" as its equivalent, "form" acquired still another, metaphysical meaning.[27]

Tatarkiewicz does not distinguish between Aristotle's use of form and Plato's, though each could be a separate sub-sense of Tatarkiewicz' form D. Aristotle relocated Plato's unchanging forms in matter. Alfred North Whitehead's "eternal objects" (Chapter 7) are similar to Plato's use of form (idea), and would fit within the same sub-sense.

Form E refers to the *a priori form* used by Kant. For him and his followers it meant the *contribution of the mind* to the perceived object. The opposite and correlate of the Kantian form is the sense manifold, which has a subjective dimension, that is, "what is not produced and introduced by the mind but is given to it from without by experience." The neo-Kantian philosopher Ernst Cassirer wrote that to see the forms of things is no less important a task for a person than to know the causes of things. Kant described form E as a property of mind that compels us to experience things in a particular way, or "form." One finds this form in objects because the subject imposes form upon them. Form E's subjective origin endows it with the unusual attributes of universality and necessity.[28]

To summarize, Tatarkiewicz' five major senses of form are listed in Table 2.1. Although I will occasionally refer to all five characterizations of form, the distinction between form D (substantial form) and form A (arrangement) will occur most frequently, with some attention to form C (contour or boundary) with respect to system boundaries.

Table 2.1 Tatarkiewicz' five major senses of form

Sense	Description	Correlate
A	Arrangement	Elements, components, or parts
B	Appearance	Content
C	Contour	Matter or material
D	Substantial form	Accidental features
E	A priori form	Sense manifold

In this book, I reinterpret Aristotle's substantial form as a dynamic and emergent collection of constraining relationships, and form D also characterizes the reinterpreted form. As described in Chapter 7, Whitehead's "eternal objects" revise Plato's "form" in a dynamic framework of event, and Jonathan Edwards's tendencies replace Aristotle's "substantial form" with a dynamic constellation of relationships. The revised form (form D) also utilizes the arrangement of components (form A) rather than an essentialist substance.

In summary, philosophers in late antiquity assumed form to be static, that is, active but not evolving, and prior to physical existence. Plato believed form to be separate

27 Tatarkiewicz, *A History of Six Ideas*, p. 236.

28 Ernst Cassirer, *An Essay on Man: An Introduction to the Philosophy of Human Culture* (New Haven: Yale University Press, 1944), ch. 9; Tatarkiewicz, *A History of Six Ideas*, pp. 221, 234, 236.

from physical existence, and Aristotle believed both form and "primary matter" were necessary for substance. Later Platonists describe separate realms from which forms progressed or receded. Although significant in early "scientific" accounts of nature, modern scientific discussion excludes form and relegates it to artistic endeavors. However the a priori, essentialist and reductionist philosophical approaches assumed in the early development of modern science have proven inadequate to explain the more recent advances of evolution, cosmology, and quantum mechanics.[29]

Scientists must now re-examine their philosophical presuppositions to develop adequate models of reality. If the world supported a reductionist and static worldview, an accurate philosophy of nature might require only Aristotle's substantial form and not require forms that evolve dynamically. Conversely, if the world required a dualistic or essentialist, static worldview for adequate understanding, then a priori forms might prove fertile for investigation. However, as the universe appears dynamic, emergent, and without a mechanistic ground, I argue an accurate philosophy of nature requires a coherent model of emergent relationships that comprise the ever-changing world. In the revised interpretation, form is best described neither as a priori nor essentialist, but as the information content of emergent systems.

Peacocke's Form as Information

The scientist–theologian Arthur Peacocke argues against taking a static view of the world because almost all entities and relationships are subject to change—though on widely disparate time scales. He does not subscribe to a metaphysical shift from entities to "events" (such as Whitehead's process philosophy provides), but believes that the world can be described in terms of the changes to entities and relationships over time. Science can reliably attribute causality only when "some underlying relationships of an intelligible kind, between the successive forms of the entities have been discovered." The explanatory relationships involve an understanding of both how the entity's constituent relationships give it the form it has and how changes in the "internal" relationships manifest themselves as observations on the system as whole.[30]

For Peacocke, the relationships of the natural world have a dynamic character. One cannot separate the observed structures of the world from how they came to be that way. History is a seamless web of continuity. For Peacocke, "the 'being' of the world is always also a 'becoming'."[31]

Patterns of information flow (in terms of molecules with distinct properties) provide order and sufficient stability over time to determine the complex interactions

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29 For example, George Ellis, "Physics and the Real World," *Physics Today* 58(7) (2005): 227–62; Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: Belknap Press, 1982).

30 Arthur Robert Peacocke, *Theology for a Scientific Age: Being and Becoming—Natural, Divine, and Human* (Minneapolis, MN: Fortress Press, enl. edn, 1993), pp. 44–5.

31 *Ibid.*, pp. 61–2. Although Peacocke's "becoming" is temporal rather than metaphysical, it provides a metaphor for metaphysical investigation.

that ensure biological life. Examples of information flow in biology include metabolic pathways, ion flow for neuron activation, and genetic signaling pathways.

Peacocke suggests form can describe patterns of information, which are stable. In emergent systems, self-organization engenders new patterns and forms of organization. Peacocke describes that aspect of emergence as a "determination of form through a *flow of information*." He conceives of causal effectiveness as the transfer of information rather than the transfer of energy.[32]

Claude Shannon suggests information is separate from energy or matter, because information can easily flow in the opposite direction to energy or be communicated by the lack of energy as occurs, for example, in switches. One can measure the amount of information conveyed by the number of yes/no (binary) decisions, called a *bit*, required to communicate the alternatives. For example, to choose among eight items requires three yes/no decisions.[33]

Information measures the order or organization of a message, and as entropy is a measure of disorder, information measures negative entropy. Measuring information as decisions and negative entropy has its limitations, such as in modeling quantum mechanics or open systems of biology. These limitations in "classic" information theory occur because of Heisenberg uncertainty and the difficulty caused by the lack of closed boundaries in open systems, though those limitations are more accurately described as a limitation of that model of information rather than of information itself. For example, physicists following David Bohm also speculate on a matter–energy–information triad where information plays an active role. Donald MacKay also discusses the flow of information separate from the flow of energy.[34]

However, information provides an alternative to the essences of substantial form for describing the organizing principles of existing entities. Rather than Shannon's bit string that characterized a one-dimensional measurement of information as a measure of uncertainty, I use information to characterize organization in systems.[35]

Dynamic Form

Traditionally, form describes the unchanging aspect of what exists which is otherwise in flux. In that sense, the term "dynamic form" is an oxymoron. However, some relationships change much more slowly than others providing the illusion of permanence. With the discovery of the Big Bang in the twentieth century, scientists

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32 *Ibid.*, pp. 50–61; Peacocke's italics.

33 The $\log_2$ of the 8 possible decisions. Split the 8 items into two groups of 4. First decision: choose between two groups of 4. Split the chosen group in half. Second decision: choose between two groups of 2. Split the chosen group into its individuals. Third decision: choose between the two individuals.

34 Bertalanffy, *Perspectives on General System Theory*; Donald MacCrimmon MacKay and Valerie MacKay, *Behind the Eye* (Gifford Lectures, 1986; Oxford, UK; Cambridge, MA: B. Blackwell, 1991), p. 46; F. David Peat, *Active Information* (11 July 1999); available from http://twm.co.nz/activeinfo.htm (accessed 28 February 2005).

35 For a discussion of alternatives to Shannon's theory, see Hans Christian Von Baeyer, *Information: The New Language of Science* (Cambridge, MA: Harvard University Press, 2004).

know that nothing natural has existed forever, which means that all that exists now, had to come into existence—and that involves change. One could discard "form" as antiquated, but then one would need to develop a new construct to describe the relatively stable aspect of what changes more rapidly, and without the benefit of two millennia of scholarship. Thus, "dynamic form" captures the permanent aspects of phenomena under investigation while acknowledging its eventual change. To the extent possible, I use "dynamic form" as a substitute for Aristotelian "substantial form," while discarding Aristotelian "substance."

Scientifically, dynamic form hides the slowly changing aspects which the scientist chooses to ignore, such as ignoring the 14-billion-year changes in cosmology and the 4-billion-year changes in geology while studying the earth's current geography, or ignoring the 14-billion-year changes in cosmology and the 2-billion-year changes in evolution to study the changes in mental function in humans over the past 100 years. In particular, biology post-evolution requires dynamic form where one can study the form of an organism as it developed over an individual lifespan and ignore the slower, dynamic shift of species as they evolve.

One treats the thread as the material in forming a garment or tapestry, but someone formed the thread from fibers of wool or cotton, and these forms have properties—length, thickness, texture—which do not reduce to the individual fibers. Dynamic form highlights an apparently permanent base against which change happens both more quickly and more slowly. While a substantial form allows for change (as various accidental forms) but cannot evolve, a dynamic form can slowly drift or evolve. From a systems perspective, dynamic form "encapsulates" the slowly shifting change and treats that as fixed while providing the appearance of permanence to slowly moving change.

Substantial form is a primitive philosophical category, and artists, architects, and aesthetic philosophers have described many characteristics of aesthetic form. Studying dynamic form requires knowledge of its internal structure. Systems theory provides a structure for dynamic form. Out of all the changing relationships comprising a system, one decides the changes to ignore (encapsulate). Peripheral relationships change and have no significant effect on an entity studied. Similar to Aristotle's accidental form, "accidental" relationships change the arrangement, appearance or contour (forms A, B, C) of the entity, but it retains continuity of identity (form D). One ignores the other slowly shifting, evolving, but still "dynamic" relationships. By fixing the dynamic relationships in one's mind and ignoring their real continued change, one can "know" the dynamic form as a mental concept (Kantian form E).

Dynamic form provides a philosophical foundation for systems, and systems theory has mathematical, logical, and computational tools to model (and thus understand) dynamic forms.

Rather than describe the "essence" of a human person, one can describe the dynamic form of the person. One can model that dynamic form using systems. In terms of the cognitive disciplines, both philosophy and computer science contribute abstractions to model which previously was considered a person's "essence" and could only be discussed ineffably using religious language of "soul." However, both dynamic forms and systems consist of relationships, and thus "relationship" must also be defined. The next section examines relationships as constraints from a pragmatic perspective.

Constraints

Constraints impose limitations. The word constrain derives from the Latin *constringere*, to "bind tightly together." If one conceives of entities as fixed, constraints add additional restrictions. However, if nature and mind consist of relationships in various processes of flux, constraints define what actually exists and limit what one can know.

From a pragmatic perspective, all meaningful relationships constrain reality. For Peirce, if the relationship has no conceivable effect, then it has no meaning. For Bateson, if the relationship makes no difference, it contains no information. This book works with the hypothesis that reality is inherently relational. Relationships have material, spatial, temporal, and/or energetic manifestations. Relationships also have an informational aspect. One can examine the information in relationships through information sciences of systems theory, cybernetics, information theory, game theory, and computer science using tools of mathematics and logic.

Mathematical Constraints

In algebra, constraints restrict the value of a variable. The mathematical equation $x > 3$ restricts the value of x to have a value greater than 3. One can combine multiple equations that a variable must satisfy. When combined, the equations $x > 3$, $x < 10$ and $x-2 > 3$ restrict the value of x to have a value greater than 5 and less than 10.[36]

One can write equations with more than one variable. The equation $y = x + 1$ constraints the relationship between the values x and y where y has a value larger than x by 1. If one were to graph the equation on a two-dimensional Cartesian plane, the graph of the equation would form a straight line.

In these equations from basic algebra, the domain of the variables consists of numbers. The domain of a variable refers to all potential values the variable could take. Computer scientists use another branch of mathematics called discrete mathematics. In *discrete mathematics*, the domain of a variable consists of a discrete set of values. The mathematical construct of *set* developed in the nineteenth century is a collection of distinct entities regarded as a unit.

Consider a variable x, whose domain consists of the letters of the English alphabet, "a", "b", "c", … "z". One could specify a constraint on the variable x such that it occurs on the range "a" through to "m". One could specify a smaller collection of letters called a *subset*—such as the English vowels "a", "e", "i", "o", "u"—and constrain the value of x to be a vowel, or to not be a vowel. More specifically, one defines the *class* named "vowel" as the set of letters "a", "e", "i", "o", "u" in the domain of letters and constrains x to that class.[37]

Discrete mathematics relates to information theory. In general for any set over the domain of English letters, one decides whether "a" belongs or does not belong, whether "b" belongs or does not belong, and so on. In terms of information theory, one makes 26

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36 By solving the equation $x-2 > 3$, one finds $x > 5$.

37 One can model the letters of the alphabet as objects with no attributes or methods (or perhaps one attribute to provide its "name"). To model both the "domain" and the "classes" of "letters" in an object-oriented language would require multiple inheritance.

decisions about whether a particular letter belongs to a class, and thus a class on the set of letters contains 26 bits of information and can take on 2^{26} (about 67 billion) values.[38]

If one constrains the value of *x* to be a letter that occurs after “n” and before “p” then one does not add any new information by also constraining *x* to be a vowel, because the constraints on *x* already specified the information that *x* has the value “o”. Computer scientists call the process of figuring out the value of a variable given a collection of constraints a “constraint satisfaction” problem. Sometimes the constraints conflict and the problem has no solution. In that case the information content of the solution consists of the information that the problem has no solution.

One can specify arbitrary sets of letters to define a class, such as the three letter set {a, b, c} the five letter set {e, p, q, t, v} or the two letter set {a, b} or the two letter set {x, y} in fact, one could create 325 sets of two letters each: {a, b}, {a, c}, ... {a, z}; {b, c}, {b, d} ...; {c, d} ...; {y, z}.[39] One can also create 26 sets of one letter each, that is, the set {a} the set {b} etc., and one can create one set with all 26 letters.

For a simpler example, consider the domain whose members consists of the first four letters of the English alphabet: “a, b, c, d.” Only 16 possible sets can occur: {a}, {b}, {c}, {d}, {a, b}, {a, c}, {a, d}, {b, c}, {b, d}, {c, d}, {a, b, c}, {a, b, d}, {a, c, d}, {b, c, d}, {a, b, c, d} and the empty set with no members {}, sometimes written ∅. No other sets of letters can occur. These sets have a “subset” relationship between many of them, where all the members of one set, such as {b, c} belong to another set, such as {a, b, c}. Mathematicians call a *lattice* the structure of all the possible sets and their subset relation. Figure 2.1 shows the lattice of the sixteen possible subsets of four letters.

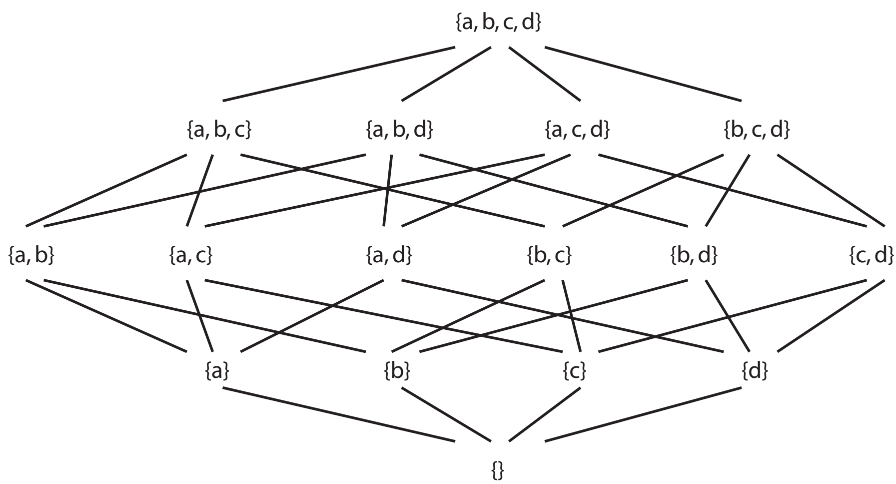

Figure 2.1 Lattice of a four-letter set

38 When a variable is restricted to have a single value, it can have only 26 values and thus contains $\log_2 26$ bits of information, or about 4.7 bits.

39 25 sets with “a”, 24 sets with “b”, etc. One counts the size using the counting formula $n(n+1)/2$ where $n = 25$ rather than 26 because duplicates “a, a” are not allowed.

Lattices provide a general way to understand constraints. If the lattice consists of all possible sets of constraints on a system, then one may diagram the addition of a constraint to a system by moving "down" in a lattice from the possible values of a variable given the current system of constraints. Pragmatism involves taking the current system of constraints into account when conceiving of a system's "real possibility."

Consider a different four element set of four names, {John, Mary, Peter, Paul}. As in the four-letter set, there exist 16 possible subsets of these four objects. If one treats those elements as names of people, technically called defining a "semantics," one can imagine non-mathematical constraints that refer to the 16 sets: "the set of males", "the set of females", "the set of names beginning with the letter 'P' ", and so on.

The lattice makes precise something that will become very important later in the book (Chapters 7, 8). If one refers to a person in the collection, then the person *potentially* could be any of the four. Mathematics makes precise the domain, or set of potential values, for a variable. If one has the information that the name begins with the letter "P," then the *real possibility* would only include the people whose names satisfy the constraints, namely Peter or Paul. Given that real possibility, the constraint that the person is male adds no information, and the constraint that the person is female would contradict what is already known, and not be possible. A mathematical description of constraint clarifies the philosophically indeterminate distinction between potentiality and real possibility. A variable can potentially take any value in its domain and has the real possibility of taking any value that satisfies its constraints.

A phase space provides an analogous abstraction for numeric dimensions as a lattice provides for discrete sets. A *phase space* maps all the potential states of a system into a space defined by a set of dimensions, each of which corresponds to a parameter of the system. For example, one would represent a moving particle in three dimensions as a six-dimensional space incorporating three dimensions of position and three of momentum. One would then represent a system of n particles as a phase space of $6n$ dimensions. The coordinates of phase space thus represent the variable states of the system.[40]

Classical mechanical systems result in one distinct trajectory through the phase space, but in "dissipative dynamic systems" the particle loses energy along the path, for example, from friction, and may approach the same behavior as particles with other initial conditions. An *attractor* defines a set of points in the phase space in which trajectories with many different initial conditions end. There are various kinds of attractors such as points (corresponding to no change in the system), orbits (corresponding to cyclically recurrent states), pseudo-cycles (corresponding to overall but not precisely recurrent behavior) and the strange attractors of chaos theory (with unpredictable behavior due to exponentially divergent trajectories from

40 See James Gleick, *Chaos: Making a New Science* (New York: Viking Penguin, 1987), for a popular introduction to phase spaces and qualitative dynamics.

nearby points).[41] Constraints, lattices, phase spaces, and attractors give mathematic precision to emergence (Chapter 4).

Logical Constraints

What if the domain consists of neither numbers nor a discrete set?

In algebra, one specifies that a variable has its domain as a number, perhaps an integer or real number, and in discrete mathematics one specifies a set of potential values. In systems modeling, one often does not know the domain completely. One may still specify constraints as above, but unless one provides the information that the variable is a number or letter in the alphabet, one cannot use the relationships "greater than," "equals," "before," "after," or the addition operations.

In logic, one specifies those relations and operations on the "domain of discourse," that is, the arbitrary domain being discussed. In a logic over a discrete set, one could specify the "before" and "after" relations between the pairs of members in a set. As "before" and "after" are relations between two items in the four-letter example {a, b, c, d}, one would specify six "before" and six "after" relationships, for example, "a before b," "a before c," etc., and "b after a," "c after a," and so on. In the alphabet example, one would specify 325 "before" relationships and 325 "after" relationships as described above. Specifying the "greater than" relation for numbers is more difficult because the relation ranges over an infinite collection of numbers. It requires more sophisticated modeling formalisms from mathematics to describe infinite sets and the relations between members of those sets. Even more challenging is specifying the relations between unknown components in complex systems, such as the relation between sodium and potassium flows between cells in the human brain.

Although mathematical biologists can use sets to model some biological processes, the mathematics becomes complex because molecules and larger structures in a living cell do not behave like members of a set. Processes occur in parallel and in concert with each other, molecules perform diverse functions simultaneously and redundant processes protect the cell from any one molecule becoming essential to significant systems, thus one cannot easily define the set's elements. In a sense, biologists (and many other scientists) describe constraints on a system without specifying the components themselves. Using the mathematical example, one would define an ordering relation, such as "less than" or "before" without ever specifying what items (members in the domain) one orders. Although mathematicians cannot readily use such relations (isolated from any domain of discourse), biologists would happily notice that the "before" relation typically functions in opposition to the "after" relation, and perhaps humorously add that it occurs most of the time under certain experimental conditions with a few notable exceptions.

Although scholars who examine philosophical interpretations of information, such as Arthur Peacocke and Alicia Juarrero, primarily draw on information theory

41 See Heinz-Otto Peitgen, H. Jèurgens, and Dietmar Saupe, *Chaos and Fractals: New Frontiers of Science* (New York: Springer, 2nd edn, 2004), for a readable, but detailed, description of attractors and their fractal patterns.

as developed by Shannon to study communication links, one may find additional models of information that describe relationships in more recently developed areas of computer science. Relevant areas of study include the relational algebra of database theory and various graph logics and constraint logics of artificial intelligence.[42]

In the next section, I describe a modeling formalism for specifying constraining relations, without specifying the values in the domain upon which they hold. Because one cannot specify the domain of discourse in disciplines such as biology or religion as one can in mathematics or computer science, not only does one specify constraints on the members of the domain, one also specifies constraints on the domain itself. Just as one can specify constraints on numbers or letters of the alphabet that allow for more than one solution, one can specify constraints on relations in arbitrary domains that allow more than one domain to satisfy those constraints. One can create two constraints on items in an unspecified domain where the "before" and "after" relations hold as inverse relations, and graph those relations as in Figure 2.2.

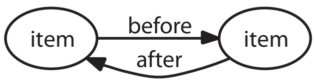

Figure 2.2 Graph of before and after relationship

The constraints specify that the domain can be any domain that admits two dyadic relations, called "before" and "after," where, in the language of logical predicates, if *before (x,y)* holds then *after (y,x)* holds and vice versa. Note the arrowhead points from the first argument to the second. Many domains would fit those constraints. In addition, there also occurs a class called "item" where those relations hold.[43]

42 Alicia Juarrero, *Dynamics in Action: Intentional Behavior as a Complex System* (Cambridge, MA: MIT Press, 1999); Peacocke *Theology for a Scientific Age*; Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach* (Prentice Hall Series in Artificial Intelligence; Upper Saddle River, NJ: Prentice Hall/Pearson Education, 2nd edn, 2003); John F. Sowa, *Knowledge Representation: Logical, Philosophical, and Computational Foundations* (Pacific Grove: Brooks/Cole, 2000); Jeffrey D. Ullman and Jennifer Widom, *A First Course in Database Systems* (Upper Saddle River, NJ: Prentice Hall, 2nd edn, 2002).

43 In typed predicate logic, $x,y \in Item$, $before(x,y) \leftrightarrow after(y,x)$, but one has not yet specified whether the formula holds for some *x,y* or all *x,y*. For more on logic constraints as used here see Mark Graves, *Theories and Tools for Designing Application-Specific Knowledge Base Data Models* (Ann Arbor, MI: UMI, 1993); Bob Carpenter, *The Logic of Typed Feature Structures: With Applications to Unification Grammars, Logic Programs, and Constraint Resolution* (Cambridge Tracts in Theoretical Computer Science, 32; Cambridge, UK and New York: Cambridge University Press, 1992); Gert Smolka, *Principles and Practice of Constraint Programming—Cp'97: Third International Conference, Cp'97, Linz, Austria, October 29–November 1, 1997: Proceedings* (Lecture Notes in Computer Science, 1330; Berlin and New York: Springer, 1997).

Constraining Relationships

During the early twentieth century, philosophers and scientists ascribing to "logical positivism" believed one could confine oneself to verifiable, empirical, scientific statements and eliminate metaphysics through the logical analysis of language. Later philosophers of language realized that one could not completely define any real concept, much less all of them. For any descriptive definition of an object, such as a cup or chair, one can always find or create examples of the concept which do not fit in the prior definition, such as in a modern art museum. Pragmatism supports empirical, scientific statements and avoids the incompleteness of language by leaving meaning open to possibility.

Consider the "before" relation over letters of the English alphabet. One can state *before (a,b)* and *before (b,c)*, and notice *before (a,c)* is also true. In general, if *before (x,y)* and *before (y,z)*, then *before (x,z)*. The *before* relation over letters has the property of "transitivity," as just defined. However, in many domains, the *before* relation is not transitive.

Consider the domain in which one might ask: which came first, that is, "before" the other, the chicken or the egg? Or, ignoring human calendars, which happens before the other—sunrise or sunset? Transitivity only occurs in linear domains, not domains where the relationships form a cycle. In other domains, the concepts themselves depend upon time and may have interdependent aspects: in the domain of romantic relationships, who falls in love first? In physics, gravity is mutual attraction, and many biological processes have interdependent aspects.

In language, concepts depend upon the encapsulation of dynamic forms (in the sense of form E, Kantian contribution of mind) to separate salient from omitted relationships. That "fixing" also occurs to some extent in natural systems, when other system's responses depend upon the relative rate of change, that is, only some differences make a difference. Only relative to some "fixed" set of constraints can one describe temporal order either within concepts or across constellations of relationships. Pragmatism differentiates between the possible relationships comprising a system and the relationships one fixes as actually occurring. For humans those constraints typically become fixed either through biology or social interaction. According to social convention, many Europeans and Americans may consider sunrise before sunset by encapsulating (and ignoring) modern knowledge of the solar system having decided that beginnings of a day come before endings, while those of Jewish descent consider sunset to occur before sunrise. Encapsulation occurs in biology also. A cell membrane (or wall), organs in an animal, an organism and other concepts taught in elementary school biology (and most elementary school subjects) encapsulate the slower shifting, less salient relationships to emphasize the ones that have greater "significance." That "significance" refers to a measure of information—some relationships make a greater difference—they constrain more potential configurations (eliminate more combinations in a lattice or affect a larger region of phase space). Those relationships inform to a greater extent the object's real possibility.

The arrangement of constraints defines the structure of dynamic form (in the sense of form A) and the structure of systems. Form B describes the appearance of the network of relationships as opposed to its content. Describing the linear or circular pattern of the *before* relation examines its form B. Form C refers to the contour of the outermost relationships in the constellation. The order of sunrise and sunset depends upon where one draws the line between relationships considered or not: does one include social constructs of calendars and days, the historical assumptions of one's culture, astronomical data of the solar system, or that human metabolic activity increases in the daylight (as opposed to nocturnal animals)?

Modeling Dynamic Forms as Systems

Graph Structure in Systems

One can represent the arrangement of constraints that form the structure of a system as a graph. Peirce developed existential graphs, which diagram logical operations, as a tool for logical analysis.[44] The computer scientist and logician John Sowa has adapted Peirce's existential graphs to conceptual modeling. John Sowa's conceptual graphs provide a logical modeling framework for understanding the concepts and relationships in a domain of study, and I describe a simple graph modeling language.

In logic, the constraining relationships that have two parameters are called *dyadic relations*. For an interconnected domain, one may find it useful to diagram the entities and relationships as a graph. The entities and constraining relationships form a graph where the entities are diagrammed as *nodes* (or *vertices*) and the constraining relationships are diagrammed as *edges* labeled with the type of constraint.[45]

Consider a person. A person has a name, sex, and a mother and father, for whom the person is a child. The system of a person consists of relationships between those constructs, and one can diagram those relationships as a graph, as shown in Figure 2.3.

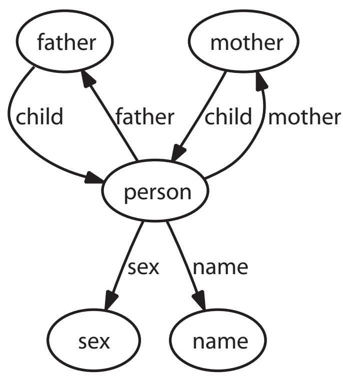

Figure 2.3 Graph of person with mother, father, name, and sex

44 Don D. Roberts, *The Existential Graphs of Charles S. Peirce* (Approaches to Semiotics, 27; The Hague: Mouton, 1973); Sowa, *Knowledge Representation*.

45 Constraints do not have to be dyadic for the logical operations to work, but I only describe dyadic relations as the use of graphs greatly simplifies the explanation.

In addition, as the mother and father are each a person, one can include relationships for them and specify that the sex of a father is male and the sex of a mother is female.[46] Figure 2.4 shows the expanded graph with mother's name and sex and father's name and sex included.

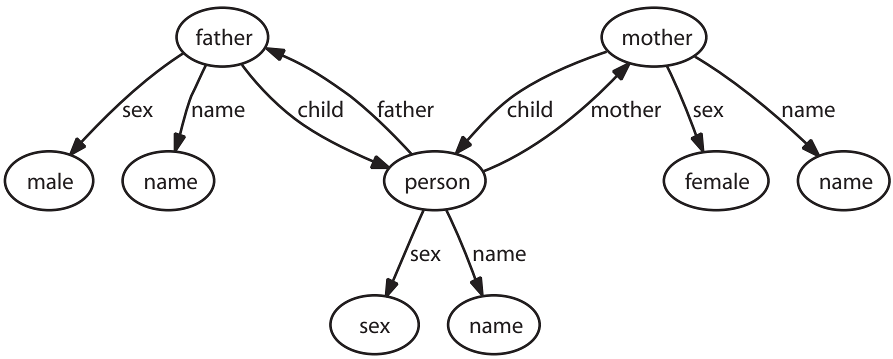

Figure 2.4 Graph of biological family with one child

Some people also have ways to contact them in modern societies, such as phone numbers, email addresses and physical addresses; they belong to organizations; and some of them write articles. Figure 2.5 shows a person with name, email, phone number and address, where the person is a member of an organization and author of an article. An article also has a title and a year, and an organization also has a name, phone number and web site.

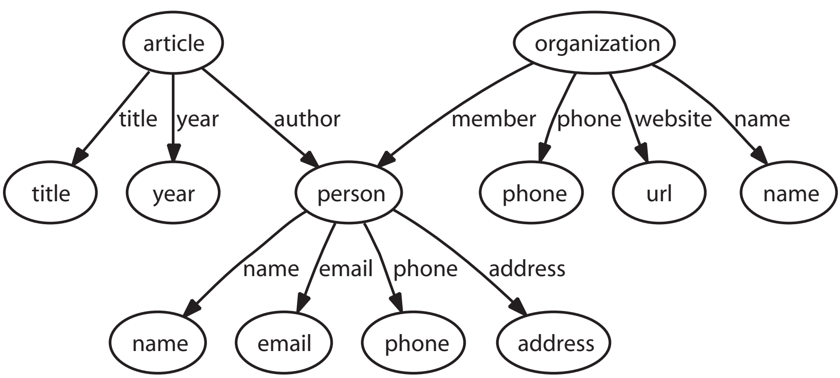

Figure 2.5 Graph of author with contact information

46 The diagram illustrates the biological relationship of "sex" which differs from the cultural relationship of "gender".

One could include many more relationships. A person also has a body, a memory of past events, and so on, and one can combine all these relationships into a graph of a person, as shown in Figure 2.6.

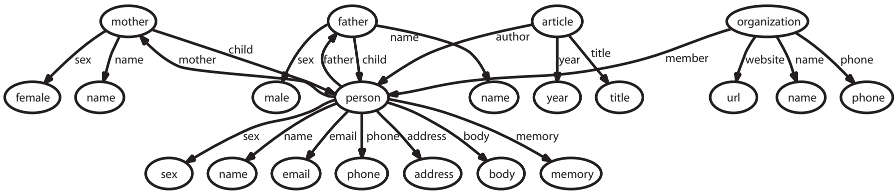

Figure 2.6 Graph of person in several biological and cultural relationships

Each of the nodes in the graph remains incomplete. A person's body or memory would contain many other relationships. Even apparently simple nodes, such as "name" or "sex" actually refer to complex relationships, they only have straightforward names to abstract those relationships. For a person's name, such as "Paul" or "Mary," the other people with that name also relate to the name itself whether an historical or an immediate namesake, and the name may have a cultural meaning. A person may value only some of those relationships, but others do influence the person, even if not intended, for example, having the same name as someone who later becomes president or a serial killer may slightly shift a person's self-perception in that society. For a person's sex, many complex biological relationships determine a person's sex, especially the transmission from the parents of certain genes.

On a technical note, although I describe graphs in terms of entities and relationships, the graph actually shows the structure of dyadic constraints. As everything is a relationship in this approach, "entities" are only a way of referring to the relationships that change more slowly than others. "Relationships" can refer to either the nodes of identity (i.e., logical variables) or the edges (dyadic constraining relationships or "constraints"). The entire graph refers to a system (or some of the relationships between its sub-systems) and part of the modeling and analysis process requires choosing which constraints form a system, and thus lie within its boundary or contour.

All the relationships of a person would form a very complex graph. One way to simplify those relationships scientifically requires grouping the relationships to bring similar relationships together. As described in the next chapter, one effective way to group relationships is to separate biological from cultural relationships. But first, another example showing biological and chemical relationships in genetics will prove useful.

DNA (deoxyribonucleic acid) plays a central role in the biology of life. If one examines DNA in isolation, one can examine its structural characteristics as a large chemical molecule. However, only in relation to numerous other complex molecules does its biological role emerge. Furthermore, the internal structure of DNA conveys little useful information without taking its biological context into account—on its own, DNA does not *do* anything.

One can use the modeling language to describe DNA both biologically and chemically. The biological process includes replication, transcription, and translation, and they depend upon the underlying molecular interactions.[47] Graph modeling language illustrates the chemical and biological structure of DNA. First consider the biological structure.[48]

Every living cell stores genetic information in the chemical structure of DNA. DNA encodes information needed to produce proteins that take part in and regulate all aspects of cellular life, including the mechanisms for replicating DNA when the cell divides. The pathways for constructing proteins from DNA involve transcribing a stretch of DNA into ribonucleic acid (RNA), then translating the (messenger) RNA into a polymer of amino acids to build a protein. The primary protein involved in DNA replication is DNA polymerase, while the pathways for transcription involve RNA polymerase. Ribosomes synthesize the protein utilizing transfer RNA, which maps the nucleic acid sequence to an amino acid.

The entities of the translation and transcription process from molecular genetics include DNA, RNA, protein, DNA polymerase, RNA polymerase, ribosome and transfer RNA. The basic constraining relationships are:

- DNA polymerase replicates DNA
- DNA polymerase synthesizes DNA
- RNA polymerase transcribes DNA
- RNA polymerase synthesizes RNA
- Ribosome translates RNA
- Ribosome synthesizes protein
- Ribosome requires transfer RNA.

Figure 2.7 shows the associated graph for the molecular genetics example.

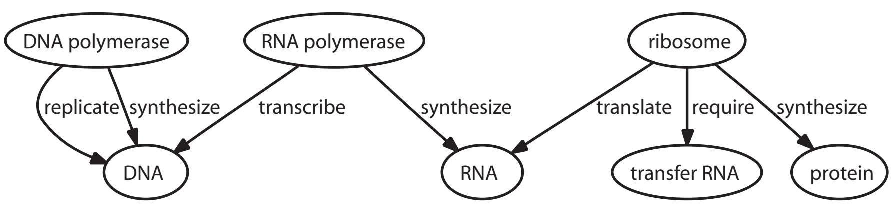

Figure 2.7 Graph of genetic transcription and translation

47 Chapters 3 and 4 describe the process more formally as physical- and biological-level descriptions of DNA, and the supervenience of the biological process on the physical ones.

48 Adapted from Mark Graves, *Designing XML Databases* (Upper Saddle River, NJ: Prentice Hall, 2002), pp. 48–50.

For readability, the nodes are labeled with the English name of the concept. However, each node in the graph expands into a sub-graph that describes its components. Consider the chemical structure of DNA. DNA consists of a chemically linked sequence of nucleotides. Chemists call that particular organization of chemicals deoxyribonucleic acid because of its chemical composition. The covalent bonds between nucleotides (called a *5'-3' sugar-phosphate link*) can also be shown as a graph. Figure 2.8 illustrates the graph between three linked nucleotides.

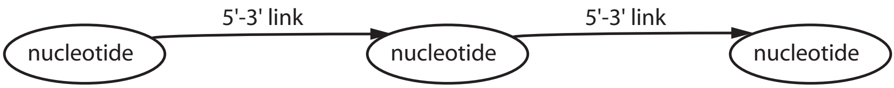

Figure 2.8 Graph of nucleotide links in DNA

DNA often occurs as two hydrogen-bonded chains of four nucleotides. The four nucleotides are adenylic acid, guanylic acid, cytidylic acid, and tymidylic acid. The four nucleic acids differ in their nitrogenous base, which restricts how the nucleotides can pair. Molecular biologists frequently abbreviate the four respective bases adenine, guanine, cytosine, and thymine as A, G, C, and T. DNA plays an important role in biology because one can abstract the four nucleotides and treat them as information. Not only do biologists' minds form an abstraction, but in a very specific way, the cellular processes itself treat the nucleic acids as abstractions that string together in a type of language. Figure 2.9 shows a double-stranded DNA with four linked nucleic acids whose bases consist of the sequence TCGA (thymine, cytosine, guanine, adenine).

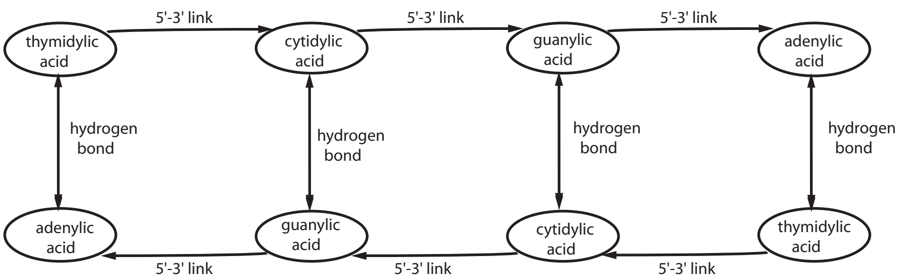

Figure 2.9 Graph of double-stranded DNA of sequence TCGA

Each of the nucleotides consists of a base, sugar, and phosphate group that can be shown in standard chemical diagrams. The chemical diagram maps onto this formalism, and the diagram of atoms can be expanded into a diagram of subatomic relationships, possibly utilizing Feynman diagrams if needed, thus forming a hierarchy of diagrams.

To summarize the graph language just described:

- A *graph* consists of a collection of nodes and edges.
- A *node* is an empty sub-graph. A *sub-graph* is a graph contained within another graph. For convenience in modeling, nodes may have descriptors, but they are only conceptually significant, not ontologically significant.
- An *edge* connects two nodes. The *label* of the edge is a word that describes the relationship between the nodes/sub-graphs. A directed edge (edge with an arrowhead) distinguishes the order of the parameters if the label is not symmetric.[49]

Although one may use the graphs for characterizing a domain at a single level of exposition, they become significant later in the book when used to describe the relationship between levels of exposition where properties of the higher-level entities emerge from interactions of the lower-level ones.

Graphs show the constellation of constraining relationships which constrain the possible configurations the natural or engineered phenomena may occur and still remain the same. Thus, graphs capture the structure of dynamic systems because its sub-graphs encapsulate the slower changing relationships fixed in any particular model of the system. In a single, logically consistent theory (such as typically occurs in a computational model), when one adds constraints to further refine the system, the higher-level systems would remain stable.[50]

However in natural systems, the addition of a constraint to a system may dramatically shift the possible relationships in which that system may occur with consequences that result in emergence (Chapter 4). For example, recall the alphabet example where different constraints could restrict the value of a variable to a single value, such as the letter “o”. If separate systems each have (possibly different types of) constraints that restrict a variable to a single value, those separate systems have an emergent constraint, namely that they have some equal (or similar) value. In the physical realm, that dampening of difference results in a variety of emergent phenomena (called first-order emergence in Chapter 4) such as surface tension in water or the ferromagnetic properties of iron. In a biological realm, constraints maintain the fidelity of the 6 billion “letters” of nucleic acid in DNA across cells in the human body, and in some statistical similarity to all the person’s relatives.

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49 Technically, the edge label is ontologically significant in this formalism, though this restriction can be removed in a more complex definition by defining labeled edges in terms of graphs. One then needs to define a set of “primitives” in terms of unique graph structures. One must also introduce a way to designate which nodes and labels in a sub-graph are not encapsulated, and thus available to the super-graph for use in additional edges.

50 In logic, the stability of the higher-level system occurs from the “monotonic” addition of constraints to the constituent system. Cf. Matthew L. Ginsberg, *Readings in Nonmonotonic Reasoning* (Los Altos, CA: M. Kaufmann Publishers, 1987).

Function in Systems

For Aristotle, a substance is a "principle and a cause."[51] For a system to model a dynamic form, systems must describe not only the relationships from which the entity proceeds (principle) but also the dependence between the two. From a systems perspective, dynamic form not only has a structure, a form has function.

Computer science and cybernetics provide a variety of formalisms to describe function. Programming languages and logic can simulate and mathematically model the functions of systems, especially using programming languages that explicitly represent constraints.[52] Cybernetics, as an aspect of systems theory, describes general properties of self-regulating systems. A systems (and cybernetic) approach to a person examines hierarchies of relationships organized into systems with feedback cycles of constraining relationships to balance modular flexibility and stability.

One of the limitations of most programming paradigms results from the strict separation of data and program. Graph structure is an aspect of information that typically occurs in the data of a computational system (such as a database). By interpreting information pragmatically rather than using a dualistic, Cartesian interpretation, one can retain the real possibility inherent in constraints and the natural dynamic processes inherent in nature. Philosophically, structure is a slow-moving process, and the structure of constraining relationships encapsulates functional characteristics. In practice, when modeling natural phenomena using artificial or statistical tools, one must presume a fixed set of constraints and model those functional characteristics explicitly. Constraints comprise dynamic forms, and dynamic forms encapsulate some constraints as less salient. Each constraint itself also encapsulates other constraints—in terms of graphs, the nodes and edges each encapsulate sub-graphs. Thus the modeling formalism of constraints also shares the characteristic of partially encapsulating relationships with dynamic forms. The difference between a constraint and dynamic form depends upon the complexity of the relationships in which it can participate, that is, the relationships the constraint or dynamic form does *not* encapsulate. (In the language of Chapter 4, one models first-order emergent systems as constraints and second-order emergent systems as dynamic forms.)

An important functional aspect of all the relationships, whether encapsulated or not, consists of the complexity of its topology (or structure), especially whether cycles of relationships provide feedback. Recall, cybernetics examines the control of a system based on the transfer of information between the system and its environment. In particular, cybernetics focuses on the mechanisms of feedback from the system's function to the environment and back to the system. A system has additional, primary, functions, but cybernetics examines how the system controls those primary functions through feedback.

Constraining relationships provides a mechanism for describing emergent systems, their feedback cycles, and what the researcher Donald MacKay calls a

51 Aristotle, *Metaphysics*, 1041a9.

52 See, e.g., Kim Marriott and Peter J. Stuckey, *Programming with Constraints: An Introduction* (Cambridge, MA: MIT Press, 1998).

"conditional readiness to reckon." MacKay describes feedback cycles using control diagrams. For MacKay systems utilize both energy and information, and causation can be understood in terms of energy or information. For example, one can explain a thermostatically controlled heating system physically in terms of mechanics and electrical systems or in terms of information flow.[53]

McKay emphasizes that one can trace chains of cause and effect at either a supervenient information level or a subvenient energy level. In the feedback system of a thermostat, one needs three perspectives to understand its function. First, from the physical level, the thermostat consist of physical objects, such as different types of metals, a supporting structure and a movable knob. Second, from an information and control (cybernetic) perspective, the thermostat has an effector, which changes desired temperature; a receptor, which receives current temperature; a comparator, which compares the desired and current temperatures; and an organizing system, which selects from possible actions to increase or decrease ambient temperature. Third, from a teleological perspective, one cannot understand why the temperature in a room is 70ºF without understanding that someone would set the thermostat to that temperature.[54] MacKay studied feedback in biological systems and points out the need for information and energy in many of those systems, too.

Nancey Murphy and Warren Brown utilize MacKay's control diagrams to model neurological correlates of moral responsibility.[55] This suggests that a diagrammatic modeling language may support an emergent systems approach to cognitive science from both biological and theological (ethical) perspectives.

Purpose in Systems

One can capture the patterns of relationships between systems as information and model their structure as graphs and their function as constraints, but what of their purpose or teleology? Aristotle distinguished between the *form* of an object and its *telos*, or ultimate aim.

Systems theory examines the structure and function of systems by examining their interrelated constituents. Although it provides a more synthetic approach than the analytical traditions from which it developed, it requires extension to explain the purpose of a system. A pragmatic systems approach requires examining the structure, function and purpose of systems.

The desire to understand purpose and teleology were key factors in Bertalanffy's and Wiener's theories, but the practical integration and application of their theories have emphasized the theories' analytical aspects, especially under the residual influence of logical positivism in philosophy of science and behaviorism in psychology. Bertalanffy wrote:

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53 MacKay and MacKay, *Behind the Eye*.

54 *Ibid.*

55 Nancey C. Murphy and Warren S. Brown, *Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility* (Oxford: Oxford University Press, 2007).

> We may state as characteristic of modern science that this scheme of isolable units acting in one-way causality has proved to be insufficient. Hence the appearance, in all fields of science, of notions like wholeness, holistic, organismic, gestalt, etc., which all signify that, in the last resort, we must think in terms of systems of elements in mutual interaction.
>
> Similarly, notions of teleology and directiveness appeared to be outside the scope of science and to be the playground of mysterious, supernatural or anthropomorphic agencies; or else, a pseudoproblem, intrinsically alien to science, and merely a misplaced projection of the observer's mind into a nature governed by purposeless laws. Nevertheless, these aspects exist, and you cannot conceive of a living organism, not to speak of behavior and human society, without taking into account what variously and rather loosely is called adaptiveness, purposiveness, goal-seeking and the like.[56]

Bertalanffy distinguished between two types of finality: static finality where an arrangement appears useful for a certain purpose, and dynamic finality, meaning a directiveness of purpose. Dynamic finality includes: direction of events toward a final state, for example, a time-independent constraint; directiveness based upon structure, such as feedback (or form); equifinality where "a final state can be reached from different initial conditions and in different ways" (i.e., an attractor in phase space); and true finality or purposiveness, that is, teleology in the original Aristotelian concept and presupposing thought and language. Ernst Mayr makes a similar distinction between behaviors: *teleomatic*, end-producing; *teleonomy*, end-directed; and *teleology*, goal seeking.[57]

A systems perspective on the relational aspects of a person describes the structural, functional and purposeful aspects of the relationships that comprise a person's body and interaction with their environment. In Chapter 4, I will return to the topic of purpose and suggest how teleology emerges from a system in the context of a higher-level system. But first, I will describe what I mean by "level" in the next chapter.

Systems, dynamic forms, and constraints each provide a perspective and general abstraction for capturing aspects of relationship occurring as fundamental to both mind and nature. Systems theory developed through general systems theory and cybernetics in the historical development of computer science and is more commonly accessible in object-oriented analysis to contemporary computer scientists and software developers. System theory examines the complexity and interdependence of relationships between the regularly interacting constituents that form a whole. Dynamic form draws from philosophical categories of form that indicate the unchanging aspect of what changes in nature, art, and mind, and encapsulates slowly changing relationships to fix relationships whose change affects the other relationships under consideration. Systems theory tends to focus on the relationships and dynamic form tends to focus on the whole, and together they describe the constellation of relationships comprising the whole. The language of constraints from logic and programming languages specifies what is meant by relationship, and

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56 Bertalanffy, *Perspectives on General Systems Theory*, p. 45.

57 Mayr, *The Growth of Biological Thought*, pp. 47–51. This work is further developed by Richard O'Grady and D.R. Brooks, "Teleology and Biology," in *Entropy, Information, and Evolution: New Perspectives on Physical and Biological Evolution*, (ed. Bruce H. Weber, David J. Depew, and James D. Smith; Cambridge, MA: MIT Press, 1988), pp. 285–316.

those relationships form logically consistent theories that each provide a coherent perspective on human systems which the next chapter describes as a level.

CHAPTER 3

Levels of Human Existence

What is Hierarchy? and what the use of Hierarchy?

Hierarchy is, in my judgment, a sacred order and science and operation, assimilated, as far as attainable, to the likeness of God, and conducted to the illuminations granted to it from God, according to capacity, with a view to the Divine imitation. Now the God-becoming Beauty, as simple, as good, as source of initiation, is altogether free from any dissimilarity, and imparts its own proper light to each according to their fitness, and perfects in most Divine initiation, as becomes the undeviating moulding of those who are being initiated harmoniously to itself.

The purpose, then, of Hierarchy is the assimilation and union, as far as attainable, with God, having Him Leader of all religious science and operation, by looking unflinchingly to His most Divine comeliness, and copying, as far as possible, and by perfecting its own followers as Divine images, mirrors most luminous and without flaw, receptive of the primal light and the supremely Divine ray, and devoutly filled with the entrusted radiance, and again, spreading this radiance ungrudgingly to those after it, in accordance with the supremely Divine regulations.

—Pseudo-Dionysius, *Heavenly Hierarchy* III.1–2

Introduction

How do natural systems organize? How can one clarify one's conception of natural systems?

When one examines the systems comprising the human person, one notices that many systems share components. The bones in one's skeleton provide structure for one's body; anchors for one's muscles and ligaments; protection for organs, nerves, and circulatory system. One's blood delivers oxygen, carries away waste and transfers heat to parts of the body. The systems of the human body overlap and interconnect in complex ways.

Some systems form structural hierarchies. Sub-cellular systems comprise cells, cells comprise tissues, tissues comprise organs, and organs comprise organisms. In addition to those structural hierarchies, functional hierarchies include a process that converts stored energy, which is part of a metabolic pathway, which is part of a metabolic network, etc, through the processes of human metabolism.

Another type of hierarchical relationship occurs when a collection of component systems constitute two different systems and the second system depends upon the first for its existence (technically called *supervenience*). Consider air molecules moving in a person's windpipe. At one level, the air molecules bounce off each other and off the cell membranes that form the windpipe, or trachea. In a typical person's windpipe about 10^{23} molecules bounce off each other with two significant features: first, each square inch of windpipe receives about 14lb of pressure from the bouncing molecules; and second, they move with a speed resulting in an absolute temperature of about 300K (80°–90°F). If the temperature drops significantly, the water in the cells will freeze. If the pressure drops significantly, the cell membranes (which push out at about 14lb/in^2) will explode, as graphically depicted in several science-fiction horror films set in outer space. The system of air molecules and cells provide a structural integrity to the hollow organ of the trachea.

At a second level, the air passing through the trachea contains oxygen going to the lungs and carbon dioxide coming from the lungs. In the lungs, the oxygen passes through the epithelial cells of the bronchioles into the blood stream where it flows throughout the body to different cells that use the oxygen and generate carbon dioxide that in turn the blood then carries back to the lungs, and finally the carbon dioxide passes through cells in the lungs to be expelled. The cells to which lungs carry oxygen and from which they carry carbon dioxide include the cells of the trachea. Note that the oxygen molecules passing through the windpipe participate in the metabolic processes of all the cells of the body including those comprising the windpipe and the lungs. For those cells oxygen participates in both structural integrity and metabolic processes. Without oxygen, those processes stop functioning and the person dies. Those biological processes also depend on the physical structural integrity provided by the air pressure and temperature of the air flowing into and out of the windpipe (and lungs).

The oxygen flowing through the windpipe participates in two systems: a physical system of air pressure and temperature that provides structural integrity to a person's respiratory system, and a biological system of respiration that provides the necessary component oxygen for cell and human life. In addition, the second system depends upon the first system for its existence. Oxygen respiration supervenes upon the structural integrity of the respiratory system provided by oxygen. As oxygen molecules occur twice in the supervenience relationship, oxygen occurs at two different levels of human existence.

Oxygen also participates in a third level. The air flowing in and out of the windpipe consists of different ratios of oxygen, carbon dioxide, nitrogen, and other gases, and as the air flows out past the larynx, or voice box, at the top of the trachea, the oxygenated cells comprising the muscles of the larynx can constrict or relax causing vibrations that propagate through the 10^{23} air molecules bouncing off each other. At a third level of human existence, a person can make sounds. The sounds may be loud, soft, rhythmic, sharp, gentle, and so on. Using commonly available computer software and a microphone, one can see different patterns that occur in vibrations of the air molecules generated by one's larynx. Those air molecules participate at three levels: first, at a physical level, they provide structural integrity to the respiratory system; second, at a biological level, they provide necessary components to cellular processes; and third, at a psychological level, they provide a medium of communication that one can hear (and now see).[1]

1 An astute reader may note that although the systems supervene, the individual atoms do not: it takes several minutes for an O_2 molecule to provide structural stability flowing through the windpipe to flow through arteries to the cells where the oxygen atom becomes part of CO_2 during metabolism and flows back to the lungs to be exhaled past the larynx where it

Although many animals can create sounds and use those sounds for communicating to other animals, humans appear to have a unique ability to develop shared, abstract mental representations and communicate them through arbitrary sounds called language. One can not only cry out in pain or pleasure, one can converse on a variety of topics, recite poetry or sing. The air molecules that participate at the physical, biological, and psychological level also participate—through "meaningful" sounds of language—in the fourth level of human existence—culture.

Culture, as I use it, refers to the products of human interaction that depend upon language. Humans interact in ways that do not depend upon language, but as I describe later, the abstraction of language that allows information to be communicated using arbitrary yet agreed upon words and grammar distinguishes a fourth level of human existence. The vibrations made by the human larynx and propagated through the air carry information when the speaker and listener have a shared interpretation of sounds.

These four levels—physical, biological, psychological, and cultural—describe supervening relationships between systems comprising human existence.

Organizing Levels of Interacting Systems

How do the levels relate to each other and to the systems that comprise them?

Reductionism

Western thinkers have often tried to understand the world in terms of hierarchical relationships. The ancient Greeks imagined reality as a hierarchy of beings. Typically, they ordered reality into genus and species: inanimate objects, plants, animals, humans, and divinities (including celestial beings). Neo-Platonists more strictly ordered the informal hierarchies, such as the three *hypostases* of Plotinus or the celestial and ecclesiastical hierarchies of Pseudo-Dionysius. During the modern period (beginning about 1600), hierarchical relations between complex systems gradually supplanted the Greek hierarchical relations of beings.[2]

Western science often organizes the systems observed in the natural world in terms of part–whole relations. *Methodological reductionism* breaks down complex wholes into smaller units for investigation. In studying complex phenomena in science, one frequently needs to reduce the complexity of the thing studied to model it and develop experiments. A methodological reductionist believes explanations should be reduced to the simplest entities possible (Occam's razor). One way to reduce complexity is to examine each component in isolation.

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becomes a medium for vibrations. Later, when I use examples in the brain, I will describe how a single calcium ion participates in several levels simultaneously.

2 Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (Cambridge, MA: Harvard University Press, 1936); cited by Nancey C. Murphy, "Nonreductive Physicalism: Philosophical Issues," in *Whatever Happened to the Soul? Scientific and Theological Portraits of Human Nature* (ed. Warren S. Brown, Nancey C. Murphy, and H. Newton Malony; Minneapolis, MN: Fortress Press, 1998), pp. 127–48 (128).

Methodological reductionism, which isolates each component, complements a systems approach, which examines how components function when combined in the whole system. The differences in behavior between examining each component in isolation (methodological reductionism) and their behavior while interacting (systems approach) provide information about the system as a whole. Because the systems interact, they have a graph-like organization. Each system may also serve as a component of a larger system allowing the modeling of increasingly complex systems. Ernst Mayr specifically notes the limitations of methodological reductionism on the complex, interrelated systems within biology. Biologists find it challenging to reduce the complexity of the system enough to study it without also removing components necessary for a complete explanation. But overall across disciplines, different areas of science focus on different parts of the part–whole and supervenience hierarchies of nature, and the various scientists, philosophers, and other scholars describe those structural and functional hierarchies in different, though related, ways. [3]

The term reductionism at other times refers to the relationship between epistemological, logical, and linguistic concepts. Although individual differences occur between actual phenomena, scientists generalize similar phenomena into concepts they use in creating theories. Francisco Ayala and Nancey Murphy each define *epistemological reductionism* as the view that the theories and laws pertaining to a higher-level field of science demonstrably follow from the lower-level laws, and ultimately from physics. Ernst Mayr calls this *theory reductionism* and notes it as a fallacy because it confuses (irreducible) concepts with (reducible) processes. Just because the processes of a cell may be explained by chemistry and physics, the cell biologist still has much to study outside chemistry and physics, for example, how the over 200 types of cells in the human body develop into tissues and organs. Systems theory helps address the confusion caused by reductionism by separating the interacting relationships among part–whole components from the supervening relationships between systems at different levels as different theories.[4]

The whole is often taken to be greater than the sum of the parts.[5] In the early twentieth century, E.G. Spaulding argued that “in the physical world (and elsewhere) it is an established empirical fact that parts as non-additively organized form a whole which has characteristics that are qualitatively different from the characteristics of

3 Mayr uses the term “explanatory reductionism” for methodological reductionism. Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: Belknap Press, 1982), p. 60.

4 Francisco Jose Ayala and Theodosius Grigorievich Dobzhansky (eds), *Studies in the Philosophy of Biology: Reduction and Related Problems* (Berkeley: University of California Press, 1974), pp. vii–xvi; Mayr, *The Growth of Biological Thought*, p. 62; Nancey C. Murphy and Warren S. Brown, *Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility* (Oxford: Oxford University Press, 2007).

5 By using the phrase “greater than the sum of the parts,” I postulate more information exists because of the whole’s organization. Some scholars, such as Terrence Deacon, clarify that in terms of the conservation of matter and energy, the whole is not greater than the sum of its parts. Shannon showed in his development of information theory that those two perspectives are compatible.

the parts."[6] The philosophical controversy addressed in this book involves *how* the whole is greater than the sum of the parts. Even the *physical reductionist* who believes the entire world may be reduced to physics believes that it may be scientifically or epistemologically useful to organize one's understanding of the world as levels.

In physical reductionism, only the lowest level, physical entities are "*really* real."[7] Because everything reduces to the physical world, as described by the laws of (Newtonian) physics, only one level exists. Physical reductionism defines the person as a physical organism and claims that the physical sciences will ultimately explain all of the person's experiences and functions.[8] I use Jaegwon Kim's definition of physical reductionism as "the view that all things and phenomena are physical and are explainable and predictable ultimately in terms of fundamental physical laws."[9]

A scientific challenge to physical reductionism is the apparent irreducibility of quantum mechanics to classical, mechanistic causality. Quantum mechanical phenomena, such as non-locality, challenge physical reductionism. Although several consistent philosophical interpretations of quantum mechanics exist, they variously propose a type of dualism (e.g., separate observer), ontological indeterminism (which cannot reduce to constituent parts because the parts are not predictable) or non-local hidden variables (which results in either dualism or a radical reinterpretation of the physical).[10]

Claiming that the world is nothing but "atomic" or "subatomic" processes fails to explain the world as it occurs and as humans observe it. Physical reductionists claim to have resolved a philosophical question but actually succumb to a fallacy. They assume that the mechanistic laws of nature apparent to humans because of the properties of atoms also hold to explain the formative process of the atoms themselves. Causation—specifically efficient causation—results from atoms on the surface of an object not sharing space with the atoms on the surface of a colliding object. Because efficient causation derives by analogy from what we now call Newtonian mechanics, reductionists over-generalize when applying efficient causation as the causal process in physical realms where Newtonian mechanics does not work.

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6 Edward Gleason Spaulding, *The New Rationalism: The Development of a Constructive Realism Upon the Basis of Modern Logic and Science, and through the Criticism of Opposed Philosophical Systems* (New York: H. Holt and Company, 1918), p. 447; cited in Philip Clayton, *Mind and Emergence: From Quantum to Consciousness* (Oxford and New York: Oxford University Press, 2004), p. 15.

7 Murphy calls physical reductionism "reductive materialism" and "atomic reductionism." This reductionist position also corresponds to *monistic materialism*. Other scholars use "eliminative reductionism" or Ayala's term "ontological reductionism." Practically no scholar believes in epistemological reductionism, and almost all scholars believe in methodological reductionism.

8 Nancey C. Murphy, "Human Nature: Historical, Scientific, and Religious Issues," in Brown, Murphy and Malony, *Whatever Happened to the Soul?*, pp. 1–29 (24–5).

9 Jaegwon Kim, "Making Sense of Downward Causation, " in *Downward Causation: Minds, Bodies and Matter* (ed. Peter Boegh Andersen *et al.*; Aarhus and Oakville, CT: Aarhus University Press, 2000), p. 306.

10 Nick Herbert, *Quantum Reality: Beyond the New Physics* (Garden City, NY: Anchor Press/Doubleday, 1985).

A systems approach to science requires analyzing phenomena into its constituent parts, then examining their interactions, and finally creating theories at each level using the discovered concepts. One may treat each constituent part as a phenomenon to be analyzed and repeat the process. Viewing the world as composed of hierarchical levels provides a scheme for organizing scientific study of natural systems. Because human systems cross scientific and scholarly disciplines, I initially divide them into four levels of organization based upon traditional academic disciplines. These levels clarify sub-systems of human existence, the sciences studying their functionality, and their relationships to each other.

Four Scientific Levels

For this book, examining the soul in the context of science requires organizing the areas of science related to the study of the person sufficiently to illustrate where the domains of the sciences and theology separate and overlap.

Several researchers have distinguished what simplifies to the four levels of inquiry I have described. Ludwig von Bertalanffy organized scientific disciplines and systems into four levels in his general systems theory and suggested physical, biological, psychological/behavioral and social scientific disciplines; his goal for general systems theory was to discover general rules about systems that crossed those four levels.[11] A.A. Abrahamsen observes that scientific disciplines may be differentiated by specialization of focus and distinguishes four levels of focus: the physical world, living organisms, the behavior of living organisms, and human culture.[12] Arthur Peacocke organizes his eight levels of part–whole hierarchies of nature into Abrahamsen's four levels of focus.[13] Claus Emmeche and his colleagues also propose four similar levels: physical, biological, psychic, and social, though they do not propose a strict hierarchy because the biological depends only on the physical while the psychological and sociological are interwoven and involve the emergence of self-consciousness and institutions.[14]

Karl Popper distinguishes three "Worlds": (1) physical objects, (2) world of experiences, and (3) objective products of the human mind. In Popper's work, physical objects refer to the non-living physical and biological objects of the world;

11 Ludwig von Bertalanffy, *Perspectives on General System Theory: Scientific-Philosophical Studies* (The International Library of Systems Theory and Philosophy; New York: G. Braziller, 1975), pp. 5–8, 30–32.

12 Arthur Robert Peacocke, *Theology for a Scientific Age: Being and Becoming—Natural, Divine, and Human* (Minneapolis, MN: Fortress Press, enl. edn, 1993), pp. 215, 218; citing W. Bechtel and A. Abrahamsen, *Connectionism and the Mind* (Oxford and Cambridge, MA: Blackwell, 1991), pp. 256–9.

13 Peacocke, *Theology for a Scientific Age*, p. 215, n. 11. For more detail see Figure 2 in Arthur Robert Peacocke, *God and the New Biology* (London: Dent, 1986).

14 Claus Emmeche, Simo Koppe, and Frederik Stjernfelt, "Levels, Emergence, and Three Versions of Downward Causation," in Peter Boegh Andersen *et al.* (ed.), *Downward Causation*, pp. 13–44 (14–15). Claus Emmeche, Simo Koppe, and Frederik Stjernfelt, "Explaining Emergence—Towards an Ontology of Levels," *Journal for General Philosophy of Science* 28 (1997): 83–119.

the world of (subjective) experiences refers primarily to mental or psychological states or processes; and objective products of human mind refer to "languages; tales and stories and religious myths; scientific conjectures or theories, and mathematical constructions; songs and symphonies; paintings and sculptures. But also airplanes and airports and other feats of engineering." Popper states that World 3 constructs depend upon World 2 subjective processes (of human minds) and in turn on World 1 objects, and he argues for the reality of the constructs in each world. Although some World 3 constructs, such as a suspension bridge, have physical realization or embodiment directly in the external world, others, such as a symphony, primarily have embodiment in the processes of the human mind. However, regardless of whether the product becomes physically realized or not, the World 3 constructs have a reality whose content depends upon the logical consequences of human mental activity, though not the historical realization of those consequences. (Later, in Chapter 7, I will clarify this distinction.) Einstein's 1905 special theory of relativity includes the theoretical construct "$E=mc^2$" and the possibility of the atomic bomb, even though he realized neither in those forms until later, and one can speak of a symphony independent of its performances as "a marvelous performance, but few appreciated it." For Popper, "by formulating a thought in some language, we make it a World 3 object."[15]

Although some differences occur among the scholars reviewed, a general consensus exists that the inorganic physical differs from the biological, that a psychological level of the human individual rises above the biological, and that the results of social interactions among humans give rise to a level distinct from the individual. The controversy surrounding emergence and reductionism occurs because of differing explanations as to the distinctions between the inorganic physical, the biological, the psychological, and the results of human interaction. Historically, some of these beliefs have been encapsulated in dualistic theories, for example, that a "vital force" from outside nature is necessary to differentiate the biological from the physical, that the mental is distinct from the biological (e.g., humans as "rational" animals).[16]

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15 Karl Popper, "Three Worlds," in *The Tanner Lectures on Human Values* (ed. Sterling McMurrin; Salt Lake City: University of Utah Press, 1980), pp. 143–67 (144, 149, 159); Karl Popper, *In Search of a Better World: Lectures and Essays from Thirty Years* (London and New York: Routledge, 1992), pp. 3–29.; Peacocke, *Theology for a Scientific Age*, p. 193; Karl Popper, "Epistemology without a Knowing Subject," in *Logic, Methodology and Philosophy of Sciences* (ed. B. van Rostelaar and J.F. Staal; Amsterdam: North-Holland Publishing Co., 1968), pp. 333–7. See also Karl Popper, "Scientific Reduction and the Essential Incompleteness of All Science," in Ayala and Dobzhansky (eds), *Studies in the Philosophy of Biology*, pp. 259–84 (259).

16 Different theories of emergence in nature will make various ontological claims on the ontological status of the levels. As discussed in Chapter 4, dualism claims levels consist of different structures; strong emergence claims the laws of causation differ between levels; and weak emergence claims that the entities of one level organize and may constrain lower level entities. Only in dualism would one likely claim that the levels "exist." In weak emergence, the emergence between levels would not even differ from the emergence within a level. However, even for weak emergence, the levels provide a clearer framework for describing emergence.

Although the scholars mentioned all refer to social structures, they have grounded their levels in the natural sciences, resulting in clearer distinctions between physical, biological, and psychological levels within an individual than between psychological, social, and cultural levels among individuals. However, other scholars have found culture difficult to model scientifically. The interdependency between social interaction and cultural products, such as language and art, may contribute to the lack of clarity from a scientific perspective: human culture is not possible without symbolic communication between individuals, and humans have difficulty communicating without a shared culture. However, other scholars have examined the transmission of "culture" (the use of tools, for example) among animals that do not have language. As I distinguish between the third and fourth level based on social interaction using symbolic language, from here on when I use "culture" I refer to the product of human interaction dependent upon language.[17]

Donald Campbell notes a human genetic predicament where social cooperation and evolution must overcome individual genetic competition.[18] Although people compete individually, they then must create societies by cooperation. However, social insects, such as ants, reduced or eliminated the predisposition to self-interest among cooperators as part of the emergence of complex social systems. However, not all species would share human's innate social versus individual tensions. Deborah Gordon has noted the emergence of characteristics in ant colonies, for example aggressiveness or passivity, that occur over a longer period of time than the life-span of an individual ant. Thus, the ant species appears to have evolved into three levels where the inorganic physical level differs from the biological, and the biological level differs from the higher "social" level. However, there is no intervening psychological level, and the social level has novel properties, but not the products of mental activity as in human culture.[19]

For this book, a simple, hierarchical model with four levels of focus—inorganic physical, biological, psychological, and cultural—suffices to explain the individual human topics covered. Table 3.1 summarizes the levels used by Peacocke, Emmeche, and Popper and shows where the example of "mind" as typically understood fits. Although differences among the models discussed are not all captured by the table, each of the levels of the examples used in this book to describe a person does fit within the stated level of each model, though in a certain sense, at the "higher" part of the level.

Levels provide a clear structure for the person and the emerging systems of the body, even though from a weak emergentist perspective, they disappear.

17 Cf. L.L. Cavalli-Sforza and Marcus W. Feldman, *Cultural Transmission and Evolution: A Quantitative Approach* (Monographs in Population Biology, 16; Princeton, NJ: Princeton University Press, 1981).

18 Cf. Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1976).

19 Donald T. Campbell, "'Downward Causation' in Hierarchically Organised Biological Systems," in Ayala and Dobzhansky, *Studies in the Philosophy of Biology*, pp. 179–86 (185); Terrence William Deacon, *The Symbolic Species: The Co-Evolution of Language and the Brain* (New York: W.W. Norton, 1997); Deborah Gordon, *Ants at Work: How an Insect Society Is Organized* (New York: Free Press, 1999).

Table 3.1 Four levels of focus in human scientific inquiry

Level	Peacocke	Emmeche	Popper	Example
Cultural	Social Products	Social	Products of Mental Activity	Philosophy
Psychological	Behavioral	Psychic	Experience	Psychology
Biological	Biological	Biological	Physical objects	Neuroscience
Physical	Physical	Physical	Physical objects	Chemistry

Although the later chapters do not depend upon the precise characterization of the levels—other than to locate the disciplines used in examples, I describe the levels in some detail to provide coherence across all the examples presented.

The physical level describes the mechanistic interactions between particles, atoms, and molecules. It includes the disciplines of physics and chemistry, especially mechanics and thermodynamics, and physical chemistry. The lower aspects of the level involve atoms and their constituents. Most scholars would also include subatomic fields of study such as quantum mechanics, string theory, and quantum gravity as the lowest aspects in this level, but I discuss in the next section some reasons to consider those disciplines as comprising the upper discipline of a yet lower sub-physical level. Other disciplines that study the physical level include disciplines like geology and astronomy. Higher disciplines in the level include organic chemistry and some aspects of biochemistry. Biochemistry acts as a bridge discipline between the disciplines in the physical level and biological level, with some sub-disciplines studying physical-level systems (e.g., enzyme chemistry), and other sub-disciplines studying biological-level systems (e.g., gene regulation).

The biological level begins with biochemistry and includes molecular biology, cell biology and biology of the entire organism, such as botany and zoology. The brain appears most connected to the biological processes that impact upon mind, language, and spirituality. Neuroscience studies the brain from a biological perspective and constitutes the highest discipline within the biological level relevant to this study in that it depends and builds upon the other required biological disciplines. In particular, the discipline of human cognitive neuroscience bridges the biological level with the higher psychological level, with neurology studying biological-level systems and neuropsychology examining the impact of neurological systems on mental activity.

The psychological level describes the behavioral and mental aspects of individual living organisms. In particular, organisms with brains appear to have interesting (psychological) properties correlated with the biological activity of the brain. Some scholars would attribute unique properties to humans based on the phenomena studied at this level, such as intelligence or abstract reasoning, but close examination by comparative psychologists suggest to some researchers that only gradients of properties shared by many animals distinguish humans. For example, some dolphins and primates show abilities in self-awareness, communication, and problem solving; even honey bees may have the ability to communicate and generalize; and microscopic worms can learn new behaviors. Not only humans, but also other animals have many characteristics of mind (as described in Chapter 1). One of the early goals of artificial intelligence is to create those computational systems with intelligent behaviors (rather than biological systems). It appears that the associative networks of the brain are key to the adaptive behaviors and mental processes studied at this level. However, there appear to be some mental characteristics developed only by humans—creation of arbitrary, abstract symbol systems, including languages.

The human cultural level depends upon the interaction of two (or more) organisms with the ability to generate, communicate, and share arbitrary, abstract, symbol systems, namely language.[20] From shared language, humans develop a variety of social products in literate societies, including written texts, laws, philosophies, institutions, governments, rituals, drama, art, poetry, and religions.[21]

Disciplines that study the cultural level include linguistics, sociology, history, cultural anthropology, philosophy, law, theology, and all the humanities. All these disciplines plus the scientific disciplines studying lower levels and mathematics occur at this cultural level because they depend upon the abstract symbol manipulations of language.[22] A compatible definition of culture is "a learned meaning system that consists of patterns of traditions, beliefs, values, norms, and symbols that are passed from one generation to the next and are shared to varying degrees by interacting members of a community."[23] Groups of other animals may interact socially and develop properties that no individual organism has, such as systems of dominance relationships, group personalities, and transmission of tool use, but they develop societies, not culture dependent upon symbolic language.[24] However, these relational, group, and social properties influence human culture, too, such as war, government, and entertainment. The higher systems in the level, such as poetry, ritual, art, and religion, appear to use the shared symbols systems of language to refer to (signify) phenomena, experiences, or other constructs that language does not easily describe,

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20 Deacon, *The Symbolic Species*; Walter J. Ong, *Orality and Literacy: The Technologizing of the Word* (London and New York: Methuen, 1982).

21 Some evolutionary studies suggest that the evolution of the larynx led to the selection of Homo sapiens over the Neanderthals, who had comparable brain development. C. Holden, "The Origin of Speech," *Science* 303(5662) (2004): 1316–19.

22 Although we use mathematics heavily in modeling the subatomic level discussed later, the language of mathematics used depends upon the constructs of Newton, Leibniz, Cantor, Peano, and Russell among others, with alternate languages possible. The use of systems and information theory in this book depends upon culturally defined concepts, and thus emergent systems theory, which defines the levels, also occurs within the cultural level. However, in a realist position such as Peirce's pragmatic philosophy, the constructs studied by these theories exist independently of these theories, as I introduced in Chapter 1 and discuss more fully in Chapter 7.

23 Stella Ting-Toomey, *Communicating across Cultures* (The Guilford Communication Series; New York: Guilford Press, 1999).

24 By symbolic language, I refer to the ability to create general-purpose abstractions of arbitrary complexity. However, Chomsky and Fitch identify the possibly human-specific aspect of language as recursion and call it the human faculty of language in the narrow sense (FLN) rather than the broad sense which also includes sensory-motor, concepts, intentions, etc. M.D. Hauser, N. Chomsky, and W.T. Fitch, "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?" *Science* 298(5598) (2002): 1568–79. W.T. Fitch, M.D. Hauser, and N. Chomsky, "The Evolution of the Language Faculty: Clarifications and Implications," *Cognition* 97(2) (2005): 179–210; discussion 211–25.

and this is described briefly later in the chapter, and more fully in Chapter 5. Although I focus on the abstraction of symbolic language, other abstractions relevant to the distinction of a cultural "level" (rather than just other systems at the psychological level) also occur in intentionality (Chapter 1), theory of mind (discussed briefly in Chapter 5) and empathy.[25]

Levels of Graphs

How can one model the systems at different levels?

Using the graph modeling language from Chapter 2, one can model the systems described in the introduction to the chapter as graphs. As shown in Figure 3.1, a human body contains a respiratory system that contains lungs and trachea. The trachea contains a gas volume of 0.25 liter at 14 lbs/in^2 of pressure at 90°F. The gas volume contains air molecules that have a kinetic interaction.[26]

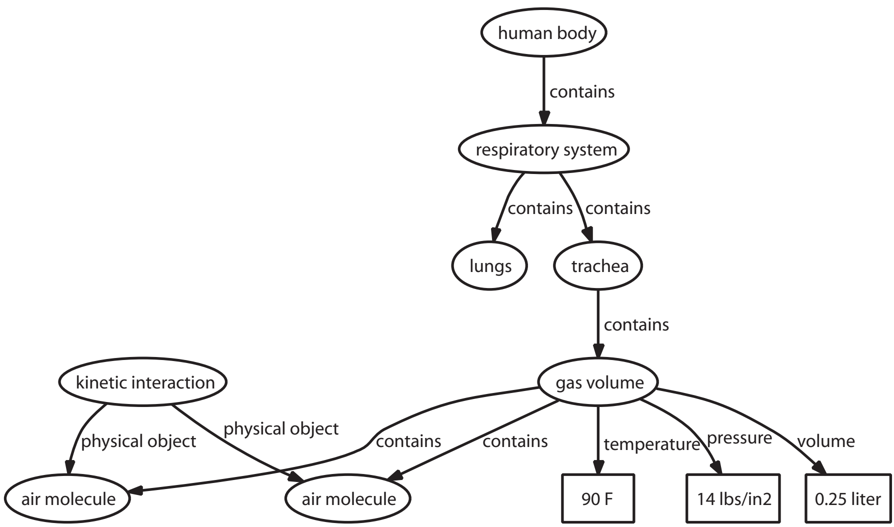

Figure 3.1 Graph of human respiratory system with trachea

25 Chapter 4 describes why abstractions of symbol and information differentiate between levels. Mark H. Davis, *Empathy: A Social Psychological Approach* (Brown & Benchmark's Social Psychology Series; Madison, WI: Brown & Benchmark Publishers, 1994).

26 The square nodes introduce "attributes" of the system that describe features or properties that cannot be reduced.

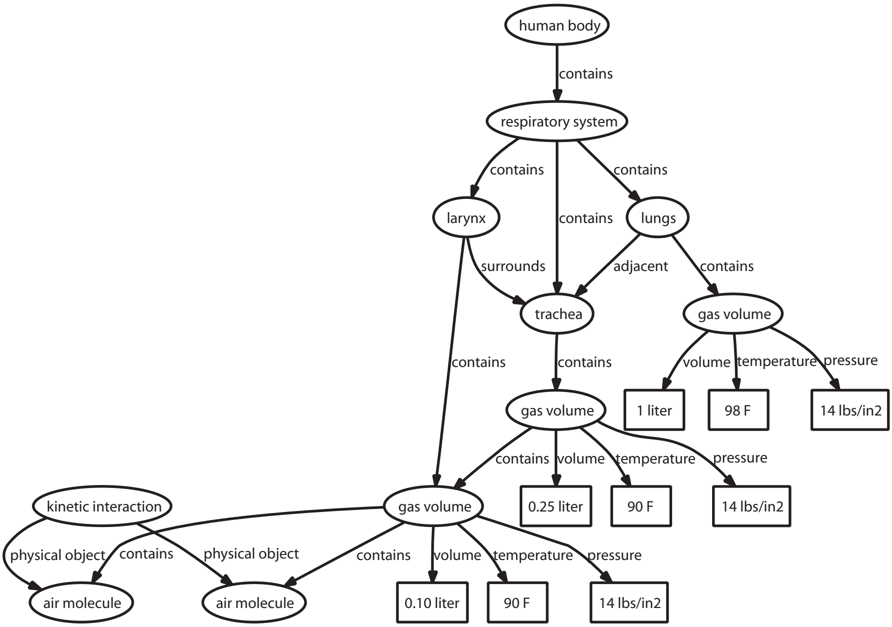

Figure 3.2 Graph of human respiratory system with trachea, larynx, and lungs

One can further describe the sub-systems, and as shown in Figure 3.2, the lungs contain a gas of volume 1 liter, temperature 98°F, and pressure 14 lbs/in^2. The larynx surrounds the trachea, and the larynx contains a gas volume of 0.1 liter, temperature 90°F, and pressure 14 lbs/in^2. As one can see, a physical-level system description rapidly becomes complex.

Although the gas volume remains an important part of the physical-level description of the system, a biological-level description would capture the muscles, the temporal aspects of their constriction and relaxation to create a vibration, and the shared gas volume, only part of which is vibrated. One can simplify the diagram by omitting some of the physical structures not directly needed for the biological description of vibration. As shown in Figure 3.3, a human body contains a respiratory system that contains lungs and larynx. The lungs and larynx together contain a gas volume. That gas volume contains another gas volume that a muscle contained by the larynx constricts and relaxes. The muscle contains at least one cell, and the second gas volume is a medium for a vibration.

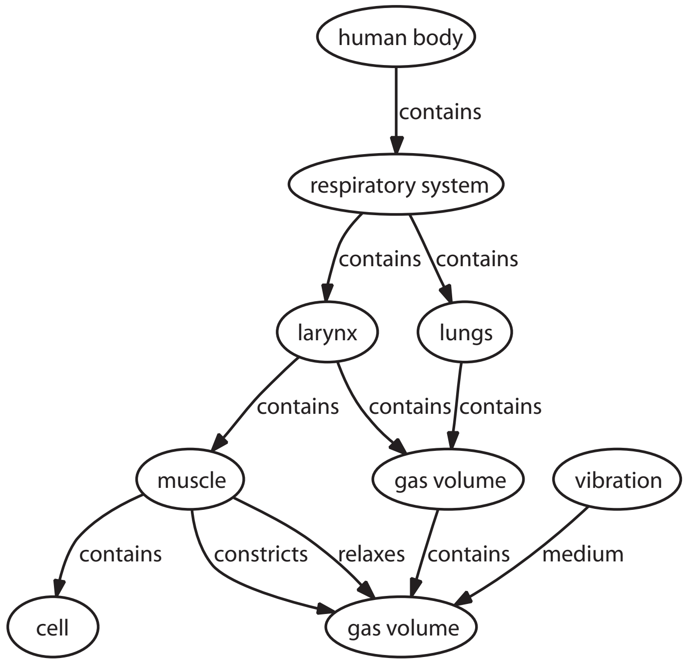

Figure 3.3 Graph of human respiratory system with larynx muscles

One could expand the description by expanding the structural hierarchy of the muscle in terms of cells and other biological processes, or one could expand the functional relationships of constricting and relaxing. Muscle constriction involves muscle fibers, proteins such as actin and myosin, ATP for energy, oxygen, carbon dioxide, and so on (diagram not shown). One can also condense the description to a human body vocalizing a vibration, as shown in Figure 3.4. Depending upon the context, the vocalizing relationship could occur at either the biological or psychological level, for example, an accidental grunt or a deliberate call.

Figure 3.4 Graph of human vocalizing a vibration

In addition to a respiratory system a human body also contains two ears and the parts of the ear respond to vibrations such as the vibrations created by a vocalization. The ear contains an eardrum, bones, fluids, and other structural and functional relationships. The outer and middle ear conducts sounds to fluids in the cochlea in the inner ear that vibrate and move hairs attached to cells that respond to those vibrations. When one person hears another person part of what occurs is shown in Figure 3.5. A human body vocalizes a vibration, and another human body contains an inner ear containing a cell and responding to the same vibration.

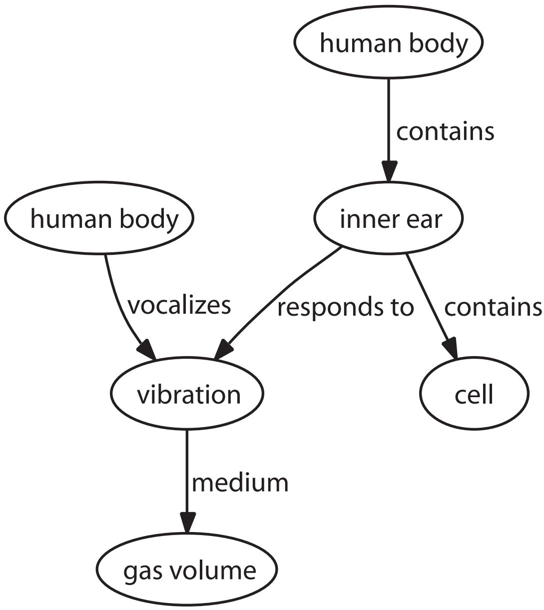

Figure 3.5 Graph of human vocalizing and human responding to a vibration

To explain what occurs with the shared vibration, one must expand the description. Figure 3.6 expands the vocalized relationship with the relationships from Figure 3.3.

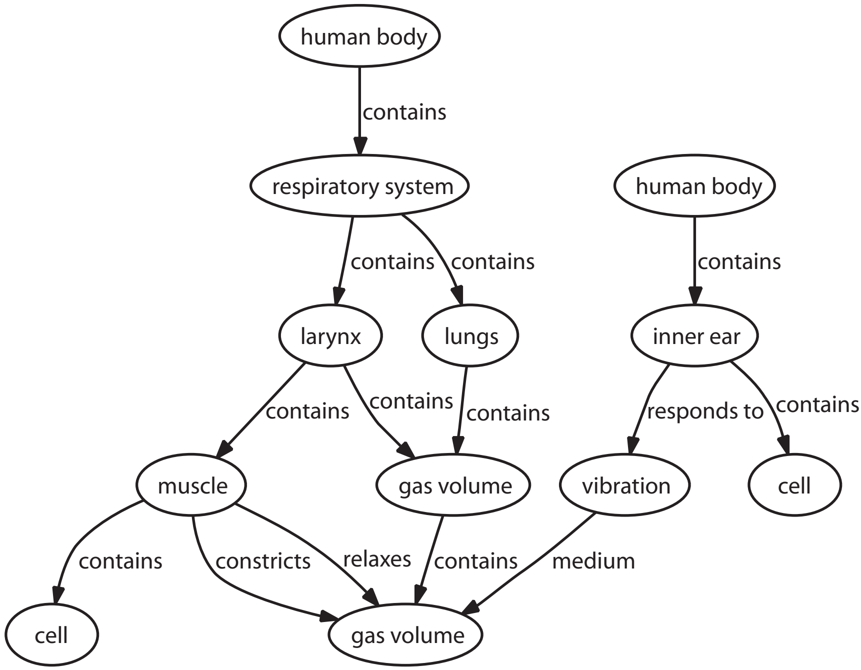

Figure 3.6 Graph of human respiratory system and eardrum

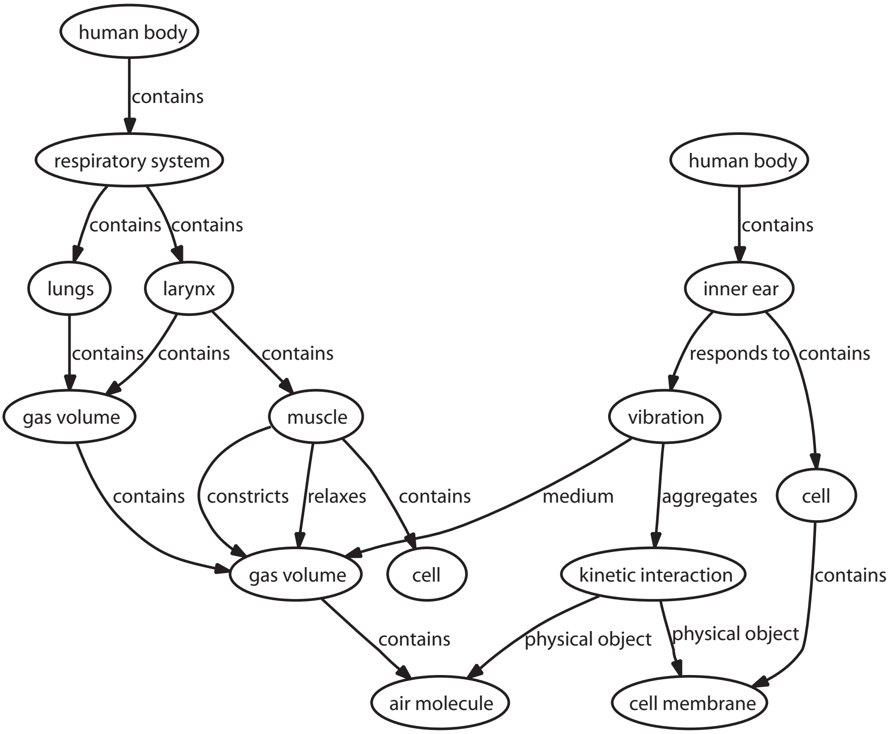

Figure 3.7 Graph of human respiratory system and eardrum with kinetic interaction

Figure 3.7 describes the vibration in more detail. The inner ear contains a cell that contains a cell membrane. The gas volume, which is the medium of the vibration, contains an air molecule. The cell membrane and air molecule participate in a kinetic interaction that the vibration aggregates.

The *aggregation* (i.e., collecting together into a structure) of kinetic interactions in the vibration forms a pattern over time (not shown).[27] The pattern of air molecule vibration determines the pattern of fluid and hair vibrations in the inner ear and what one hears.

So far, the descriptions could refer to reflexive grunts or belches. To include intentional sounds at the psychological level and language at the cultural level, the description must include the nervous system and brain.

27 The simple graph modeling language does not illustrate cardinality or quantity, e.g., the number of air molecules, or temporal relationships, such as the series of kinetic interactions as the vibrating gas volume shifts from one person's lungs and larynx to another person's eardrums.

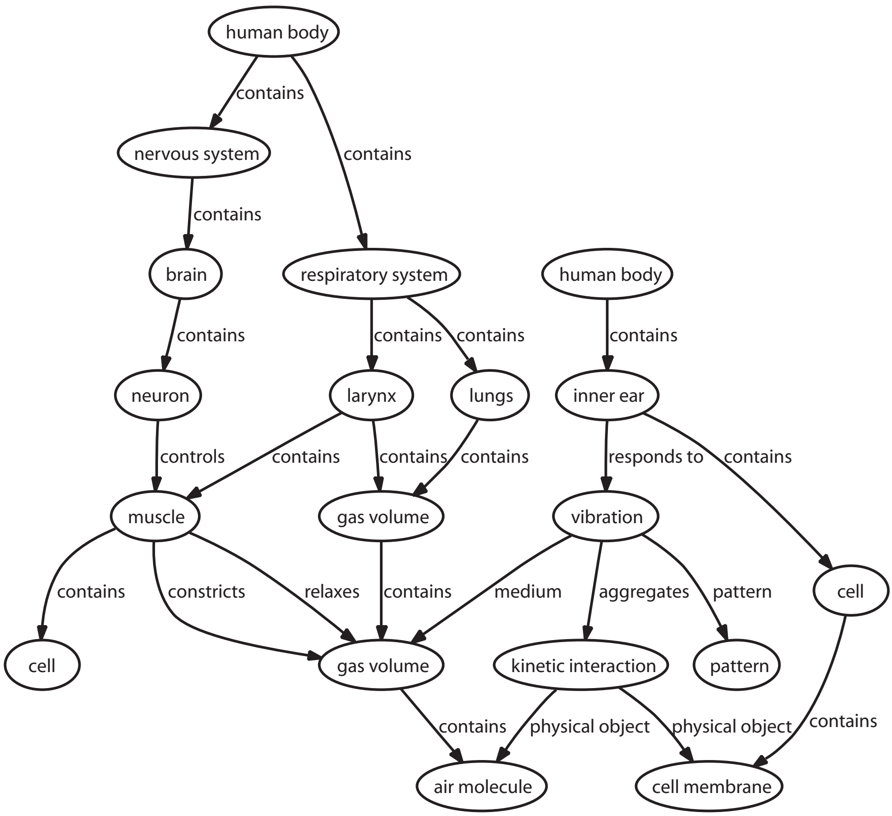

Figure 3.8 Graph of human brain, respiratory system, and eardrum with kinetic interaction

As shown in Figure 3.8, a human body contains a nervous system that contains a brain that contains neurons that control a muscle contained by the larynx. The remainder of the relationships remains the same as the last figure, except that the vibration now has a pattern. Not shown is the nervous system of the other person whose neurons in the brain respond to vibrations of hairs in the cochlea.

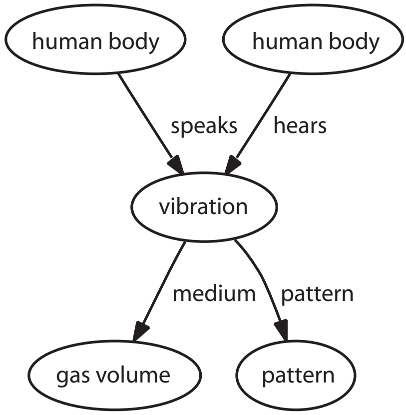

Figure 3.9 Graph of human speaking and human hearing a vibration

As shown in Figure 3.9, one can condense the relationships of the nervous and respiratory systems into a human body that speaks a vibration, and the relationships of the auditory and nervous system of another human into a human body that hears a vibration.

One could also condense the vibration relationships of pattern and gas volume medium to "sound," or even "words," but that would hide the open questions that the remaining sections of this chapter and the next chapter begin to address.

- What about the pattern distinguishes grunts from sounds from words? Do other relationships change, too?
- How is one gas volume contained in the lungs, in the larynx, and in another person's eardrum?
- How do patterns of kinetic interactions form sounds?
- How does one's intention to speak and communicate to another initiate physical-level changes?
- How do patterns relate to the kinetic interaction? Do those relationships change when modeling the 10^{23} molecules of the gas volume, rather than one air molecule? Do they relate to other abstractions, such as temperature, pressure, and volume?
- What is the relationship between the vibration pattern; the neural state in the brain; and one's thought of a particular word?
- What relationships must be included to describe a "human person" rather than a "human body"?

The questions depend upon the relationship between systems at different levels and how the perspective of a system at one level may differ from the perspective at a different level. Before exploring perspectives on the relationships between levels, I need to set the context for the levels by describing two additional, boundary levels. Four levels cover much of human existence as studied by science, but some phenomena do not fit into systems at those levels.

Two Boundary Levels

Phillip Clayton, in his *Mind and Emergence,* provides a rigorous overview of emergence from the natural sciences of physics and biology to the emergence of mind, and finally to the emergence of transcendence.[28] Harold Morowitz, in his *The Emergence of Everything*, describes 28 levels of emergence in natural history from the Big Bang to the present.[29] Examining emergence and reductionism in an ecclesiastical, institutional, or communal situation might require untangling the distinctions between social, cultural, and spiritual aspects of human interactions. A more fine-grained model with a plurality of cultures, religions, or species might also require a less strictly ordered model.

Although the four scientific levels of inquiry organize the scientific disciplines (and humanities) in the study of the person, one may find it beneficial to expand the organization to relate science and religion. Theology, religious studies, and popular approaches to religion or metaphysics sometimes refer to a ground of being, global consciousness, interpretations of quantum mechanics, subtle energies, spirit, ethical principles, and many other concepts that relate to the natural world as inhabited by humans. These metaphysical and other constructs may borrow from the sciences, but because science does not provide placeholders for their study, they are rarely related to serious scientific study. For example, one may understand consciousness as a fundamental property of matter; occurring in the human psyche; and/or emerging from the interactions of the universe.[30] However, these proposals rarely connect the ubiquitous consciousness or mind with the biochemical, neurological, and cultural constructs that, according to the model of scientific levels, would interleave those proposed phenomena.

When one omits the boundary between traditional scientific and religious disciplines from the description of either, one cannot relate the findings between them. Several early workers in quantum mechanics, such as Schrödinger and Bohr, turned to Eastern religions for worldviews more compatible to their discoveries than the Western mechanistic one. Although one need not borrow from Buddhism to understand quantum mechanics, that historical shift of modern physics indicates a possible crossing over into study of a different level. The theoretical limits to measurement discovered by Max Planck and others also indicate a lower level supportive of ambiguity, partial information and indeterminacy.

In addition to scientific reasons to consider a lower, sub-physical, level, philosophical and religious reasons also exist. As described later in the chapter, typical theories of causation often presume physical-level type interactions and relationships. A distinction between physical and sub-physical systems clarifies the types of causation applicable at each level. Many contemporary theologians

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28 Clayton, *Mind and Emergence*.

29 Harold J. Morowitz, *The Emergence of Everything: How the World Became Complex* (New York: Oxford University Press, 2002).

30 In Alfred North Whitehead's process philosophy, his proposed metaphysical "mental" pole also lacks a well-defined placeholder in science, though Bracken relates process thought to systems through Whitehead's "societies", as described in Chapter 7.

subscribe to *panentheism*, where God exists in the physical world and beyond.[31] If panentheism best describes the relationship between God and the world taking into account what we have learned so far from religion and science, then providing accurate lower-level system descriptions of the physical world facilitates further fertile investigations in science and religion.

In addition to the four scientific levels, to examine science and religion from a systems perspective one needs a lower (sub-physical or subatomic) level below the physical level that incorporates the non-mechanistic phenomena of quantum mechanics not yet unambiguously interpreted; and a higher (transcendent or spiritual) level above the cultural level that cultural constructs, such as poetry, ritual, and religion point to, but which appears ineffable to serious study within the disciplines of the cultural level.

The next section describes the subatomic level and Chapter 5 describes a higher, sixth, level which could contain the ineffable aspects of ethics, spirituality, and transcendence that some communities of humans refer to with language, or that emerge from interactions between cultures of people as properties of relationships between cultures. From a systems perspective, one must denote the system which grounds physical existence and the system to which various spiritual, mystical or religious experiences relate, even if one cannot specify any intrinsic properties of that system.

Subatomic Level

The subatomic (or sub-physical) level separates the unknown (and perhaps ontologically indeterminate) foundations of modern physics from the well-understood atomic physics and chemistry in the physical level. When physical reductionists describe reducing the world to physics, they frequently claim reduction to the physics of atoms, efficient causation, and Newtonian mechanics. Although that physics provides a necessary foundation for chemical, biochemical, and biological processes, twentieth-century physics discovered quantum effects such as non-locality, Heisenberg uncertainty, and wave–particle duality, which nineteenth-century physics could not explain. The lower (subatomic) level consists of phenomena studied in quantum mechanics and quantum electrodynamics and perhaps theorized phenomena in string theory or quantum gravity. I call the level *subatomic* because its effects are greater on the scale smaller than atoms and quickly drop off at larger scales. The higher physical (atomic) level consists of physics and chemistry above the level of the atom. An open scientific question is whether the subatomic phenomena can be explained by the mechanistic processes of the atomic level (in which case, one physical level with atomic and subatomic aspects would remain appropriate) or whether the mechanistic processes of the atomic level result (i.e., emerge) from the interactions of non-local, non-mechanistic relationships of,

31 Philip Clayton and A.R. Peacocke, *In Whom We Live and Move and Have Our Being : Panentheistic Reflections on God's Presence in a Scientific World* (Grand Rapids, MI: William B. Eerdmans, 2004).

say, energy and space. As considerable evidence suggests the latter more likely than the former, I will treat subatomic phenomena as belonging to a separate level.[32]

At the beginning of Chapter 1, I claimed that to gain insight into the unity of the human person, one must surrender remnants of overly simplistic nineteenth-century science and the expectation of a single coherent view of the person. Systems theory models the entities from diverse perspectives, and its levels organize distinct, consistent, and coherent theories that would otherwise contradict. The next chapter will explain the emergence of constraints to relate systems within and across levels, but how they relate will touch upon deep philosophical issues of causation. Here one must surrender remnants of nineteenth-century understanding of the physical world that still pervade twenty-first-century Western thought. Although quantum electrodynamics and general relativity currently provide the best theories for existing experimental data, quantum mechanics suffices to demonstrate the inapplicability of nineteenth-century, classical mechanics and its predictable determinism to interpret constraints and the philosophical category of causation.

Quantum mechanics describes the behavior of matter and waves at the sub-atomic level. Whereas classical, or Newtonian mechanics, describes many of the physical properties and interactions of the physical level, scientists in the twentieth century discovered many systems where Newtonian mechanics fails. As a theory, Newtonian mechanics and classical electromagnetism explain much of what was visible and known to scientists prior to the twentieth century, but as scientists have explored the small and large extremes of size, energy, or temperature, they discovered that the classical theories only cover a moderate range of situations. Einstein's theory of relativity explains many more of the physical-level phenomena, but modeling subatomic phenomena requires at least quantum mechanics.

Classical mechanics uses "point particles," objects with negligible size, and characterizes the point particles by a small number of parameters, such as position, mass, and the forces applied to them. The type of objects that classical mechanics describes always have a non-zero size, but many properties and behaviors can be predicted by ignoring the size of the particle. Ironically, one cannot understand very much about true point particles, such as electrons or photons, using classical theories and one must use quantum mechanics, which allows for properties such as size and spin to model them. Although classical mechanics remains useful for many engineering applications dealing with objects larger than a few atoms and smaller than the solar system, physicists view classical mechanics and electrodynamics as special cases of quantum mechanics and quantum electrodynamics.

Quantum mechanics calls into question some very deep assumptions in how Westerners think about objects in the world. What is something? What can one know about something intrinsically? What can one know about something in relation to other things? Quantum mechanics places strict limits on these questions to the extreme that at certain scales and situations the questions not only cannot be answered, the questions themselves have no meaning. Quantum mechanics undermines a modern philosophical (ontological) understanding of the world through interpretation of experimental evidence underlying wave–particle duality, the uncertainty principle,

32 Herbert, *Quantum Reality*.

and quantum entanglement. One cannot ask whether an object at the subatomic level is a wave or a particle, and one appears to define the properties the object has by the question one asks of it or of other objects to which it has no physical-level relationship.

Wave–particle duality provides a single theoretical framework for understanding that matter behaves in both wave-like and particle-like fashions in the appropriate circumstances. Electrons and other similar small particles behave like waves when "no one looks at them," but when one observes them, they behave like particles. Quantum mechanics holds that one may describe the particles as a solution to a differential equation called the Schrödinger equation. The solutions to this equation are called wave functions, as they diffract and interfere, just like other waves. However, one may interpret the wave functions as proportional to the probability of finding a particle at a given point in space. If no one looks, the object is best described by a wave, but if one looks for a particle, one will find one, with a probability derivable from the wave function.

One way to appreciate wave–particle duality is through the double-slit experiment. In a double-slit experiment, two narrow slits in a wall allow water, light, or even electrons to pass only through the slits. In a non-quantum example, with water waves, two streams of water will pass through the slits and spread on the other side. As they spread, they will interfere with each other, leading to some regions where the ripples overlap and are twice as high and other regions where a ripple peak from one stream meets a ripple valley from the other stream and they cancel each other out. A similar interference can be observed if one throws two stones into a calm lake close to each other and at the same time.

A large particle, on the other hand, thrown or fired through the slit would continue to pass through the slit and in the experiment would be detected by a screen on the other side of the slits, as one would expect. A stream of particles spreads slightly to form a cluster pattern very similar to shotgun pellets hitting a target.

A beam of light fired toward the double slit exhibits wave-like phenomena producing patterns of light and dark regions on the screen, clearly illustrating its wave nature. A beam of electrons or atoms fired through the two slits also creates an interference pattern, but the particles may interfere with each other just like the water waves do and create the interference pattern.

If the experiment is set up to fire individual particles or photons, so only one photon at a time goes through the slit, one would expect that a single photon would only go through one hole or another, so one would expect to see two clusters of photons. If one does the experiment, one sees the particles strike the detector one at a time.

However, if one waits until enough individual photons have passed through the slits to build up a pattern, which takes millions of photons, one does not get two clusters opposite the two holes like a shotgun blast, one gets the same interference pattern as if each particle were a wave. Each individual particle, passing through the slits hits the wall in such a position that when enough particles have passed through they have collectively built up an interference pattern, even though no interference between particles can exist because of the time delay between them.

If one repeats the experiment, but with only one slit open, the individual photons behave as originally expected and cluster around a point on the detector screen behind the open slit. However, as soon as one opens the second slit, they immediately start forming an interference pattern. An individual photon passing through one of the slits appears aware of the other hole, and aware of whether or not the slit is open.

One could try peeking at the slits to see how the particle splits, but when detectors are placed at the slits—to record the passage and allow the particle (or wave) to continue through the slit—the particle then behaves as a classical particle—only going through one slit and forming a cluster pattern without interference. Even if only one detector is used, the particle passing through the other hole somehow seems to sense the presence of the detector and behaves classically.

From theories at the physical level, these phenomena make no sense. Physicists have performed numerous variations on the double-slit experiment, including Wheeler's delayed choice experiment where the result of the experiment depends upon a decision made after the particle hits the detector, that is, the decision appears to effect a result that happened "in the past."

Although these phenomena seem very strange, many modern technologies depend upon these strange phenomena, including nuclear medicine that uses radiation for cancer treatment and the quantum tunneling in transistors in practically all electronic and computer equipment where an electron "borrows" future energy to cross a barrier that a physical-level description would preclude it from crossing.

A second aspect of quantum mechanics is Heisenberg's uncertainty principle. In 1927, Heisenberg realized that quantum mechanics limited what one could theoretically know about complementary aspects of a single particle, such as position and momentum. If one measures the position of a particle to a certain level of accuracy, there is a theoretical limit to what one can discover about its momentum, or vice versa. As in the double-slit experiment, the device used to measure the location of the particle interferes with it in some way. As one desires more accuracy of position, the instrument used may use more energetic means to detect the position, but that additional energy interferes with detecting the particle's momentum. From an information perspective, the amount of information carried by the particle is limited, so one cannot ask for its momentum and location past a certain point of precision.[33]

A third aspect of quantum mechanics is quantum entanglement. In quantum entanglement, two or more objects have states that can only be described with reference to each other, even though they have no physical-level connection. Particles have properties, such as "spin," and experimenters can create entangled particles so that one particle has a "spin-up" state and a second particle has a "spin-down" state. When an experimenter measures several paired particles created by the device, then as expected, half the particles have spin-up and half have spin-down, however no one can predict in advance which state will occur for either of the paired particles. But, when one of the paired particles is measured, the other particle will always have opposite spin—no matter how far apart or how quickly after the first measurement

33 See Hans Christian Von Baeyer, *Information: The New Language of Science* (Cambridge, MA: Harvard University Press, 2004).

the second measurement is taken. Scientists, using galaxies as gravitational lenses, have demonstrated quantum entanglement among particles that at one time were separated over a hundred thousand light years. Albert Einstein coined the phrase "spooky action at a distance" to describe these phenomena.

Wave–particle duality, Heisenberg uncertainty and quantum entanglement describe physical phenomena not easily modeled by the traditional systems of the physical level, with characteristics of permanence, measurability, and predictability. Unfortunately, those physical-level characteristics have influenced philosophical theories of causation that we now know do not hold at the other levels.

Relational Perspectives

In the earlier chapter and sections on systems and levels, I described the tools of systems theory modeled using graphs at four clearly defined scientific levels and two boundary levels under scientific and scholarly investigation. Now, I can begin applying those tools to explore how levels relate.

How do systems at one level influence systems at another level? Do the relationships between levels differ from the relationships within levels? What is meant (and not meant) by level? What differs between the interactions of some systems that form a system at the same level and interactions of other systems that form a system at the next higher level?

I explore the first three questions in the remaining three subsections of this chapter, and the fourth question in the next chapter. Those insights will allow us in Chapter 5 to investigate the transcendent boundary level.

Causation

As claimed in Chapter 1, the processes of the human mind parallel some processes in nature. In particular, the category of causation in philosophy of nature (within the human mind) refers to particular relationships in nature. The human mind models and simulates those relationships to make decisions about how to act. One makes a decision about acting (or acts automatically) when some difference in one's perception of the world has significance, that is, makes a difference.

For Aristotle, changing or transforming one thing or quality into another required that something of the original endure through the change and that something new came to be. If no differences exist, nothing has changed; and if no identity or continuity remains, there is no change—only two independent things existing at possibly different times. A *cause* is that from which something proceeds with dependence in being or in becoming.

Aristotle classifies the four types of cause that produce change:[34]

1. The material cause—that out of which a thing comes to exist and persist, e.g., the bronze of a statue.

34 Aristotle, *Physics* II.3.

2. The formal cause—the form or pattern that provides the essence of a thing
3. The efficient, or moving cause—the primary source of the change or coming to rest.
4. The final cause—the sense of the end or "that for the sake of which" a thing is done. Often, a goal-seeking behavior. For example, health is a final cause for exercise.

Efficient causation describes the laws and regularities of the physical level. Although some of those regularities hold at other levels, "causation" as understood in a classical, mechanistic, Newtonian paradigm only holds at the physical level. Although the levels are defined in terms of the somewhat arbitrary, human scientific endeavors, scientists have formed the distinctions between levels because of the difficulty in determining laws and regularities which cross levels.

Ernst Mayr and other biologists have argued that Aristotle's formal cause better describes the process of biology than efficient causation does. Final causation does not contribute to biology post-Darwin, but it does still describe how people understand each other's actions.[35] At the risk of over-applying Aristotle's theory, one could say the laws and regularities of the subatomic level deal with the existence, persistence, and constitutive relationships of Aristotle's material causation.[36] From the human perspective, each of Aristotle's four types of causation: material, efficient, formal, and final, appear to best describe some of the regularities of the subatomic, physical, biological, and psychological levels respectively.

Mapping levels of human systems to Aristotle's causation would be an arcane exercise except for an unfortunate series of events over the past few hundred years, in which philosophers, beginning with Francis Bacon in the very early seventeenth century, gradually dismissed Aristotle's formal and final causation, ignored his material causation and redefined the philosophical category of "causation" to refer to efficient causation. Philosophers, beginning with David Hume in the eighteenth century, have refined and expanded our understanding of causation to eliminate many inadequacies of Aristotle's original definition, but unfortunately the later philosophers still worked within the area of Aristotle's efficient causation, because given the scientific understanding of their time, those other types of causation were not needed as they are now. Twentieth-century scientists amassed a staggering amount of evidence that the scientific theories which underlie the focus on efficient causation and the dismissal of Aristotle's other categories are incomplete or incorrect.

Using causation to describe emergence can cause confusion because of an often presumed Newtonian, efficient causation and a failure to differentiate between real causation between objects and metaphorical use of downward causation as a way to relate the two (supervening) systems descriptions of the same object(s). Using emergence to describe causation clarifies the utility of causation within a level to categorize a variety of relationships.

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35 Bertram F. Malle, *How the Mind Explains Behavior: Folk Explanations, Meaning, and Social Interaction* (Cambridge, MA: MIT Press, 2004).

36 In Chapter 4, I draw on Salthe and Ulancwicz for a more general mapping of Aristotelian causation to the relationships between levels of emergent systems.

Hume noticed that cause and effect are "constantly conjoined." Although most later philosophers disagreed, Hume assumed general patterns of causation with instances of particular causal events. Many later philosophers agreed with Hume's singularist features, such as, that causes must be temporally prior to effects and temporally contiguous with their direct effects. Neo-Humeans replace unqualified constant conjunction with laws of nature: causes are lawfully sufficient for their effects. However, causation may not require lawful sufficiency. [37]

Philosophers have developed many alternative perspectives on causation, including "singularist accounts", where causation occurs locally between particular events; "probabilistic accounts", which incorporate indeterminate settings such as probability theory and quantum mechanics; and "counterfactual theory". Counterfactual theory—beginning with David Lewis—notices that causes generally make a difference, and thus causes are counterfactually necessary for their direct effects, that is, if the cause had not occurred, then the effect would not have occurred. If one does not strike a match, it will not have lit. A challenge to counterfactual theories are non-causal counterfactuals and joint effects, such as Jaegwon Kim's example: "If my sister had not given birth at time *t*, I would not have become an uncle at a time *t*" or the mutually counterfactual dependence of a headache and fever when both are actually caused by a virus.[38]

Manipulation theories of causation hold that manipulation of the cause will result in manipulation of an effect. These theories appeal to many social scientists and statisticians, though many recent philosophers have criticized the reductionist versions of the theories as circular and too anthropocentric—requiring human manipulation to define causation. However, some scientists, including computer scientist Judea Pearl, have proposed a non-reductive theory of causation that relies on the notion of an intervention rather than a manipulation. One may also classify these *interventionist theories* as counterfactual theories, though without some of their limitations.[39]

Although this book focuses on neo-Aristotelian causation and reinterpreting formal causation using information, systems theory, and cybernetics, placing causation in a broader philosophical context situates the constraining relationships of formal causation as a causal "intervention." The alternate philosophical interpretation of the information-theoretic construct of constraint as intervention increases in the philosophical utility of constraints outside of a neo-Aristotelian framework.

Conflict occurs between philosophers and scientists when philosophers attempt to coerce scientific findings into prior philosophical categories, and scientists undermine the worldview in which those prior categories were developed. Many contemporary

37 Douglas Ehring, *Causation and Persistence: A Theory of Causation* (New York: Oxford University Press, 1997), pp. 4–5.

38 John David Collins, Edward J. Hall, and L.A. Paul, *Causation and Counterfactuals* (Representation and Mind; Cambridge, MA: MIT Press, 2004), Ehring, *Causation and Persistence*, pp. 5–6.

39 James Woodward "Causation and Manipulability", in Edward N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy (Fall 2001 Edition)*; available at http://plato.stanford.edu/archives/fall2001/entries/causation-mani/.

philosophers have become aware of the scientific findings and the inadequacy of their own categories, but few if any accessible and adequate alternatives exist, as indicated by the fact that scientists and scholars typically resort to Aristotle's original types of causation to describe non-efficient causation and the conflict remains.[40] In particular, philosophical definitions of causation frequently depend upon an absolute time reference that does not exist given Einstein's theories of relativity.

One's understanding of causation impacts on not only how one understands the systems of each level to interact, but also how one understands the systems of one level to influence systems of another level. How can systems of one level "cause" a change in another level if causation is a theory of interactions *within* a level?

Intra-Level Relationships

To the extent that science observes and experiments on nature, the levels describe different types of causal relationships. Because Westerners try to understand the world through cause and effect, the levels provide a useful strategy to organize the systems comprising human relationships. The organization of systems into levels comes from one's understanding of causation in the human mind embodied in biological processes and enculturated in Western traditions. The next chapter describes the explicit natural boundaries between levels that exist due to natural "abstractions" that occur between systems of adjacent levels, and uses the framework of "strong emergence" to distinguish the different kinds of causation between levels.

The relationships between systems have patterns that constrain the effects system interactions may have. Systems influence systems to which they connect directly or indirectly. Multiple systems may influence a particular system by acting in concert in ways that no individual system can enact. Some systems influence or constrain other systems which influence yet more systems which then influence the original system leading to cycles of interaction and feedback that can either stabilize or destabilize the larger system that contains those interactions. The human body contains many homeostatic cycles that regulate the important processes, such as temperature or breathing, and increase the stability of the person's biological processes. In contrast, a small mutation in a cell's error-checking and self-destruction mechanisms (*apoptosis*) can propagate dysfunctional cellular processes into cancer and disrupt the entire organism.

Patterns occur in interaction between systems as well as in the constitutive relationship where several systems comprise a larger system. What are these patterns of patterns? Are some of the sub-systems shared with other systems? Do those systems interact with the original system in ways other than through the shared sub-system? Is a sub-system completely enclosed within its larger system, that is, encapsulated, or do aspects of the sub-system interact with other systems? What patterns of relationships occur and how do those patterns differ from other systems?

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40 Another indication of the inadequacy of the Western understanding of causation and its impact on contemporary culture is apparent in the Western fascination with, yet inability to comprehend, the Buddhist framework of causation called *karma*.

A physical-level system typically has fairly well-defined boundaries, certain aspects that are essential for its composition, and others that are more peripheral. A rock has fairly well-defined boundaries, depends upon the strength of the bonds between its molecules to exist as a rock, but can be chipped or split and remain a rock. A biological-level system typically has porous, transitional boundaries, most sub-systems slowly evolve or are replaced, and the relationships determine the system, but those shift and flow. When one drinks a glass of milk, the calcium shifts from one's nutritional system, to one's circulatory system, to one's skeletal, or if the calcium is used for calcium channels in the brain, one's neurological system.

A calcium ion comprises a physical system with 20 protons, about the same number of neutrons, and, as it is utilized by calcium channels in the brain, 18 electrons. Quantum mechanics and other constraints of subatomic systems explain the "locations" and relationships between those subatomic particles. The physical system has a positive charge and interacts most easily with molecules with a negative charge, such as through ionic bonds as described in physical chemistry, and moves towards regions of negative or lesser positive charge. Biochemists have determined the rate that a collection of calcium ions would flow through fluid to a region of negative charge. Molecular biologists have described an arrangement of proteins, called a *calcium channel*, that can regulate the flow of calcium ions through a cell membrane. As described more fully in subsequent chapters, the positive charge of the calcium ion participates in the biological system process called neuronal activation that underlies most psychological systems including perception, thinking, learning, and acting. Those psychological behaviors, when combined with behaviors of other individuals, form cultural systems dependent upon language and other social interactions. In particular, as one reads or hears, calcium ions appear to trigger neurological processes that enable remembering what was perceived.

Because a calcium ion has patterns shared with other calcium ions and has some inherent stability, a calcium ion forms a robust system in a way that half a calcium ion, a calcium ion without neutrons, or two positive calcium ions in close proximity would not. System robustness and consistent, stable properties mean that one can interchange one calcium ion with another. One can talk about the collection of all calcium ions, that is, its *class*, which becomes an important distinction in language as one often discusses the class of items such as calcium ions rather than an individual ion.

Calcium, as a class, occurs in cultural systems in addition to language, such as agricultural systems of dairy production, government subsidies, public service announcements, advertisements on nutrition, and economic systems of commodity futures. An individual calcium atom participates over time in a cow's nutrition, the content of a milk bottle, a person's nutrition, and a person's thought. An individual calcium ion participates in a variety of systems at one time such as described above using subatomic physics, atomic physics, physical chemistry, biochemistry, molecular biology, neurology, psychology, linguistics, agriculture, and economics. Every object in the universe participates in multiple systems (including the system of itself and the system of the universe.) Levels provide one way to organize the systems and distinguish the collections of system with which they interact.

Levels as Concentric Circles

Higher-level systems are grounded in lower-level ones. Systems do not exist in isolation but build upon other existing systems. All systems described in this book have subatomic-level characterizations, which provide existence, spatial location, and stability. Most of the subatomic-level systems have physical-level description except the occasional discussion of electrons, photons, fermions, or mechanisms of chemical bonding. Many, but not all of the physical systems have biological descriptions, such as cells or the brain. Some of them have psychological descriptions, such as thought, behavior, or decision-making. A few of those depend upon language and social interaction and form cultural level systems. A calcium ion in the region of the brain responsible for language comprehension (*Wernicke's area*) participates in all these levels.

If one considers the set of all subatomic systems, then all physical systems constitute a proper subset of the subatomic ones. Biological systems are a proper subset of physical ones, etc. The set ("Venn") diagram of Figure 3.10 presents the five levels of systems as concentric circles where each higher level properly nests within the lower level.[41]

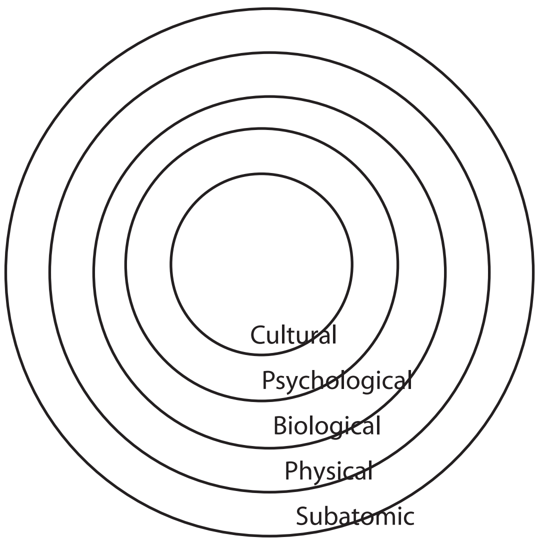

Figure 3.10 Five concentric circles of human scientific systems

Note that one cannot have a cultural-level system without also having a psychological, biological, physical, and subatomic one. No cultural system exists that is a physical-level system without also existing as a biological and psychological-

41 For a critique of models and metaphors used to organize emergence, see Antje Jackelen, "Emergence Everywhere?! Reflections on Philip Clayton's Mind and Emergence," *Zygon* 41(3) (2006): 623–32.

level system. An "artifact" without biological and psychological level-systems remains only a physical-level object.

A *reductionist error* occurs when one tries to characterize a system at one level by much lower-level systems without incorporating intervening levels. One could characterize money as either paper or metal with some defining markings, but that error reduces an economic (cultural-level) system to physical-level constituents without incorporating necessary intervening psychological or biological levels. As a cultural economic system, money depends upon psychological systems of desire, motivation, need, and self-preservation. Those psychological systems depend upon biological systems, primarily in the brain, which depends upon underlying physical systems of proteins and other molecules (including the ubiquitous calcium ion). Thus the physical-level constituents comprising money occur in the molecules of the human brain, not paper and metal. Hard currency in various (or all) forms could disappear and money remain, but if all human brains disappear from the earth, then "money" disappears.

A system intrinsically depends upon its lower-level constituents, but its meaning depends upon the effects it has or could have on the world. Money depends upon a physical object being used in trade for another physical object to meet a person's need or desire. Part of the meaning of money depends upon the actual and conceivable things it could be traded for, including items not yet invented. A thorough systems analysis requires separating the intrinsic constituents from the extrinsic relationships which provide meaning to an object and by which it functions.

One can focus attention on various aspects of an object's context and analyze those systems. By highlighting certain aspects of an object's context, one interprets the significant relationships used to understand the system. Similarly, other systems depend upon certain relationships of an object and that dependency defines the function and interface of that object for the system that utilizes it. The unmatched positive protons in a calcium ion define the ion for other molecules that bind to it ionically. Its positive charge defines its part of a gradient for biochemical flows. Its ability to trigger "second-messenger pathways" in the brain defines its function in learning. One cannot reduce the relationships of the calcium ion to its individual constituents as those relationships do not depend so much on the existence of a proton but the lack of an equal number of electrons to match the protons. From a systems perspective, it is the difference between number of protons and electrons that make a difference, and pragmatically that difference enables the real possibility of calcium ions to trigger complex biological processes. That real possibility arising from a relationship of difference defines an aspect of what it means to be a calcium ion, or more accurately, how a calcium ion becomes meaningful. All the relationships within and across systems at every level define the objects of nature, not just the physical-level description of constituents.

Levels organize systems of relationships into coherent theories that scientists study. As the mental relationships correspond (to some extent) with real, natural relationships, the distinction between mental levels depending upon logical consistency corresponds to natural levels depending upon causation. Recalling from Chapter 1, not that one projects mental (psychological-level processes) of logical reasoning onto nature, but that natural relationships of difference (or change) may have led to the evolution and development of certain human-brain characteristics that recognize and categorize those differences in symbolic language that philosophers of nature call causation and logicians call inference. The next chapter examines how those differences relate and emerge.

CHAPTER 4

Emergence of Water: Emergence of Life

> Thirty spokes converge at the wheel's hub, to a hole that allows it to turn.
> Clay is shaped into a vessel, to take advantage of the emptiness it surrounds.
> Doors and windows are cut out of walls in order that the barrier they provide might be used.
> Though we can only work with what is there, use arises from what is not there.
> —*Tao Te Ching*, #11

What is emergence? What distinguishes emergent phenomena from other phenomena? How do emergent properties relate to the objects from which they emerge?

The last chapter described five scientific levels—subatomic, physical, biological, psychological, and cultural—to organize systems for scientific investigation of the human person.

How do these levels relate?

Emergence captures the apparent novelty in the world where the whole appears greater than the sum of its parts. Emergent properties may appear from interactions that one would not predict from the properties of the components. Regularities may appear among relationships that constrain how the components interact in the future. The absence or completion of components in a constrained configuration may give rise to a new emergent system.

Emergence describes how simple objects interacting in simple ways can give rise to the complexity in the world, it addresses how these complexities appear as a coherent whole and combine with other emergent complexities, and it explains how those interacting complexities weave together to give rise to stability in the world rather than fragility.

Emergence in the World

The world is full of surprising phenomena. When hydrogen (a highly flammable gas) and oxygen (a gas necessary for fire) combine, they produce water—a liquid that puts out fire. When sodium (a silver-white metal that reacts strongly with water and other substances) combines with chlorine (a toxic, green gas), they form sodium chloride or table salt—a common substance in ocean water necessary for life.

Emergence requires a tension between novelty and continuity. As Aristotle defined change, some new thing or quality must come into being for one to consider it change, and something must endure for it to be change rather than a replacement. In emergence, all the prior properties and processes remain the same. Only something new is added. Emergence is a type of change where everything already existing endures, but something new comes to be—namely a new constraining relationship. When one adds a drop of water to a glass, water is added, but air at the top of the glass is removed (pushed out of the way by the falling drops). When surface tension emerges as a property of water, no properties of the air, the glass or the water are removed.

In emergence, all the existing, actual properties, and processes remain the same, but a future possibility is removed while another possibility becomes actualized. When hydrogen and oxygen combine, they eliminate the possibility of combining with different elements through covalent bonds. Emergence eliminates some possibilities by realizing others. As the hydrogen atoms share their electrons with the oxygen atom, the two atoms bond, and that bond of shared electrons has certain properties that neither atom had separately. The physical level emerges from subatomic interactions. These properties of the bond, such as a 120° angle between the two hydrogen atoms bonded to the oxygen atom in a water molecule, contribute to other emergent properties, such as the six-fold symmetry of a snowflake. Most of what one experiences day to day in the physical world depends upon covalent bonds where atoms share electrons: other than light (photons), all solids, liquids, and gases one experiences in everyday life are mixtures of covalent bonded molecules. One could claim (and I do) that all of one's everyday experience includes emergent phenomena.[1]

If one analyzes everything and reduces the world to its primitive parts, one eliminates the covalent bond which provides the foundation for most of the real world. However, the opposite approach of ignoring the parts and only attending to the whole does not work either. Covalent bonding depends upon subatomic properties of electrons, such as quantum uncertainty (the electron can "orbit" both the hydrogen and oxygen nucleus) and the Pauli exclusion principle (two electrons cannot share the same place at the same time); thus, covalent bonding emerges from subatomic relationships.

Scholars debate an anthropocentric distinction in emergence between what humans can predict from interactions and cannot predict. Most scholars studying emergence would concur that one can predict the property of water (as the chemical dihydrogen oxide) to extinguish fire from the laws of chemistry, and that property does not emerge; but one cannot predict surface tension and thus one may call that emergent. When I began writing this book, I held the same assumption, but systems theory highlights that those chemical properties of water have to come from somewhere, namely the interaction of subatomic components. Emergence depends upon relationships in nature, not the current state of science.

To understand how water emerges from hydrogen and oxygen or table salt from sodium and chlorine, one uses the laws and regularities studied by the physical-

1 As I will discuss below, some properties are resultant not emergent, such as the weight or mass of physical objects. However, weight emerges from gravitational interactions and no one knows whether mass emerges from subatomic constructs. Resultant properties at one level combine constructs which incorporate lower-level emergent ones.

level discipline of chemistry, which emerge from the laws of quantum mechanics. In emergence, the combination of parts gives rise to novel properties. At the physical (atomic) level, chemists can provide coherent explanations of how these surprising phenomena occur, based on the chemical properties of the individual atoms, which in turn derive from the relationship between subatomic components. However, once one develops models of individual atoms, one can predict their interaction based upon those models. From a systems perspective, because neither component has the property in isolation, their combination forms a system and the novel property results from their relationship. One can describe such emergent phenomena as relationships between different components where something novel arises or emerges in the relationship between parts.

A different type of emergence occurs when a new property emerges from the interactions between typically many, somewhat similar constituents rather than combining a relatively few different constituents. At the physical level, electromagnetic and thermodynamic phenomena demonstrate this order of emergence.

Individual iron molecules do not appear magnetic, but in quantity iron orients along a magnetic field even to the point of moving iron filings around on a piece of paper when in the vicinity of a magnet. Individual water molecules do not form a liquid, but only in quantity do molecules have phases. The differences between the solid, liquid, and gaseous phases of water depend on the temperature, or energy of interaction, between water molecules. Again, scientists can explain those phases using the laws and regularities of thermodynamics and chemistry, and mathematical statistics, but not via the physics of the individual molecules. Nothing mysterious comes into existence when water molecules interact with each other, but the amount of kinetic energy in those interactions differentiates between solid, liquid, and gas with surprisingly sharp transitions between each phase. Each phase has phenomena specific to that phase, such as crystallization, surface tension, and Benard cells.

Surface tension in water occurs because of the van der Waal force between atoms of water molecules. Surface tension emerges in large quantities of water molecules and makes a stream more than a disconnected collection of water molecules. Van der Waal force refers to the intermolecular attraction of molecules. As an electron "orbits" the atoms of a water molecule, the molecule becomes temporarily, slightly positive on one side, which slightly attracts another close molecule that is temporarily, slightly negative on the side closer to the first molecule. As the electrons continue to orbit the nucleus, the slight polarity reverses direction, but becomes synchronized. In large quantities, the synchronized, slight oscillation of polarities holds the similarly sized water molecules together, leading to the phenomena of surface tension.

In another emergent phenomena, under certain conditions when water begins to boil, water molecules self-organize into a hexagonal, rolling cell called a convection or "Benard cell," and the molecules become interdependent on each other: the behavior of each water molecule suddenly depends on what all the others are doing, and thus on its relation to the Benard cell as a whole. One can describe the Benard convection cells as temperature differences, but not the hexagonal shape.[2]

2 The experimental conditions include a relatively shallow layer of liquid between two very smooth parallel surfaces heated from below.

Surface tension occurs with the dampening of differences in their interaction, namely the dampening of difference between the angular "location" of electrons relative to the nucleus. In Benard cells the interactions facilitate additional interactions that constrain subsequent ones. The property of surface tension and the hexagonal shape of Benard cells emerge from the reduction of possible differences between the large quantity of similar constituents.

Another type of emergence occurs when a new constraining relationship emerges to "accidentally" facilitate the initial interaction or constrain subsequent ones. Not only do the differences in possibility reduce, but something new becomes actualized that continues to maintain that shared synchronicity.

In chemistry, some molecules catalyze, or accelerate the rate of, a chemical reaction. On occasion an "autocatalytic loop" will occur in which molecule A catalyzes the formation of molecule B, which in turn catalyzes the formation of molecule C, which then catalyzes D, and so on, but at some point a molecule such as D closes the loop and catalyzes the formation of molecule A. That organizational closure creates a system, which depending on the actual reaction rates, can become stable.

The Belousov–Zhabotinsky chemical reaction (or B–Z reaction) describes a chemical oscillator. A series of 18 reactions contains both positive and negative feedback mechanisms that self-organize and amplify the reaction toward a threshold and then suppress and counteract the change, returning the system toward its original state. In a beaker, the entire liquid changes color back and forth, but if done in a thin layer between two glass plates, concentric or spiral patterns of color emerge from the trapped reactions.[3]

Snowflakes form because different crystal patterns grow depending upon the combinations of humidity, temperature, and pressure. Water molecules freeze in a hexagonal-shaped crystal lattice because of the geometric properties of the individual water molecule and the efficient use of space that hexagons provide. The snowflake becomes symmetric as each of the six sides grows identically as it passes through the same environmental conditions. The symmetry emerges from the constraint that each side of the snowflake falls through the same environment as the other five sides. The uniqueness of each snowflake depends upon the variety of plates, prisms, and dendrites that occur at the slightly different environmental conditions and the statistical improbability that two snowflakes would have equivalent histories.[4]

Systems can provide their own *boundary conditions* or constraints that select or delimit further development. The closed catalytic cycles of metabolic pathways constrain the chemicals used and generated, and the feedback cycles provide stability.

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3 A variety of these oscillators exists. Irving R. Epstein and John A. Pojman, *An Introduction to Nonlinear Chemical Dynamics: Oscillations, Waves, Patterns, and Chaos* (New York: Oxford University Press, 1998).

4 In practice, snowflakes bump into each other, etc., and rarely have the perfect six-fold symmetry the theory predicts, but the process is modeled by theory. Ukichiråo Nakaya, *Snow Crystals, Natural and Artificial* (Cambridge, MA: Harvard University Press, 1954); Kenneth G. Libbrecht, "The Physics of Snow Crystals," *Reports on Progress in Physics* 68 (2005): 855–95 .

The geometric structure of water molecules organizes the symmetry of snowflakes. Systems may organize via external constraints or self-organize. In either case, constraints emerge from the relationships among constituents to provide stability of form to the emergent system.

In living organisms, an essential component of the cell wall are "lipids," or fatty substances that repeal water on one side and attract water on the other. As the lipids connect to each other, they form a sheet. In isolation, the lipid has a part that attracts water "hydrophilic" and a part that repeals water "hydrophobic," and when lipids connect in similar orientation into a sheet, the sheet has similar hydrophobic and hydrophilic sides. In larger quantities, the properties of hydrophobicity and hydrophilicity amplify and the presence of water holds the sheet intact. However, when a sheet connects its edges into a three-dimensional sphere, a new property emerges, namely an inside and an outside of the sphere. A pair of complementary oriented lipid sheets forms the cell wall and prevents the water inside and outside the cell from passing through the cell membrane. The emergence of an interior and exterior provides a construct used by biological processes that allow and regulate the passage of other molecules through the cell wall.

In the brain, the neuron cells have a selectively permeable membrane that normally prevents the passage of sodium, calcium, potassium, and chloride ions through the cell wall. Additional protein complexes within the cell membrane form ion gates that allow the passage of those ions through the membrane under certain conditions. The three-dimensional closure of the cell membrane restricts the passage of ions between the interior and exterior, and the ion gates control the passage of the ions. In Chapter 6, I describe some of the higher-level biological processes of the brain that use the controlled ion flow between adjacent neurons for signaling and its higher-level emergence of the mental processes of memory, learning, and decision-making.

Another type of emergence occurs with a constitutive absence. Hemoglobin is a construct of four proteins that carries oxygen through the blood stream. The four sub-units bind to an iron molecule which then binds to an oxygen molecule. The hemoglobin proteins consist of amino acids comprised of carbon, hydrogen, and nitrogen atoms, and they contain no iron molecules. However, the arrangement of the amino acids in each protein and the shape and position of each sub-unit with respect to each other is specifically tailored to the chemical properties of iron and in particular those properties that supports its bonding to oxygen.

If one takes a reductionist perspective and assumes one can understand hemoglobin by examining its four protein sub-units, one would miss its most defining feature—the iron molecule—because hemoglobin does not contain iron. If one knows the chemical properties of iron, one can marvel at the precision at which hemoglobin configuration appears tailored to carry iron and iron bonded to oxygen, but if one did not know how hemoglobin functioned in a biological system, one would miss all that consistent and significant structural information, as the amino-acid positions would otherwise appear random or insignificant. To understand hemoglobin, one must recognize the constitutive absence of iron in hemoglobin.

In hemoglobin, as in the prior type of emergence described, all existing relationships endure (all atoms and bonds remain); differences in variation reduce (the atoms do not move freely); new constraints propagate continuity of the constellation of stable relationships or form (by formation of additional bonds and environmental conditions to maintain proper protein folding). But rather than supervening upon existing systems, some of the new constraints exist where no system actually occurs—a constitutive absence—and a new possibility enters the realm of possibility described by the system's phase space. (Without a constitutive absence, one could argue that the new constraint merely actualizes configurations that were already possible.)

After one discovers many of the relationships of a system, one can analyze the relationships and identify some of the constituents as more central than others. DNA plays a central role in the biology of a human cell. The constitutive absence of oxygen (as bound to iron) in hemoglobin plays a central role in the human circulatory system. However, emergent systems may depend upon these constituents in surprising ways. The ancient Jewish ritual of sacrifice depended upon the spilling of animal blood which they recognized as central to life. The Christian ritual of communion (or "The Lord's Supper") developed from early Christian interpretation of the wine as blood in the sense of Jewish sacrifice. Thus, the arrangement of hemoglobin molecules tailored to iron molecules carrying oxygen plays a constitutive role in the Christian ritual of communion. Obviously, one cannot reduce Christian communion to the three-dimensional structure of hemoglobin, but neither does communion have its sacramental meaning without some chemicals in blood carrying molecules needed for life.

Another constitutive absence occurs in the *synapse*, a connection between neurons in the brain. As described in Chapter 6, the synaptic connection between neurons is *plastic* or malleable and changes as the neurons participate in mental activity. Because of the empty spaces between neurons, the strength of connection between the neurons can vary by creating or removing ion channels (and other protein complexes) in the cell wall. The ions and other "neurotransmitters" can cross the small synaptic cleft to communicate information between the neurons. The ability to vary the strength of neuron connections, in a process called *long-term potentiation*, which provides the cellular basis of learning, and is an important emergent phenomena that differentiates between the biological and psychological levels.

Philosophically, one could argue that the possibility of the biological process of oxygenation exists in molecules of hemoglobin and iron or that the psychological process of learning exists in possibilities of neurons, but that argument implies that the possibility of Christian communion exists in the molecules of hemoglobin, too. Mathematically in phase space and logically within the theories of a level, those claims become meaningless. In a less problematic attribution of possibility, I suggest that the possibility of oxygenation, learning, or Christian communion occurs in the relationship between a constitutive absence and the other constituents. In terms of the graph-modeling language of Chapter 2, a constitutive absence requires introducing a new node which encapsulates no independent constraining relationships.[5]

5 In terms of logic, one introduces a free variable, or what C.S. Peirce called a "line of identity" in his existential graphs. Philosophically, those free variables already existed as

Another type of emergence occurs in the selection of constraints in a system. In hemoglobin, the precise configuration of amino acids, tailored to the properties of iron and its oxygen-bonding abilities were not designed but evolved over time through the process of natural selection. Different variations of the hemoglobin proteins were generated by random mutation, and as the variations were available in different systems (animals), the most efficient ones survived and propagated. Biological evolution is a type of biological process that depends upon mechanisms to generate variation, select for fitness to an environment, and propagate the information of that variation for subsequent refining variations. Evolution is a type of emergent phenomena that occurs over time at the biological level. Emergence is more fundamental than evolution because genetic variation, fitness and genetic transmission are each emergent phenomena. However, selection, as most clearly observed in evolution, provides an important aspect of general emergence.

Selection occurs in symbolic language among the possible meanings, related psychological concepts, and their neurological substrates. Cultures may select among meanings given to words by individuals. A constitutive absence also occurs in symbolic language, and one may use semiotics to model symbolic language as an interaction between psychological individuals giving rise to the emergent phenomena of culture. Although some signs refer directly to their objects, such as a weather vane referring directly to wind direction, other signs require an interpretation, and the arbitrary convention in which language has meaning and its symbols combine provides a constitutive absence of reference which allows for shared interpretations essential to culture, and the use of that reference to refer to transcendent systems as described in the next chapter.

As mentioned earlier, in C.S. Peirce's organization of signs based upon their object: an icon signifies by resembling its object like a painting or a map, an index represents its object through an existential connection between itself and the object, and a symbol represents its object through a convention that governs how the symbol will be used.

As discussed later in the chapter, one way to distinguish among the types of emergence involves these semiotic distinctions. Some constitutive absences create an interface between systems that resemble the object, such as iron in hemoglobin. Others create an interface that represents its object through an existential connection, such as hemoglobin referring to oxygen through the existential connection of iron. Other constitutive absences require a convention to interpret its use, such as the synapses between neurons which only acquire meaning in the context of other synaptic connections, human language acquiring meaning through convention among others, or DNA whose constitutive absences in its backbone structure accept certain nucleic acids that other transcription, translation, and transport processes interpret.

Selection does not always occur among abstractions. Selection occurs at the physical level as raindrops roll down the side of a mountain, the raindrops form into puddles, the puddles into trickles and streams, and the stream flows down the most direct path selected by gravity. If there were no surface tension, no raindrops

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possibilities and became actualized in the constitutive absence, as an equality constraint.

would form, and each water molecule would independently slide down the mountain as part of a porous sheet. The surface tension of water suffices for an emergent stream pushing or cutting through obstacles rather than yielding and splitting back into trickles. The erosion of water cuts gullies, reinforcing the arbitrary path, and propagating the information from its history to subsequent rainstorm runoff.

Although selection of raindrop paths occur by gravity, the individual paths do not appear as directly emergent as some of the other phenomena described in this section. A more interesting type of emergence occurs when a system selects among emergent constraints in a system and in particular when those constraints include a constitutive absence that acquires meaning through convention or symbolically and results in the emergence of a new level. But to describe that phenomenon precisely, we need to characterize the types of emergence in terms of constraints, systems, and their topology.

Framing Emergence

In the previous section, I described several types of emergent phenomena, including those when:

a. The combination of different components result in a property that neither component has individually, such as covalent bonding.
b. A collection of similar constituents demonstrates an unpredictable property in large quantities, such as magnetic properties of iron.
c. A collection of somewhat similar constituents reduce their differences and a novel property appears, such as when the elimination of electron orbit differences in water molecules leads to surface tension.
d. The combination of a collection of components results in a novel property that facilitates or constrains the continuation of their relationship, such as autocatalysis, snowflakes, or cell membranes.
e. The relationship between components becomes sufficiently stable to create a constitutive absence in the system that enables novel interactions with other systems, such as hemoglobin or a partially permeable cell membrane.
f. The components form a novel construct that constrains influences, or controls the system and provides sufficient abstraction that the system may retain, manipulate, and vary the abstraction separate from its interpretation and implementation in the system, such as DNA, circuits of synapses in the brain, or symbolic language.

Although all the phenomena exemplify emergence, emergence itself has a relational nature with different types of structure. I will characterize emergence as a general category, present contemporary theories for emergent systems and relate those theories to the types of emergence that occur within and across levels. By the end of the chapter, I will organize the six types of emergence presented so far into three orders of emergence—two within levels and one that results in the existence of levels. To avoid confusion between the terms “level” and “order,” I use *order* to characterize three aspects of emergence that occur within natural systems, one of which gives rise to the existence of levels, and "level" to distinguish the resulting organization of systems into maximally coherent theories.

Characteristics of Emergence

Philosophers call the view described here *emergentist monism*, where reality consists of an emergent relationship from which all phenomena arise.[6] In ways not yet understood, protons, neutrons, and electrons emerge from interactions of simpler constituents. The properties of atoms emerge from the interactions of protons, neutrons, and electrons. The properties of molecules emerge from the interactions of atoms. The properties of biological systems emerge from the interactions of molecules. Interactions of molecules give rise to various structures and processes including human cells such as neurons in the brain. These neurons interact giving life to psychological behaviors and thoughts. Psychological individuals interact giving rise to culture.

Stephen Jones surveys the emergentist literature and describes several characteristics of emergent properties, which serves as a good starting place to begin discussion of emergence:

- Novelty—instances of the first time something appears in the universe, or the emergence of something new with every instance of a particular organization of constituents.
- Unpredictability—the unpredictability of the properties of something is at the very basis of calling it emergent.
- Coherence, integrity—objects that are "held together by causal interactions that constitute their organic unity … act[ing] coherently and resist[ing] internal and external fluctuations."
- Self-maintenance—contingent stability with respect to variations in the environment: self maintenance is part of the cohesive nature of an emergent system.[7]

Although disagreement between emergentist theories prevent a universally accepted definition of emergence, the contemporary scholar and critic of emergentism Jaegwon Kim describes the central doctrines of emergentism as including two

6 Philip Clayton, *Mind and Emergence: From Quantum to Consciousness* (Oxford and New York: Oxford University Press, 2004); Joseph A. Bracken, "Emergent Monism and the Classical Doctrine of the Soul," *Zygon* 39(11) (2004): 161–74.

7 Stephen Jones, "Organizing Relations and Emergence," in *Artificial Life VIII: Proceedings of the Eighth International Conference on Artificial Life* (ed. Russell K. Standish, Mark Bedau, and Hussein A. Abbass; Cambridge, MA: MIT Press, 2002): 418–22; Jones also includes causal asymmetry, downward causation, and non-linearity. As explained in Chapter 3 and below, I avoid describing emergence in terms of causation, because, as scientific evidence suggests, emergence appears more primitive than causation. See also John D. Collier and Scott J. Muller, "The Dynamical Basis of Emergence in Natural Hierarchies," in *Emergence, Complexity, Hierarchy and Organization, Selected and Edited Papers from the Echo III Conference, Acta Polytechnica Scandinavica* (Mathematics, Computing and Management in Engineering Series, 91; ed. George Farre and Tarko Oksala; Espoo: Finnish Academy of Technology, 1998).

claims.[8] First, the emergentist position claims the emergence of complex higher-level entities. Higher-level systems are generated from the coming together of lower-level entities in new structural relations. These structures may embed other structures, resulting in a cumulative process that generates increasingly more complex systems. This claim is also shared with physical reductionism. Second, the emergentist position claims the emergence of higher-level properties. All properties of higher-level entities arise out of the properties and relations that characterize their constituent parts. Some of these properties are "emergent," while the rest are merely "resultant." Kim differentiates between predictability, explainability, and reducibility of the properties. *Emergent properties* of a higher-level system are not predictable from, explainable by, nor reducible to, the most exhaustive information about the properties and behaviors of lower-level entities and the structural relations that configure them. *Resultant properties* are predictable from, explainable by, and reducible to, lower-level information. Kim holds the view of physical reductionism (Chapter 3) and claims no emergent properties exist.

The controversy of reductionism and emergence centers on which properties emerge and which ones directly result from the constitutive parts. The distinction arises as to which properties are sufficiently novel or predictable to deserve the label "emergent." However, that distinction depends upon the observer or subject who determines novelty or creates a prediction.[9]

Rather than separate mind from nature, if one examines the relationships of a system to characterize emergence, one can consider the general aspects of those natural relationships, such as the central role a relationship plays in a system or how robust a process is. Robustness refers to the ability of a system to continue functioning despite the existence of faults and to adapt to new situations. Robust processes, such as in biological systems, often depend upon redundancy. Robustness provides a more objective measure of properties rather than novelty. A collection of similar systems provides redundancy, and processes may depend upon a class

8 Jaegwon Kim, "Making Sense of Downward Causation," in *Downward Causation: Minds, Bodies and Matter* (ed. Peter Boegh Andersen, *et al.*; Aarhus and Oakville, CT: Aarhus University Press, 2000), pp. 307–308. Kim also claims downward causation as an essential aspect of emergence. Higher-level entities causally affect their lower-level constituents. Many scholars disagree with this assessment if causation refers to "efficient" causation, as it typically does and Kim implies; and as described below, Emmeche and his colleagues suggest formal and/or final causation provide a better description of how entities affect their constituent parts.

9 Defining emergence in terms of novel properties can only describe what exists in the world in terms of what one knows. In addition to the obvious anthropocentric problems with presuming a human observer, a subtler problem exists in requiring even more objective measure of novelty. Although no scholar would deliberately define emergence as dependent upon a human observer, in practice, normative examples often draw upon the limits of contemporary science. Novelty presumes a reference to which to compare the phenomena, and a reference point from which to compare, that is, requiring a "memory" and a subject. Definitions of emergence that depend upon novelty depend upon a philosophical foundation with subjectivity and the existence of subjects who determine novelty, and thus, limit emergence to an epistemological tool inadequate to describe ontological emergence.

of constituents without depending upon a particular individual. Water is a robust class because water molecules participate in many relationships, such as constituting rivers, snowflakes, or animal bodies, that do not depend upon specific systems of water molecules and that its constituents in isolation—an oxygen atom and hydrogen atom—do not comprise.[10] In contrast, unlocking a door is fragile rather than robust as it depends upon a very specific system, namely a key that fits the locking mechanism.

Although after a couple of millennia, we now understand how hydrogen and oxygen constitute water, we actually understand one simple case of a more complex relationship of emergence. When reductionists see predictable, resultant relationships, they presume a model of efficient causation that emerged from the subatomic level and only models physical phenomena.

To understand emergence, one needs to broaden the phenomena incorporated by emergence to include ones that human scientists now understand in physical terms rather than arbitrarily limit the focus to emergent properties that we have not yet explained. Emergent relationships include the relationships between hydrogen, oxygen, and water; water molecules and rivers; water molecules and snowflakes; and water molecules and hydrophobic lipids in cell walls.

Reductionism and Emergence

Three approaches to understanding the relationship between systems and their constituents in emergent systems are dualism, physical reductionism, and emergence. Dualism separates the systems as distinct substances. Physical reductionism eliminates all but the lowest, "physical" level. Emergence grounds everything in the constituents, but nevertheless the interaction between constituents result in the gradual appearance of properties or substances that cannot be reduced to the component parts.

Dualism and physical reductionism describe extreme religious and scientific positions that lead to conflict, and both appear inadequate to describe common phenomena examined in either science or religion. They provide extreme positions that emergence theories mediate, and understanding them helps provide a context to understanding emergence.

Reductionists argue that everything can be reduced to its simplest parts and that the laws of physics suffice to explain all phenomena.[11] Some reductionists might argue that only the atoms are *really* real and that the laws of chemistry can be derived from the laws of physics.[12]

Most contemporary emergentists would agree with the former claim and disagree with the later one. Atoms—or the constituent parts of atoms comprising the physical world—have a primacy of existence not shared with higher-level phenomena, such

10 In Chapter 7, I differentiate between the relationships in which something does participate (pragmatism after William James) and the relationships in which something could conceivably participate (pragmatism after CS Peirce).

11 See Chapter 3 for characterization of reductionist positions.

12 An ontological and epistemological reductionist position.

as phases of water or the magnetic properties of iron. But emergentists and many scientists would argue that the processes, properties, laws, and theories found in chemistry and biology cannot be derived from the lower-level physical laws. Some reductionists concede that the laws of higher-level sciences, such as chemistry, biology, or psychology do not reduce to physics, but still claim that those higher-level phenomena are predictable from, explainable by, and reducible to, lower-level information.[13] And, the debate ensues about what properties result from lower-level components and what properties emerge.

However, I disagree with many emergentists, and all reductionists, that only the lowest level is *really* real. I do not claim that a mysterious new substance appears at higher levels, but that the constitutive relationships at each level have equivalent claims to reality. In the emergent systems approach described in this book, reality consists of one construct: the relationship, and the natural world consists of two constructs: the relationship and empty space. Before proceeding to examine how the distinctions between levels each comprise perspectives on a single reality, it may help to look at the contrasting position where each level does consist of a separate substance.

Dualism

A metaphysical distinction, called *dualism*, means that the nature of reality determines a distinction between levels. Dualism remains a popular belief and is a useful boundary theory along with physical reductionism to dialectically describe emergence.

Until the nineteenth century, many considered life (at the biological level) separate from the physical level, and the most refined theory of the distinction occurred in "vitalism," where organisms required a separate substance, the *élan vital*, to live. Aristotle noted the distinction between the mineral kingdom and the animal and vegetable ones, and until Fredrich Woehler synthesized the biological compound urea from inorganic components in 1828, no connection between the two realms existed. Biologists now realize that life occurs not because of one big story of a vital force, but because of lots of little stories in metabolic pathways, genetic replication, and so on. Vitalism reappears in New Age and related thought as "energy" that permeates living systems. If "energy," "spirit," or "consciousness" exists separately from living matter, then philosophically the position espouses dualism.[14]

Recall from Chapter 1, Descartes describes the body as a machine and the mind or soul as a separate entity made of a separate "thinking" substance. For Descartes, the only quality he knows he possesses is "thinking." Although Descartes does not distinguish between conscious thought and other mental behavior, he draws a sharp

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13 Jaegwon Kim, *Supervenience and Mind: Selected Philosophical Essays* (Cambridge Studies in Philosophy; New York: Cambridge University Press, 1993).

14 Vitalism (and "energy") differ from the Chinese "*chi*" which, because it underlies physical existence, would more likely indicate a traditional Chinese perspective on subatomic-level systems with emergent properties at the physical and biological level not yet studied by Western science.

distinction between mind and body. Many still hold a separate "thinking" substance based on Cartesian dualism (that would distinguish the psychological-level "instinctive" behavior of animals from the cultural-level "thinking" of humans). However, most scholars recognize the inadequacy of Descartes' position. If mind and brain are of separate substances, how can they affect each other? Because they consist of different "materials" in separate realms, they have no commonality in which to interact.

Another common dualist view occurs as the distinction between a person's spirit (often called soul) and body. A classic example of dualism comes from Middle Platonism where the soul belongs to a second *hypostasis*, or realm of substance, separate from the physical world. This Platonic notion of soul assimilated into Christianity as an immortal soul through early Christians who believed Platonic philosophy provided a rational foundation for Christianity, often believing that as all truth came from the Holy Spirit, integrating the best ideas about how nature works into Christian beliefs furthered the work of the kingdom.

Levels differ metaphysically in a dualist position. As the laws and properties of the substances differ between levels, a dualist position requires an additional construct to explicitly connect the levels. One can avoid the problem of relating substances dualistically if the substance remains the same between levels and only properties are different. However, in "property dualism," one must still explain the origin of the properties and how they relate to the properties that are intrinsic to the substance.

A presumption of separation between levels in either mind or nature creates artificial gaps that one must then overcome. Reductionism ignores or de-emphasizes the contribution of the higher-level systems, and dualism ignores or de-emphasizes the constitutive role the lower-level systems play as parts of the higher-level wholes. Emergent systems capture the necessary constitutive and holistic aspects of natural phenomena and human's mental representation of them.

Theories of Emergence

Philosophical Distinctions between Levels

Many types of emergence occur within levels, but other types of emergence seem to relate across levels; hemoglobin and DNA relate physical and biological systems, and synapses relate biological process in the brain with mental process of the psychological level. Levels could differ from each other in at least six ways: metaphysical, ontological, epistemological, phenomenological, logical, or semiotic, which I will briefly describe in turn before using them to characterize emergence in the remainder of the chapter.

Metaphysics refers to the unnamed book after Aristotle's *Physics* in which he describes general categories of reality. Kant showed that one cannot prove a priori metaphysical judgments (i.e., purely rationally), though subsequent philosophers such as Joseph Maréchal, Charles S. Peirce, and Alfred North Whitehead clarified that one can make metaphysical claims with the same rigor as scientific judgment

(Chapter 7). Using the language of constraints (Chapter 2): what possible metaphysics could hold given our scientific knowledge of the world? I agree with contemporary Christian theologians and philosophers of science Phillip Clayton and Nancey Murphy, among others, that ample evidence falsifies physical reductionism in the world or dualism in humans.[15] Uncountable possible metaphysics remain, and in Chapter 7 I describe some metaphysics that allow for (technically: "admit") human systems with no metaphysical difference between levels.

In ontology, one studies the nature of being. What differs between what exists and what does not? What does it mean for something to exist? Historically from Aristotle, ontology and the nature of being referred to a static category of being, but with an undercurrent of philosophies that emphasized "becoming," such as John Duns Scotus, Jonathan Edwards, and Whitehead.[16] With science chipping away at static processes in the universe in cosmology and evolution, twentieth-century philosophers generally backed away from ontology, but questions remain on the nature of existence, change, or becoming. Although systems of the physical level typify existence, in what way do electrons, digestion, thoughts, or governments exist? Whether levels differ ontologically depends on how one defines the term, though I use the traditional definition as referring to "being" and use other categories from pragmatic and process philosophy to refer to existence as "becoming."

Epistemology involves studying theories of knowledge, especially its methods, validity, and scope. What can one know? Specifically, what true statements of the world can one justifiably and reliably believe? In terms of levels, epistemology depends upon philosophy of language and philosophy of mind. Statements of the world depend upon the concepts and theories ones uses to perceive and describe the world. Those concepts and theories differ between levels, and the sciences that study them. The opposing view is epistemological reductionism. An epistemological reductionist believes processes, properties, laws, or theories found in higher levels of complexity can be derived entirely from those found in lower levels of complexity (psychology to biology to physics). I know of no contemporary scholar who believes in epistemological reductionism.

To recap, in the traditional philosophical disciplines of metaphysics, ontology, and epistemology, the levels described in Chapter 3 do not differ metaphysically, they do differ epistemologically, and whether they differ ontologically depends upon how one defines ontology.

Phenomenology studies direct experience, and in particular views as primary the relationship between the first-person subject and the putative "objects" of the world. How do "I" experience the world? As phenomenology relates to philosophy of mind, one experiences the systems of each level as different, and thus phenomenologically the levels differ. However, more subtly, philosophers and scientists studying the mind (and brain) use culturally constructed categories to create those distinctions.

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15 Clayton, *Mind and Emergence*; Nancey C. Murphy and Warren S. Brown, *Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility* (Oxford: Oxford University Press, 2007).

16 Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (Cambridge, MA: Harvard University Press, 1936).

Logic refers to reasoning conducted according to strict principles of validity and depends upon the terms forming the basis of the logic. As the levels organize human systems, do logical theories of human systems require structures such as levels to avoid inherent contradictions or admit a coherent semantics? As a novel contribution in this book, I argue that levels are required because the abstraction of information at the boundaries between levels require separate semantics for each level.

Semiotics refers to the study of signs or symbols and their interpretation. Terrence Deacon draws upon the semiotics of C.S. Peirce in differentiating a type of emergence (third-order emergence) that requires arbitrary interpretation between levels. Although one can directly map the structure of a folded protein to its activity, one requires an interpretive framework to map genes in DNA to the molecules in amino acids that form proteins (specifically a process utilizing tRNA) or words in a specific language to networks of neurons in the brain correlating with a person's comprehension of those words (specifically other systems and learned networks in the brain).

Levels as Existence

Historically, the three types of emergence include British, strong, and weak. Emergence became a popular view in the 1920s as a way of describing how material organisms "live." In contrast to dualists who believe in "pre-existing" (metaphysical) substance, British emergentists believe that only the material substance existed before life emerged (evolved). Many, but not all, British emergentists believe that new substance resulted as life emerged, and thus a type of dualism emerged over time.

The British emergentists of the 1920s articulated a specific model of levels for the world. According to the layered model, nature is stratified into levels, from lower to higher, from the basic to the constructed and evolved, or from the simplest to the more complex. All objects and phenomena have a unique place in this ordered hierarchy, and most early emergentists, such as Conway Lloyd Morgan, viewed this hierarchy to have evolved historically.[17]

Since the 1960s, more nuanced positions between reductionism and British emergence have arisen. *Strong emergentists* claim that cosmic evolution produces new, ontologically distinct levels characterized by their own distinct laws or regularities and causal forces. *Weak emergentists* claim that although emergent categories may be required to explain causal processes and emergent structures may constrain lower-level structures, they should not be viewed as active causal influences. In general, weak and strong emergentists differ in the ontological difference between levels, where one defines ontology in terms of being.[18]

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17 Although I know of no contemporary scholar that holds the British emergentist position, it remains an important position in the debate because some reductionists assume emergentists hold that position, then argue against it.

18 Clayton, *Mind and Emergence*, pp. 9–31; drawing upon Mark Bedau, "Weak Emergence," in *Philosophical Perspectives: Mind, Causation, and World 11* (ed. James Tomberlin; Atascadero, CA: Blackwell, 1997), pp. 375–99.

The five levels of emergent human systems described in Chapter 3 provide a framework for differentiating between the three types of emergence. For the British emergentist, not only would a higher-level entity have properties not reducible to its lower-level constituents, such as a biological organism's dependence on nutrients, the levels themselves would consist of distinct substances. Although the physical level existed prior to the biological level, not only did biological entities with irreducible properties emerge, but a new substance emerged.

In a strong emergentist position, the five levels differ ontologically.[19] Psychological laws differ from biological laws which differ from physical laws. For example, an animal does something in the world, "sees a predator or prey," that cannot be predicted by the partial absorption and reflection of yellow light off two particularly configured molecules without incorporating the significant regularity that the first molecule is a protein on the skin of an animal; the second molecule is a protein on the retina of a different animal; and the pattern of protons striking the retina triggers a complex neurological chain of events resulting in the "seeing" of predator or prey.

In a weak emergentist position, the organization of knowledge comprises useful information in describing the world, but the organizing structures do not "cause" what happens in the world. The emergent structures may constrain what occurs in the lower levels, but even if causation appears to occur in the higher level, it still actually occurs in the lower levels. In the predator–prey example, one may require the categories of animal, skin, eye, light, retina, and neuron to explain the process, but the causal process actually occurs at the physical level.

Donald Campbell utilizes strong emergent language (in his 1970s work). In his illustrative example, the jaw of a soldier termite or ant requires the "laws of sociology" to explain the division of labor in the social organization of ants (or termites) where the soldier cannot feed itself and is fed by workers (whom the soldier protects). According to Campbell, the laws of the higher level determine in part the distribution of lower-level events and substances. The presence, prevalence, or distribution of lower-level terms often require reference to higher-level laws. Not only do higher-level laws conform to the lower-level laws and the lower-level laws restrain the higher-level ones (as both reductionists and emergentists would agree), but the lower levels conform to the higher-level laws, and the higher-level laws restrain the lower-level ones. In contrast, from a weak emergentist position, the categories of soldier, worker, enemy, and food are required to explain the behavior of the ant colony; and the soldier's and worker's behavior are constrained by their relationships; but the "laws of sociology" are not an active causal influence that determines ant (or termite) behavior.[20]

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19 Specifically, the laws, regularities, and causal processes are ontologically significant. The levels organize entities that share those laws, regularities, and causal processes. Strong emergentists might each propose different levels depending upon their theories of the laws, etc. However, they do not claim emergence of a new substance.

20 Donald T. Campbell, " 'Downward Causation' in Hierarchically Organised Biological Systems," in *Studies in the Philosophy of Biology: Reduction and Related Problems* (ed.

In emergentism, some of the properties and behaviors of the higher-level entities, though physically grounded, belong outside the physical level. British emergentists consider the higher levels non-physical; strong emergentists consider the higher levels as ontologically significant; and weak emergentists consider the higher levels as informative.

One can distinguish five positions on emerging levels:

1. Dualism—two (or more) substances exist, e.g., material and spiritual or physical and mental.
2. British emergence—although only one substance originally existed, a new substance emerged when life evolved.
3. Strong emergence—the cosmic evolution produces new, ontological distinct levels characterized by their own distinct laws or regularities and causal forces.
4. Weak emergence—although emergent categories may be required to explain causal processes and emergent structures may constrain lower-level structures, they should not be viewed as active causal influences.
5. Physical reductionism—everything reduces to the physical world as described by the laws of physics because the only substance is the material world.

Emergence describes the properties that appear from the interacting systems as the other properties endure. Strong and weak emergentists differentiate the ontological status of the distinct, emergent levels, with strong emergentists attributing laws or regularities and causal power to a level, and weak emergentists attributing constraining relationships and explanatory utility. Note that distinctions between weak and strong emergence relate to causation. In emergent systems theory as presented here, strong emergence describes the relationship between levels, which have their own types of causation, while weak emergence remains useful to describe the activity that occurs within a level. In terms of the traditional philosophical category of ontology—which no longer quite works—the levels differ ontologically because the "being" at each level differs, as "being" historically relates to change (and what does not change), and each level has distinct causal powers.

Emergence of Causation

How do the objects at one level cause activity at another level? If emergence is more fundamental than causation, and causation emerges, does this question make sense? Causation refers to a relationship between real objects and thus emerges. Philosophers studying emergence often use causation as a metaphor to relate abstractions and in that sense (and only in that sense) can one appropriately use causation and the misleading terms "upward causation" and "downward causation" to describe emergence.

Francisco Jose Ayala and Theodosius Grigorievich Dobzhansky; Berkeley: University of California Press, 1974), pp. 179–86 (181).

Relationships involved in the emergence of causation occur in at least three separate configurations. How constraining relationships interact in natural processes both within and between systems (in a strong emergentist position, this type of causation would differ with each level); the relationship between the parts and whole of a system; and the relationship between systems in different levels.

As described in Chapter 3, the category of causation appears inadequate to capture relationships across all the levels, thus an emerging systems approach requires a kind of strong emergence, and a different type of causation for each level. In a classical organization, one can consider certain subatomic-level constraining relationships in terms of Aristotle's material cause, physical-level relationships as efficient causes, biological-level relationships as formal causes, and psychological-level relationships as final causes.[21]

Causation as defined by Aristotle depends upon a human's ability to perceive, remember, and think about the world. Our descriptions of causation occur in a cultural-level system defined in part by the influence of historical Greek men. However, if the human mind evolved toward understanding the world, perhaps we can also use those categories to understand limited aspects of emergent relationships between the parts and whole of natural systems.

Before examining the relationships comprising emergence and how the appearance of causal relationships illuminates the organization of those relationships, a final word about strong emergence. One could interpret strong emergence as the emergence of something very significant—almost substantial—at a new level, and then claim that new stuff is real like the physical relationships are real. That interpretation seems counter to scientific findings and the intuition of many Western-trained scholars who note the gradual simplification of scientific theories toward the physical. As described in Chapter 1, that position which leans toward scientific materialism promotes conflict with religion and its awareness of the ineffable. However, with a more comprehensive interpretation of contemporary science, one does not attempt to increase the significance of non-physical levels, one recognizes the insubstantial nature of physical-level systems. Instead of claming higher-level systems exist like physical-level systems, one claims physical-level systems only exist like systems of the other levels.

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21 Cultural-level relationships appear to operate differently. One possible model of cultural-level causation occurs in the work of Donald Gelpi and Alejandro Garcia-Rivera who suggest an aesthetic model of change where the addition of an individual to a community acts similarly to how the addition of a new daub of color to a painting results in a completely new painting, rather than just the old painting with the daub. Donald L. Gelpi, *The Gracing of Human Experience: Rethinking the Relationship between Nature and Grace* (Collegeville, MN: Liturgical Press, 2001); Alex Garcia-Rivera, *The Community of the Beautiful: A Theological Aesthetics* (Collegeville, MN: Liturgical Press, 1999).

Orders of Emergence

Emergent relationships in nature give rise to constraints, forms and levels. One can characterize the general philosophical category of emergence according to those three kinds of relationships.

Emergence of Constraints

Contemporary scholars such as Alicia Juarrero and Claus Emmeche and his colleagues examine emergence of constraints in a system using phase space terminology from qualitative dynamics.[22] Recall from Chapter 2, a phase space maps all the possible states of a system into a space defined by a set of dimensions, each of which corresponds to a parameter of the system, and an attractor defines a set of points in the phase space in which trajectories with many different initial conditions end.

Complex systems, such as dissipative structures, autocatalytic webs, and the central nervous system are distributed patterns of dynamic relations. As these systems have relations and properties, not concrete substance, one would make a category mistake to expect them to exercise (efficient) causal power by impressing a force on their components. However, complex systems do indeed affect their components. Analyzing the causal relations of complex systems as the operations of constraint, allows hierarchical relationships, previously intractable, to be incorporated into a more comprehensive understanding of "cause."[23]

Jaegwon Kim holds that "if emergent properties have no downward causal powers, they can have no causal powers at all," that is, emergent properties are epiphenomenal. An "epiphenomenal" phenomenon does not accomplish anything and one could easily discard it. In contrast, Emmeche and his colleagues argue that their description of this type of emergence as a common attractor in phase space strongly suggests the existence of an emergent property (i.e., belonging to an attractor in phase space) that is more than epiphenomenal. To them, the ontology of abstract objects—

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22 Claus Emmeche, Simo Koppe, and Frederik Stjernfelt, "Levels, Emergence, and Three Versions of Downward Causation," in Peter Boegh Andersen, *et al.*, *Downward Causation*, pp. 13–34 (26–7). They describe a type of downward causation that organizes constituent systems they call "weak downward causation." Although they attempt to characterize downward causation as *either* medium or weak, I use their characterizations to describe two different types of emergence, *both* of which I claim exist. They also define "strong" downward causation which refers to the effects of a separate substance, such as in dualism or British emergence, which they dismiss. I avoid using their terminology of strong and weak downward causation in the text to avoid confusion with the separate distinction between weak and strong emergence, as weak and medium downward causation fit within weak emergence, and strong emergence (emergence of causation) and strong downward causation (dualism) are unrelated.

23 Alicia Juarrero, *Dynamics in Action: Intentional Behavior as a Complex System*. (Cambridge, MA: MIT Press, 1999), p. 133.

forms, shapes, mathematical and topological relations—indicate that entities "do not have to have causal powers in order to exist" non-epiphenomenally.[24]

In Emmeche and his colleagues' first type of emergence, the structure, organization, or form of the entity provides an ontologically significant function without constraining or "causing" lower-level activities. Cell biology provides many examples where the shapes of proteins interlock and form a cell wall or other boundary. These "structural" proteins provide an essential function to cell life, but do not have causal efficacy in isolation. For structural proteins, any constituent sequence of amino acids may be replaced by a structurally equivalent sequence.

Alicia Juarrero shows how non-linear, far-from-equilibrium systems are created from interacting components, which they then control. These systems actively exercise causal power over their components akin to Aristotle's formal and final causes. She offers an analysis of the hierarchical causality of systems as the workings of constraint to demonstrate "downward" causality, in particular, on how intentions can cause behavior and inform its trajectory in phase space.[25]

Shannon demonstrates theoretically the possibility of encoding messages to reduce transmission error as much as desired. If encoded correctly, a message can be made as error free as desired. Juarrero uses equivocation and noise from communications theory to capture the effectiveness of constraints imposed at the origin in ensuring information flow, that is, causality. Similarly, Stuart Kauffman claims that that order in complex systems arises in making particles and processes interdependent by correlating and coordinating them.[26]

Although physical mechanics grounds Juarrero's concept of constraint in the geometry of a constrained object's environment, she utilizes information theory to show how some constraints create new possibilities rather than reduce the number of alternatives, that is, constraints can simultaneously open up as well as close off options. Drawing upon Jeremy Campbell, she argues that constraining "the number of ways in which the various parts of a system can be arranged reduces randomness by altering the equiprobable distribution of signals, thereby enabling potential information to become actual information." Because constraints turn the amorphous potential into definite actual, constraints effect change in an Aristotelian sense. She further quotes Howard Pattee as arguing, "control constraints must also create freedom in some sense by increasing the potential variety of messages."[27]

Juarrero emphasizes that contextual constraints enlarge the variety of states the system as a whole can access by correlating and coordinating previously aggregated parts into a more complex, differentiated, systematic whole.[28] She writes:

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24 Kim, *Supervenience and Mind*; Kim, "Making Sense of Downward Causation"; Emmeche, Koppe and Stjernfelt, "Levels, Emergence, and Three Versions of Downward Causation," p. 31.

25 Juarrero, *Dynamics in Action*, pp. 132–3.

26 *Ibid.*, p. 136.

27 Jeremy Campbell, *Grammatical Man: Information, Entropy, Language, and Life* (New York: Simon & Schuster, 1982); Juarrero, *Dynamics in Action*, pp. 132–6; Howard H. Pattee, *Hierarchy Theory: The Challenge of Complex Systems* (The International Library of Systems Theory and Philosophy; New York: G. Braziller, 1973), p. 85.

28 Juarrero, *Dynamics in Action*, p. 138.

> The emergence of Benard Cells and B–Z chemical waves signals the abrupt appearance of context-sensitive constraints in mutualist-driven, open processes far from equilibrium. This discontinuous change occurs when previously unrelated molecules suddenly become correlated in a distributed whole. A complex dynamical system emerges when the behavior of each molecule suddenly depends both on what the neighboring molecules are doing and what went before. When components, in other words, suddenly become context-dependent.[29]

Organization limits the degrees of freedom of a system's components. For example, in an autocatalytic system, one molecule catalyzes the formation of another molecule, which in turn catalyzes a third molecule, and so on, until one of the catalyzed molecules "closes the loop" and catalyzes the creation of the first molecule. The organizational closure partially decouples the collection of interactions from the background out of which it emerged. Once autocatalytic closure takes place, the intermediate molecules become components in the system.[30]

For Claus Emmeche and his colleagues, attractors result in higher entities and provide an explanation of the emergent "formally causing" the self-organization of its constituents. The attractor may be highly complicated and presupposes "a specific historical process of generation", this in their example is "localized in a strongly delimited part of the biochemical phase space." Because an attractor has many, specific boundary conditions, rather small and delimited areas in the phase space constitute the basin of attraction of this attractor. For emergent properties and relationship to show up systems may have to pass through a very narrow bottleneck. However, an attractor is the center of a basin of attraction, and is thus locally generic, stable and insensitive to perturbations. The relative stability of the attractor explains the "governing" of the behavior of the entity, for example, when a biological attractor regulates physical perturbation. (Cybernetically, a type of controller emerges.)[31]

Self-organization enlarges a system's phase space by adding degrees of freedom. The physical constraints imposed by organization create potential information increasing potential message variety available to each new higher level. The renewed repertoire of behavioral alternatives and properties that becomes available to the emergent system as a whole allow a more complex organization to emerge, with novel properties that the isolated parts lacked.[32]

For example, although a mound of dirt has the freedom to exist in many configurations, most of those configurations do not provide stability with respect to gravity and wind. However, by restricting some of the otherwise free interactions between particles, more stable configurations can develop. If sufficiently robust, the stable configurations can combine into even higher organizations, for example, from mud to clay to fired pottery.

As systems develop dynamically, the current state partially depends on a prior one, and feedback incorporates the past into the system's present "external" structure.

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29 *Ibid.*, pp. 138–9.

30 *Ibid.*, pp. 120, 123–4, 144.

31 Emmeche, Koppe, and Stjernfelt, "Levels, Emergence, and Three Versions of Downward Causation," p. 28.

32 Juarrero, *Dynamics in Action*, pp. 142–3.

By making a system's current states and behavior systematically dependent on its history, feedback loops incorporate the effects of time into those very states and behavior patterns. Thus, feedback threads a system through both time and space, which allows part of the system's external structure to run through its history.[33]

Feedback processes embody the context-sensitive constraints of history. Juarrero writes:

> By embodying context-sensitive constraints, mutualist feedback renders a system sensitive to (constrained by) its own past experiences. This makes nonlinear dynamical systems historical, not just temporal the way near-equilibrium thermodynamical systems are. Once the system's subsequent behavior depends on both the spatial and temporal conditions under which it was created and the contingent experiences it has undergone, the system is historically and contextually embedded in a way that near-equilibrium systems of traditional thermodynamics are not. The very structure of a snowflake, for example, embodies the conditions under which it was created. Because dissipative structures are not just dropped into either time or space the way Newtonian atoms with only primary qualities are, their evolutionary trajectory is therefore not predictable in detail. Mutualism thus makes a dynamical system's current and future properties, states, and behaviors dependent on the context in which the system is currently embedded as well as on its prior experiences.[34]

Thus, complex systems do not forget their initial conditions: as Prigogine says, they "carry their history on their backs." In terms of phase space, their origin constrains their trajectory.[35]

Juarrero distinguishes between first-order and second-order contextual constraints. *First-order contextual constraints* operate at the same level of organization. For example, the ability of a catalyst to increase the likelihood that a reaction will occur, and the result of that reaction to increase the likelihood another reaction will happen, and so on. In a *second-order contextual constraint*, the network's organization *itself* emerges as a contextual constraint on its components. These top-down, second-order constraints function as boundary conditions in which the components are located. Examples of second-order constraints include virtual governors, the B–Z reaction and Benard (or convection) cells. From a systems perspective, Juarrero's first-order constraints occur between constituents of an emergent system while her second-order constraints refer to a characteristic of the system as a whole.[36]

The two orders of constraints differentiate between relationships attributable to the individual constituents, as within their realms of possibility, and relationships which one can only attribute to new relationships between constituents, within the realm of possibility of the emerging system. The two orders of constraints characterize a system from the perspective of the parts, but philosophically the system as a whole has a form.

33 *Ibid.*, pp. 139–40.
34 *Ibid.*, p. 140.
35 *Ibid.*
36 *Ibid.*, p. 141.

Emergence of Form

How do forms arise?

The emergent system qualitatively differs from the constituent ones. A coherent laser beam can cauterize flesh; but the separate waves of the individual laser atoms cannot. Because of this dynamic, Benard cells organize movement differently than independent water molecules, proteins act differently than amino acids, animal cells function differently than proteins, tissues do different things from independent cells, organs function differently than tissues, and organisms can behave differently from organs. For Bateson, each of these differences would make a difference and thus result in information.[37]

In self-organization, when external influences take the organism far from equilibrium and precipitate a bifurcation, the persistent interaction of components establishes interdependencies between the organism and its environment. The interaction of parts produces a greater organism–environment whole, which in turn affects (top-down) those parts. Once the systems self-organizes, "the global dynamics of the overall organism–environment system become the control knob of its components—top-down causality." If the top-down constraints begin to weaken, the system becomes unstable, the components fluctuate more widely, and the overall system's integrity is jeopardized.[38]

As a distributed whole, a self-organized structure imposes second-order constraints on its components, which restricts their degrees of freedom. Once top-down, second-order constraints become present, structural boundaries arise, energy and matter cannot flow arbitrarily, and the dynamic organization restricts importation into the system. In self-organizing dynamical systems, the organization itself determines the stimuli to which its components will respond. By making its components interdependent—constraining their behavioral variability—the system preserves and enhances its cohesion, integrity, organization, and identity. They implement the ongoing, structuring mechanism described (metaphorically) by Aristotle's formal and final causation.[39]

The neuropsychologist Roger W. Sperry gives an example of a wheel rolling downhill. None of the individual molecules constituting the wheel—nor gravity's pull on the molecules—suffices to explain the rolling movement. To explain the rolling movement, one must refer to the higher system at which the form (shape) of the wheel becomes conceivable. In other words, the wheel consists of both a collection of atoms and a particular configuration, called "round," both of which are necessary to explain "rolling." The same configuration of atoms as constituents could correspond to either the wheel falling over or the wheel rolling as the whole system.[40]

37 *Ibid.*, p. 143.

38 *Ibid.*, p. 142.

39 *Ibid.*, p. 143.

40 Roger W. Sperry, "A Modified Concept of Consciousness," *Psychological Review* 76 (1969): 532–6; cited in Emmeche, Koppe, and Stjernfelt, "Levels, Emergence, and Three

In the hierarchy of levels (Chapter 3), the systems of atoms comprising the wheel and the wheel itself both occur within the same (physical) level. An inter-level example between physical and biological levels occurs when a cell's function and processing depend upon the continual flow of oxygenated blood. At the lower (physical) level the same state of cellular processing could correspond to the different higher (biological) level phenomena of either a fluctuation of oxygen level during exertion or the death of the organism.

Claus Emmeche and his colleagues describe this type of emergence as "medium downward causation" when emergent entities constrain in a particular way conditions for the emergent activity of their constituents. An emergent entity comes into being through a realization of one of several possible hierarchically lower states with the previous states of the higher emergent entity as the factor of selection. They make this more precise with the use of boundary conditions as used in mathematics and physics. Boundary conditions are a type of constraint (Chapter 2).[41]

A boundary condition selects and delimits various types of the system's several possible developments. Mathematically, a boundary condition refers to "the set of selection criteria by which one can choose one among several solutions to a set of differential equations describing the dynamics of a system." In classical mechanics, a system's initial conditions describe the starting point of a system at a certain moment and form the basis for the calculation to predict the system's behavior. Thus the boundary conditions are the set of initial parameters within which certain changes in initial conditions make central properties in the dynamics change.[42]

For example, the boundary conditions for a supported beam state that the supported ends of the beam do not experience any deflections. The boundary conditions for water in a glass state that the glass does not move, and the boundary conditions for wind blowing across a lake state that the interface between the air and water result from their motion without gaps between them. For a biological example, some proteins have enzymatic activity and when combined into a metabolic pathway, constrain and influence other proteins and chemicals. The configurations of proteins in a sodium ion (Na^+) voltage-gated channel of a neuron provide a boundary condition for the flow of sodium ions. In terms of levels, the biological state of neuron activation (voltage gradient) provides a boundary condition for the physical movement of a single sodium ion.

Perhaps unsurprising in hindsight, the emergence of dynamic forms and systems depend upon the emergence of boundaries. In Tatarkiewicz' characterization of form in Chapter 2, the arrangement of constraints (form A) creates a contour for the system (form C) and presents the appearance of a whole (form B).

This completes the explanation of the relationship between form and systems begun in Chapter 2. The emergence of boundaries distinguishes a (partially encapsulated) system from a collection of relationships by contributing to the robustness of that constellation of relationships. One can describe those internal relationships as

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Versions of Downward Causation," p. 24.

41 Emmeche, Koppe, and Stjernfelt, "Levels, Emergence, and Three Versions of Downward Causation," pp. 24, 25.

42 *Ibid.*, p. 24.

constraints, and philosophically refer to the form of the whole which supports both continuity and change. Chapter 7 will examine the dynamic or evolving aspects of form from a pragmatic perspective, and the next subsection re-examines form and systems in relation to causation.

Organization in Dynamic Systems

Robert Ulanowicz provides a neo-Aristotelian framework for relating the structuring mechanism of form to emergence. He describes the emergence of order as “centripetality,” a term coined by Newton, where “the autocatalytic assemblage behaves as a focus upon which converge increasing amounts of energy and material that the system draws unto itself.” Unlike Newtonian forces, which always act in equal and opposite directions, self-organizing (autocatalytic) configurations impart an asymmetric direction to the behaviors of the systems in which they appear. For Ulanowicz, autocatalytic systems “ratchet all participants toward ever greater levels of performance.”[43]

Ulanowicz uses a triadic explanation of systems theory attributed to Stanley Salthe to differentiate final, formal, and efficient causation across three levels of emergence. Explanations of emergence emphasize the relationship between efficient causes of the lower level with the concepts of the middle, or “focal,” level. The interactions of the focal level, such as autocatalysis, take on the guise of formal cause. In addition, the constraints that the activity of the higher level places on system behavior appear teleological at the focal level perspective and explain final causation.[44]

One may reinterpret Aristotle’s causation as the influence of the constraining relationships between levels. Constraints at the lower level interact to provide a system in which higher-level properties may emerge, that is, Aristotle’s material causation. New properties develop within the flexibility allowed by the interacting system of constraints. For example, the constraints imposed by the structure and activity of the chemical components of the Krebs (or citric acid) cycle oxidize fuel molecules and result in energy transformed for use in many biological systems. The higher-level entity organizes the constraining relationships between constituents and, as formal causation, causally restricts the behavior possible at the lower level. For example, the organization of hemoglobin constrains its capacity to carry iron molecules and not other molecules. In formal causation for Aristotle, a static form influences the behavior of an entity. In an emerging entity, the interaction of constituents defines the stable structure of the entity, which defines its emerging form. Final causation captures the tendencies of the dynamic process to take on certain values. For example, certain proteins in the retina have the tendency to absorb and reflect a particular wavelength of light, and their genetics has the sequence it does based on the value to the organism of that protein reacting to color.

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43 Robert E. Ulanowicz, *Ecology, the Ascendent Perspective* (Complexity in Ecological Systems Series; New York: Columbia University Press, 1997), pp. 46–7.

44 *Ibid.*, pp. 50–52. Stanley N. Salthe, *Evolving Hierarchical Systems: Their Structure and Representation* (New York: Columbia University Press, 1985).

The metaphor of causation used to describe emergence appears to relate more closely to Aristotle's formal and final causes than efficient cause. Recall in Chapter 3 I suggested perhaps Aristotle's material cause best captured interactions at the subatomic level, efficient cause at the physical level, formal cause at the biological level, and final cause at the psychological level. That description of causation between real objects depends upon our perspective as psychological-level individuals participating in a cultural-level system informed by Greco-Roman and subsequent Western European philosophical systems. In a strong emergentist position, those types of causation emerge as a characteristic for each level. Earlier in this chapter, I also used causation as a metaphor to untangle hierarchical relationships between systems that some scholars refer to as upward and downward causation. Philosophically, causation refers to a fundamental aspect of nature that Alicia Juarrero and I describe as constraint. One can use Aristotle's organization of causality to organize systems of constraints. Rather than an absolute category of causation, I suggest a systems view of emergent causation that depends upon the relative position of the observer within the emergent systems.

Causation emerges from the interactions within a system, and four causes describe the perspective of the intrinsic system relationships:

1. Material cause captures the relationship between the parts of a system and its whole, from the perspective of the whole.
2. Formal cause captures the relationship between the parts of a system and its whole, from the perspective of the parts.
3. Efficient cause captures the interaction between the parts of a system, from the perspective of the whole, e.g., on an emergent phenomena from above.
4. Final cause captures the interaction between the parts of a system, from the perspective of a part, e.g., on an emergent phenomena from below.

Table 4.1 summarizes the four types of emergent constraints as perspectives on the part–whole or part–part relationships.

Table 4.1 Four types of emergent constraints

Type	**Relationship**	**Perspective**
Material	Part–Whole	Whole
Formal	Part–Whole	Part
Efficient	Part–Part	Whole
Final	Part–Part	Part

Those relationships hold both in the composition of systems within a level and in the composition of systems across level boundaries.

As a physical creature, one views atoms and the forces between subatomic particles as one's "material" constituents. Biological systems organize and constrain those constituents "formally." One can perceive "efficient" interactions within one's bodily system and between oneself and other physical-level objects in a broader system with which one can view as a whole. One can sense teleological or "final" patterns that affect one's physical body, such as gravity, atmospheric pressure, and other "attractors in phase space" with which one views oneself as a component. One knocks over a chair (efficient) and falls down the stairs (final).

As a biological organism (with a brain), proteins and other molecules "materially" constitute one's body. Those systems of molecules "form" one's body and one's body has a form (traditionally called the soul, though in Chapter 8, refined as the biological relationships of the soul). As biological systems, one's organs "efficiently" cause responses, such as hunger, as long as one understands efficient cause organically rather than mechanistically. From the perspective of one's limbs (and the interaction between neurons in the brain), they appear oriented toward an end determined by the overall pattern of brain activity.

As a psychological-level individual, one's thoughts appear "materially" constituted by one's sensations (activations in sensory regions of the brain). Those activities have a pattern or form, we call "thought," that structure the mental activity. One has thoughts that interact and may conflict and resolve (efficiently). One's thoughts may seem oriented toward an end (final cause) that seems beyond one's immediate realm of awareness.

As a participant in a cultural-level system, one "materially" constitutes that system. One's culture "forms" the individual (Chapters 5, 7). Individuals interact within a culture and (efficiently) cause changes within the culture from the individual's perspective. A culture provides the "final" ends (or norms: Chapter 5) for an individual.

As an embodied individual, we primarily view lower-level subatomic, physical, and biological systems from the perspective of the whole, emphasizing their material constitution (via reductionism) and their interaction (as "efficient" cause). As an enculturated individual, we primarily view higher-level cultural and transcendent systems as forming and providing ends to the individual. Natural scientists studying lower-level systems from those perspectives highlight those systems' form and purpose. Social scientists and scholars studying higher-level systems from those perspectives highlight their material constituency of human individuals and "efficient" interactions. However, all four perspectives on emergent constraints—material constitution, form, efficient interaction, and final norm—exist as intrinsic relationships in emergent systems.

Emergence of Levels

To recap, Emmeche and his colleagues differentiate between types of "downward causation" that either organize constituents as an attractor in phase or constrain its constituents through boundary conditions. Juarrero differentiates between "first-order" contextual constraints that operate between constituents of a system and "second-order" contextual constraints that characterize aspects of the system as a whole. Although differences exist between their assumptions and approaches, I argue that they both distinguish between the same two kinds of weak emergence: *first-order emergence*, which organizes constituents and one can model as an attractor in phase space, and *second-order emergence*, where a constraint emerges as a characteristic of the system as whole that they call boundary conditions. Because the boundary constraint depends upon the history of the system, one cannot reduce its whole–part influence to the initial conditions of the system or a set of independent constraints, and it functions in a top-down manner. One can distinguish between four types of constraints related to Aristotelian causation depending upon perspectives and interactions across the emergent part-whole dichotomy.

Both orders of emergence occur within a level, but what of the difference between levels?

The contemporary scholar and scientist Terrence Deacon suggests three orders of emergence describe the topological relationships occurring within and between levels, which he calls orthodynamic, morphodynamic, and teleodynamic. First-order emergence, or "orthodynamics," includes entropic systems where emergent properties result from the diffusion of energy and difference. Relational properties of parts directly constitute a first-order property of the whole. Orthodynamic emergence refers to dampening effects that occur at every level, such as thermodynamic effects in physical-level systems. Second-order emergence, or "morphodynamics," includes self-organizing systems where propagation and amplification of form and constraint result in asymmetric emergent constraints, such as occurs over time. The emergent entity depends upon its history and remains sensitive to its initial condition: its temporal development results in symmetry breaking in complex phenomena, such as chaotic or self-organizing systems. *Third-order emergence*, or "teleodynamics," includes selection dynamics in systems where replication of concordance and significance result in transmission of adaptive regulators. Third-order systems involve information or memory and regulate the production of multiple second-order phenomena with respect to a third-order phenomenon, which constitutes its teleology. Deacon would characterize every boundary between emergent levels as requiring teleodynamic selection operations.[45]

Deacon's first two orders roughly correspond to Emmeche and Juarrero's distinction. Juarrero's two orders correlate with Deacon's first two orders, though Deacon examines the topology of the whole while Juarrero examines the resulting interactions between components in terms of constraints, and Emmeche and his colleagues examine the distinction in terms of downward causation. Rather than explore the differences, I summarize the similarities in terms of systems. First-order emergence organizes constituents by dampening differences, and the synchronized constituents enable functions not feasible or possible when isolated. The first-order emergent property supervenes on the interactions between constituents. Second-

45 Terrence W. Deacon, "The Hierarchic Logic of Emergence: Untangling the Interdependence of Evolution and Self-Organization," in *Evolution and Learning: The Baldwin Effect Reconsidered* (ed. Bruce H. Weber and David J. Depew; Cambridge, Mass.: MIT Press, 2003); Ursula Goodenough and Terrence W. Deacon, "From Biology to Consciousness to Morality," *Zygon* 38 (2003): 801–819; Terrence W. Deacon, "Emergence: The Hole at the Wheel's Hub," in *The Re-Emergence of Emergence: The Emergentist Hypothesis from Science to Religion* (ed. Philip Clayton and Paul Davies; Oxford; New York: Oxford University Press, 2006), pp. 111–50. In earlier work, Deacon called "orthodynamics" by the name "thermodynamics," but later changed the name to emphasize that first-order emergence occurs not only at the physical level.

order emergence results from the emergence of a constraint on the system as a whole that typically depends upon the breaking of some symmetry, such as occurs in the progression of interactions over time, that creates an (emergent boundary) condition on subsequent activity for the system. Third-order emergence captures the distinction between levels.

Now, we can characterize the six example types of emergence from the beginning of the chapter (p. 100) into four groups.

The first group consists of phenomena in which the (a) combination of different components result in a property that neither component has individually, such as covalent bonding. Although I argue that covalent bonding occurs as an emergent interaction between atoms at the subatomic level, which share the wave-like distribution function for an electron, that simple resultant phenomena differs from what most scholars mean by emergence. As a physical-level system, most scholars correctly describe covalent bonding as a non-emergent interaction. However, as a subatomic-level system, covalent bonding describes the most complex of the six types of emergence. To retain consistent terminology, I call this type of emergence *resultant*, as it results from the interaction between lower-level, third-order emergent systems, although from the (necessary) perspective of the higher level.

First-order emergence characterizes phenomena in which (b) a collection of similar constituents demonstrates an unpredictable property in large quantities, such as magnetic properties of iron; or (c) a collection of somewhat similar constituents reduce their differences and a novel property appears, such as the elimination of electron orbit differences in water molecules leads to surface tension.

Second-order emergence characterizes phenomena in which the (d) combination of a collection of components results in a novel property that facilitates or constrains the continuation of their relationship, such as autocatalysis, snowflakes, or cell membranes; or (e) the relationship between components becomes sufficiently stable to create a constitutive absence in the system that enables novel interactions with other systems, such as hemoglobin or a partially permeable cell membrane.

Third-order emergence captures the distinction between levels and characterizes phenomena in which (f) the components form a novel construct that constrains influences, or controls the system and provides sufficient abstraction that the system may retain, manipulate, and vary the abstraction separate from its interpretation and implementation in the system, such as DNA, circuits of synapses in the brain, or symbolic language.

In first-order emergence, properties emerge from interactions between qualities of systems such as shape or energy. First-order emergent relationships capture latent properties that depend upon environmental conditions provided by its constituents. The environmental conditions include initial conditions, (non-emergent) boundary conditions, or self-propagating conditions. The interaction of water molecules generates surface tension or crystallization, or the interaction of iron atoms creates ferromagnetic properties. In orthodynamic entropic systems the diffusion of energy and difference result in first-order emergent properties. First-order emergence provides a novel quality to the system.

In second-order emergence, morphodynamics, a separation occurs between interactions, such as symmetry breaking down or progression over time. What happens next depends upon what happened before. The formation of a snowflake depends upon the amplification of initial and boundary conditions over time as the snowflake falls. Second-order emergent systems, such as self-organizing or chaotic systems, depend upon their history and the propagation of constraints. In second-order emergence, an internal constraint emerges in the system that prevents otherwise natural behaviors of the system's constituents. That constraint becomes a defining feature of the system and distinguishes components which constitute the emergent system from those that do not, that is, those restricted by the constraint from those that are not.

In first-order emergence, properties emerge from interactions, but do not yet constrain additional relationships, while in second-order emergence, those properties have constraints that propagate through the system they form. Stable second-order emergent systems often include closed cycles of interactions that provide a basis for response to environmental change.

When lipids form a bi-layered sheet, the conditions of the lipids' chemical properties in the presence of water create a new quality of having two sides—first-order emergence. When that quality is constrained across all the lipids so they orient appropriately and form a closed three-dimensional shape, say a sphere, they close the possible spatial locations around an empty interior and provide a mechanism for creating a distinguishing relationship of exterior or interior with other systems—second-order emergence.

In third-order emergence, Deacon's teleodynamics, the interactions gain a memory. Not only is the system influenced by initial conditions and responsive to changes over time, but it also retains information or a memory that regulates or controls behavior and that memory can change and give rise to different tendencies of the system. In biology, genetic instructions regulate the biochemical processes occurring in a cell. Mutation and selection pressure may modify those genes and shift the tendency or purpose of that system.[46]

A third-order emergent system selects among possible second-order emergent systems by selecting among the defining constraints of the second-order systems. Novel qualities emerge in first-order systems that second-order systems constrain to define a distinguishing form, and third-order systems select among those forms. When raindrops roll down a mountain, the first-order surface tension is selected by gravity, but no internal constraint emerges between the water molecules and thus no second-order relationship forms, and the phenomena remains first-order. An internal constraint between water molecules does emerge in snowflakes, which makes snowflakes second-order. Evolution among single-celled organisms, as a third-order phenomenon, selects among the various second-order properties, including augmented bi-layer lipid cell walls.

In first-order emergence, an irreducible property gains existence as a constraint, perhaps modeled as an attractor in phase space. In second-order emergence, the constraint propagates by amplifying an aspect of the system in an asymmetrical (often temporal) way. In second-order emergence, the collection of constraints becomes a *system* because one can no longer reduce its form to constituent constraints.

46 Deacon, "The Hierarchic Logic of Emergence."

A third-order emergent system selects among the constraints defining the second-order system and thus shifts its dynamic form.[47] In terms of constraining relationships, one distinguishes between relationships that independently constrain other relationships and dampen them, relationships that constrain interrelated systems of relationships, and relationships that require a third interpretative relationship to constrain (via selection) other systems. In terms of temporal process, first-order emergence captures present relational properties, second-order emergence also captures past history, and third-order emergence influences future behavior.

Distinctions between the three orders of emergence parallel Peirce's three relations to objects in signs from semiotics. Recall an icon resembles its object, an index has a direct relationship with its object and a symbol requires some context for interpretation. Third-order emergence requires a memory or type of abstraction against which selection can occur, and thus parallels a symbol's dependence upon an abstraction. Second-order emergence, or morphodynamics, depends upon the propagation of form and constraint and, like an index differs from an icon, cannot "resemble" a non-propagated form. Although easy to create superficial parallels between systems with only three categories, a deeper relationship occurs. Recall semiotics generalizes human language to examine meaning formation through any sense. Whereas human language occurs in cultural-level systems, semiotics examines how humans can gain any information at any level of a system. The domain of semiotics includes all that nature communicates to humans.

Figure 4.1 illustrates the relationship between the three orders of emergence and four of the levels presented in Chapter 3. First- and second-order emergence occur within a level and third-order emergence results in the emergence of a new level.

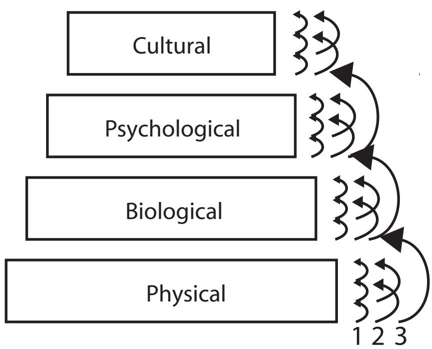

Figure 4.1 Three orders and four levels of human systems

The description of how the emergent relationships, as organized into three orders, give rise to the constraints, systems, and levels ends the description of emergent systems theory. Each level organizes the coherent theories about human systems that cannot be logically reconciled because the selection of second-order systems

47 In part, it is likely the selection of forms (by third-order systems of second-order systems) that necessitates "dynamic" forms rather than "substantial" forms in human systems.

depends upon constraints that occur in the higher-level system. As those higher-level constraints influence or control the lower-level systems, information forms that regulates the lower-level systems, but cannot be represented (indexically) by the lower-level systems, that is, the upper-level systems provide the convention by which the lower-level systems are interpreted.

In the transition from the subatomic to the physical level, the emergence of atoms denotes a stable system of subatomic constituents. An atom has an interior (toward nucleus) and exterior (not predominantly occupied by the electron cloud) distinguished by the boundary of the outermost electrons. The boundary partially encapsulates the atom and under most circumstances directly perceived by humans the atom acts as a whole. The atom has information and memory that even in a simple model of ions includes discrete positive and negative values (e.g., –2, –1, 0, +1, +2) that correspond to its residual electrical charge. Larger physical-level systems select among those ionic memory states as the bonds of molecules flow in charge gradients, electric conductivity, and so on.

The emergence of the macromolecule DNA from physical-level constituents results in a stable system that contains and stores information encoded by the long strands of (four types of) nucleotide bases. Most of the systems interacting with DNA support its stability and accurate storage and transmission of information, with some key exceptions significant for evolution. The accurate propagation of information from gamete to adult organism enables the formation of complex biological systems.[48]

The emergence of neural networks from biological-level constituents in the brain enables a variety of activation patterns that represent information embodied in the structural connections and functional pathways among neurons. The senses, nervous system, and muscles of the body situate the neural network within specific external contexts. The stability and plasticity of the network result in responsive psychological systems.

The emergence of shared interpretation from psychological-level individual constituents results in stable cultures that store, propagate, and develop information through language in oral and then written forms. Symbolic language facilitates the precise sharing of information within communities, though art, rituals, and other signs also refine and develop the shared memory of the cultural-level system.

Within a level, weak emergence describes the emergence of constraints among constituents and among the newly formed systems, as first- and second-order emergence, respectively. In strong, or third-order, emergence, each level has its own causal power and coherent theories. The next chapter explores the effect of third-order emergence in cultural systems that results in a sixth, transcendent, level. Chapter 6 examines the relationship between biological systems in the brain, and the selection of those systems by the psychological-level processes of thought—in particular learning and decision-making. Chapter 7 deepens the philosophical foundation for describing emergent systems in nature, and Chapter 8 addresses the question raised

48 And the mutability of information enables the formation of complex ecological systems.

at the beginning of the book of unity among the independently coherent levels of human systems.

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CHAPTER 5

Spiritual Relationships

> Triad supernal, both super-God and super-good, Guardian of the Theosophy of Christian men, direct us aright to the super-unknown and super-brilliant and highest summit of the mystic Oracles, where the simple and absolute and changeless mysteries of theology lie hidden within the super-luminous gloom of the silence, revealing hidden things, which in its deepest darkness shines above the most super-brilliant, and in the altogether impalpable and invisible, fills to overflowing the eyeless minds with glories of surpassing beauty.
>
> This then be my prayer; but thou, O dear Timothy, by thy persistent commerce with the mystic visions, leave behind both sensible perceptions and intellectual efforts, and all objects of sense and intelligence, and all things not being and being, and be raised aloft unknowingly to the union, as far as attainable, with Him Who is above every essence and knowledge. For by the resistless and absolute ecstasy in all purity, from thyself and all, thou wilt be carried on high, to the superessential ray of the Divine darkness, when thou hast cast away all, and become free from all.
>
> —Pseudo-Dionysius, *Mystical Theology*, I.1

As discussed in Chapter 3, one can study most human activity as occurring on subatomic, physical, biological, psychological, and cultural levels where the boundaries occur in atomic, biochemical, neurological, and linguistic systems, respectively. Each emergent level illuminates a coherent perspective on human systems, but those levels of systems of constraints remain logically distinct and cannot directly be unified. The selection of abstractions resulting in third-order emergence and the incompatible types of causality and function for each level preclude a single unified view of the human person.

This chapter performs two closely related, distinct, and apparently non-separable functions. First, it describes a sixth level of emergence to capture relationships of human systems that do not cohere with the five levels previously discussed: The contemporary philosopher of science and religion Philip Clayton in his *Mind and Emergence* suggests an emergent level of spiritual or transcendent activity, which emerges from mental (and cultural) activity, that in this systems model would capture activity at a sixth, *transcendent*, level. Second, the chapter describes a way to relate the six levels as a community of perspectives that unify only in their shared interpretation: The twentieth-century American pragmatist Josiah Royce characterizes the formation of community and describes their shared interpretations. Although all academic fields exist only as cultural-level systems, the domains studied by the disciplines of cognitive science and religion cross the six levels (albeit unevenly), and thus one can view those disciplines as also forming a community who share interpretations of human cognition. The non-separable aspect of the two functions occurs because the sixth level of transcendence or spiritual relationships also emerges from communities of interpretation.

A unified view of the human person depends upon a community of interpretation, and without all six perspectives, the five individually coherent levels remain incomplete and not unifiable. As the sixth level categorizes constructs typically considered religious, a unified meaning of the human person depends upon theories from natural science, social science, and religious scholarship, in general, and to understand the human person as an individual at the psychological level, meaning depends upon the disciplines of cognitive science and religion, in particular. Those theories of the person do not connect in any single discipline (with its overall assumptions and specific methods), but a community of scientists and scholars may develop a shared interpretation (that no one person can individually hold).

Emergent systems characterize both mind and nature—the human systems of the natural world and the person's attempt to understand them. To characterize the human mind requires recognizing the role of evolutionary, developmental, and integrative biological processes on the human brain and the social and cultural influences on a person's self, identity, perception, and thought. In Chapter 1, I carefully distinguished between the projection of human mind onto nature and the 'mind-like' quality of nature as intelligible. However, that concept of mind as conceived by Searle, Peirce, Bateson, and most cognitive scientists has an individualistic character to which logical coherence is sometimes ascribed. However, if one cannot understand the human person without a community, then the individual mind is necessary but not sufficient to understand at least one aspect of nature. Perhaps nature not only has physical quality, a 'life-like' quality, and a 'mind-like' quality, but it also has a 'community-like' quality, and perhaps a 'transcendent-like' or 'spirit-like' quality. Again, one should not project human systems onto nature but recognize the selection influences that occur on human systems by third-order emergence in nature.

The first three sections of this chapter address the following three questions, and the final section unifies the perspectives:

1. Scientifically—how does emergent-systems theory suggest the emergence of transcendent-level systems occurs?
2. Philosophically—what forms occur at the cultural level from which transcendent-level systems select?
3. Religiously—do transcendent-level systems correlate with prior spiritual traditions?

Transcendent-Level Phenomena

For Philip Clayton, the spirit, deity, or "transcendent mind" not only emerges from the natural world, but also develops agency or autonomy—similar to how cells or organisms develop autonomy from physical-level constituents. Clayton postulates that although transcendent mind encompasses or includes the universe in its being, it also transcends it. Clayton holds a *panentheist* view where God exists in the world—or universe broadly construed—and beyond. Unlike "pantheism," where God is no more than the universe, in panentheism, God is more than the universe but also includes and interpermeates the universe. Clayton claims the emergent deity is not less than personal (such as karma or religious naturalism) but conceives of it as supra-personal as it characterizes a higher form of emergent (strong) causality. [1]

I suggest the higher sixth level could contain the ineffable aspects of ethics, religion, and spirituality that communities of humans refer to with language, but which language cannot adequately describe. These aspects emerge from interactions between societies of people as properties of relationships between cultures. This level begins with ethical principles such as justice, includes constructs noticed in inter-religious dialogue, and provides placeholders for systems to which people ascribe ultimate value. Although culture can describe the relationships of people within groups, it lacks the systemic power to ascribe value or purpose to relationships between those groups, and thus a sixth level becomes necessary even to model fully cultural interactions.

Religious-studies researchers, such as Steven Katz, indicate that although some psychologists and neuroscientists who study religious experience assume the various states of mystical religious experience to be culture-independent, religious experience appears to require epistemological activity, which in turn depends upon culture.[2] Some mistakenly ascribe universality to phenomena that emerges from culture yet transcends it. In addition to capturing cross-cultural and other emergent phenomena, the level also may include what Samuel Alexander calls the emergence of deity, and provides a scientific placeholder for Ian Barbour's limit or boundary questions which facilitate dialogue between the discipline that raises the question and the discipline that explores it.[3]

Systems theory illuminates modeling ethical, religious, and spiritual relationships from the individual and collective perspective. The individual, at the psychological level, can draw upon cultural systems to describe psychological systems or provide reductionist accounts of lower-level biological and physical systems, but the individual does not have direct access to the phenomena emerging from cross-cultural interactions between societies, thus individual perspectives on transcendent systems become necessarily ineffective. Without a systems understanding, some philosophers and other scholars have traditionally viewed cross-cultural emergent phenomena (and often even cultural phenomena) as absolutes or universals. Systems theory provides tools to model ethical norms, religious ideals, and spiritual relationships, while avoiding the modernistic fallacies of relativism and absolutism. From a systems perspective, one must denote the transcendent systems to which various religious and mystical experiences relate, even if one cannot specify any

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1 Philip Clayton, *Mind and Emergence: From Quantum to Consciousness* (Oxford and New York: Oxford University Press, 2004), pp. 182–3; Philip Clayton, "The Emergence of Spirit: From Complexity to Anthropology to Theology," *Theology and Science* 4(3) (2006): 291–307.

2 Steven T. Katz, *Mysticism and Philosophical Analysis* (New York: Oxford University Press, 1978); discussed in Kelly Bulkeley, *The Wondering Brain: Thinking About Religion with and Beyond Cognitive Neuroscience* (New York: Routledge, 2004), pp. 162–3.

3 Clayton, *Mind and Emergence*, ch. 5; Samuel Alexander, *Space, Time, and Deity: The Gifford Lectures at Glasgow, 1916–1918* (London: Macmillan, 1920); Ian G. Barbour, *Religion and Science: Historical and Contemporary Issues* (San Francisco: HarperSanFrancisco, rev. edn, 1997).

intrinsic properties of those systems. Some religious systems and relationships between cultures have emergent properties that transcend cultural systems, and this chapter describes how some of those emergent systems form a higher, transcendent level.

Cross-Cultural Interactions

Cross-cultural interactions form systems with their own emergent properties. National cultures differ in many value orientations. Some of those properties mirror characteristics of individuals; one could apply psychological-level instruments to a society and stereotypically say that West African societies appear more extroverted than Japanese ones or that in the early twenty-first-century American society appears narcissistic to other cultures. Cross-cultural scholars have identified other value systems, including "individualism" versus "collectivism" and "power distance." Individualism refers to the general tendency of a person in the culture to value individual identity over group identity and individual rights over (in-)group obligations, and collectivism refers to the opposite tendency. Power distance refers to the degree that the *less* powerful members of society expect there to be differences in power among individuals. Although the criteria depend upon properties within a culture, the relationships between them occur cross-culturally, and interactions between an individual in an individualistic society (such as an American) and a person in a collective society (such as a Chinese or Latin American) "transcend" both cultures.[4]

However, a subset of emergent properties becomes sufficiently "universal" that a different sort of emergence results in an additional level of emergent systems. As no clear, consensual agreement on the distinction between the four scientific levels yet exists, the existence of a separate transcendent level remains indefinite, but I argue that similar emergent mechanisms resulting in the emergence of life, thought, and culture also result in the emergence of transcendence.

Consider a non-spiritual cross-cultural transformation. Science and religion each comprise different cultures and communities. When an American neuroscientist and a Tibetan Buddhist enter serious dialogue, they participate in cross-cultural interaction. Because of the newness of findings in neuroscience and the historical isolation of Tibetan Buddhism from Western culture, they can soon discover several facts and insights that no human previously knew and thus fits into neither culture.[5] Because the interaction transcends the cultures, it occurs as part of a transcendent system. The interaction—like other first-order emergent interactions—dampens differences between cultures and similarities may become apparent, which then highlight other differences.

4 Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (London and New York: McGraw-Hill, 1991); Stella Ting-Toomey and John G. Oetzel, *Managing Intercultural Conflict Effectively* (Communicating Effectively in Multicultural Contexts, 6; Thousand Oaks, CA: Sage Publications, 2001).

5 Anne Harrington and Arthur Zajonc, *The Dalai Lama at MIT* (Cambridge, MA: Harvard University Press, 2006).

When does that result in second- or third-order emergence? When do they result in a transcendent-level system rather than another cultural-level one? What transforms a cultural-level system into a transcendent-level one? Currently, such conversations occur as part of a recently formed community whose founding event was the first few conversations between neuroscientists and Tibetan Buddhists. At first those conversations transcended culture, but then cultural systems grew to incorporate those interactions. Similar accommodations occur in spiritual systems; Martin Luther nailing 95 theses on his Wittenberg church's door initiated the community and culture of Lutherans; the mystical experience of Teresa of Avila and St. John of the Cross in the sixteenth century formed the community (and culture) of the Roman Catholic monastic order of Discalced (i.e., "barefoot") Carmelites.

One can only participate at the cultural level in the Buddhist–neuroscience dialogue, however that interaction may transform the previously separate cultures. Neuroscientists continue to open bridges between natural science and religion that typically remained closed between the seventeenth-century European early Enlightenment and the exploration of Eastern thought by German physicists in the mid-twentieth century. Tibetan Buddhists, many no longer living in Tibet because of the Chinese presence there, examine Western culture as practitioners from "younger" strands within Buddhism. If Tibetan Buddhists and American neuroscientists continue dialogue without inducing change in their respective communities, then a new cultural system forms of Buddhist–neuroscience dialogue—the result of second-order emergence.[6] If the dialogue influences the distinct cultures, giving rise to new cultural systems, while the original systems retain their identity, then something (by definition) emerges. In that cross-cultural relationship (a new cultural system) lies the possibility of becoming selected in a third-order emergent process, which transforms the cultural-level system into a constituent of a transcendent-level one by creating a difference at the transcendent level, which has no meaning at the cultural level. The individuals may not know whether they participate in a transcendent-level process (and can only know through culture).

By analogy, from the perspective of a calcium ion in a neuron in the brain, its identity remains at the physical level. When the calcium ion flows through a channel in the neuron's cell wall, it might "sense" participation in a biological-level process, but it has no access to the psychological-level process of thought that involves many ions distributed over many neurons. However, even when the calcium ion remains waiting for significant activity, it participates in the voltage gradient necessary for the biological process of action potentials; it remains part of the "real possibility" of thought.

A physical-level system of a calcium ion becomes transformed into a constituent of a biological-level system that depends upon information carried by its ionic state (and other chemical characteristics). One might consider transformation as a change of essence—such as in personal or spiritual transformation—though in emergent systems depending upon relationships and with no "essences," *transformation*

6 B. Alan Wallace, *Contemplative Science: Where Buddhism and Neuroscience Converge* (The Columbia Series in Science and Religion; New York: Columbia University Press, 2007).

consists of participation in a higher-level system. People decide whether to participate in a cultural-level religious system, but transcendent-level systems select whether the possible information in those cultural-level systems actually informs transcendent-level processes.

Is an emergent level required? Although many interactions between cultural systems may result in emergent cultural properties, such as war, which also depends upon at least two autonomous societies, other emergent properties transcend human culture as "universals" that categorize all human cultural systems and can form components of emergent cross-cultural systems. Treating phenomena as "universal" (that may exist as a separate realm of existence) indicates the possibility of a distinct level.

Humans often label as "universal" systems that may occur at the transcendental level. A more nuanced account than universalizing cultural systems occurs in the work of the contemporary Christian theologian David Tracy, who defines "classics" as texts, events, images, persons, rituals, or symbols that reveal permanent possibilities of meaning or truth. Classics within any religious tradition so disclose a compelling aspect of truth about human lives that one cannot deny them a kind of normative status.[7] The classic refers to a norm that crosses cultures (or historical periods within a tradition) and thus indicates possibilities for cross-cultural constructions that may result in transcendent-level systems.

Although cross-cultural interactions and conformational change emerge from relating cultural systems, the stability and self-maintenance of a transcendent system requires self-sustaining interactions between the emergent qualities or components. Mutual dependence between cultures supports sustainable interactions, and a transcendent system begins to emerge when that system and its components begin to interact with additional systems. A clear example of a transcendent relationship occurs in Royce's "loyalty to loyalty" described later in the chapter, but a simple example occurs in dialogue between Christians and Buddhists (or Muslims) when each practitioner recognizes in the other's key "classic" founder an insight for understanding the practitioner's own religion. In sustained dialogue respectful of plurality, one finds a new, cross-cultural (cross-religion) relationship that strengthens the coherence, integrity, and autonomy of each system.

Although it could be a historical accident, the cross-Western-cultural norms referred to in ethical, aesthetic, and philosophical activities as relating to the Greek Good, Beauty, and Truth, respectively, may indicate transcendent-level systems. At every level, systems interact with each other in a complex network of relationships that vary over time. The topology of relationship networks may have their own emergent properties, such as open, closed, self-organizing, cyclic, chaotic, or stable. Some of those graphs of relationship networks may have a form that humans view as beautiful. Many aspects of beauty depend upon human biology—human visual range, the structure of the brain's parietal lobe which organizes spatial relationships, auditory range, and perception, and so on. An experience of beauty that depends only upon biology would necessarily be a cross-cultural experience, and the relative

7 David Tracy, *The Analogical Imagination: Christian Theology and the Culture of Pluralism* (New York: Crossroad, 1981), p. 8.

relationships between experiences of beauty would form a norm. Although one may presume beauty to be in the eye of the beholder; for a human, beauty has cross-cultural norms that depend upon human biology and may be less relative than presumed.

Western thought attends to truth as an absolute, especially since the Enlightenment, but scholarly studies of "postmodern" thought indicate a relativism to the Greek ideal of Truth that depends upon culture and language. Many contemporary philosophers examine psychological and cultural level phenomena of mind and philosophy as grounded in neurobiological systems.[8] Truth itself may depend upon genetically influenced characteristics of mind in the organization of the human brain, especially cortical regions. The presumed relativism of beauty and presumed absolutism of truth in "modern" science make difficult explaining (or conceiving of) clear transcendent-level systems of beauty or truth, so I will focus the remainder of the section on cross-cultural interactions leading to the emergence of the good.[9]

Emergence of Ethical Norms

Transcendent-level systems emerge from cross-cultural interactions. The US military has studied what makes an effective unit and discovered that camaraderie and the ability to work as a team greatly impacts upon unit effectiveness. Other studies have examined suicide bombers who either surrendered or hesitated and were captured.[10] Speculation suggests that terrorist cells become effective through similar mechanisms to other military units with a shared, often ideological, vision. A frequent thread among captured suicide bombers who decided not to act is their reports of seeing a mother and young child. Although each society has strong, intracultural relationships to form autonomous systems, and the interaction between the cultural systems includes high conflict behaviors such as military and terrorist actions, something occurs when a terrorist sees a mother and young child in the opposing cultural system whom the terrorist is about to kill. Something surprising, unpredictable, and highly efficacious, that is, emergent, occurs that transcends the suicide-bombing attempt. Perhaps the terrorist training demonized the opposition to an extent that an enemy mother's love was excluded from the terrorist worldview. Although suicide bombing and military actions can occur between two cultural systems, something emergent happens when some suicide bombers see a mother and young child that breaks down the prior coherence, integrity, and self-maintenance of the system.[11]

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8 George Lakoff and Mark Johnson, *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought* (New York: Basic Books, 1999); Patricia Smith Churchland, *Neurophilosophy: Toward a Unified Science of the Mind–Brain* (Computational Models of Cognition and Perception; Cambridge, MA: MIT Press, 1986).

9 For a more nuanced pragmatic treatment of beauty, see Alex Garcia-Rivera, *The Community of the Beautiful: A Theological Aesthetics* (Collegeville, MN: Liturgical Press, 1999).

10 Christian Caryl, "Why They Do It," *The New York Review of Books* 15(14) (22 September 2005).

11 An earlier version of this section appears as Mark Graves, "The Emergence of Ethical Norms in Human Systems," in *50th Annual Meeting of the International Society for the*

Similar phenomena occur in non-violent resistance. Something occurred in the British soldiers when Gandhi's followers allowed themselves to be beaten under British law. In the American Civil Rights movement, an emergent property appeared when US citizens saw blacks beaten by agents of federal, state, or local governments. Two coherent, autonomous, self-maintaining cultural systems interact at a place of possible and partially expressed violence, yet both systems become surprisingly transformed in a way that one cannot model in either cultural system.

To work by analogy from physical systems, atoms can interact with each other to create emergent properties of temperature or surface tension by bouncing off each other or synchronizing orbiting electrons. (From Chapter 4, the elimination of difference indicates first-order emergence.) Human individuals can interact with each other through conflict to create a violent or litigious society or through empathy to create a harmonious one. Likewise human societies can interact with each other in a closed system, such as a planet, to create a violent, warlike planetary cultural system or a harmonious one.

In ethical systems, John Rawls takes a Kantian approach to ethics in developing a social contract based on a bargaining game. In Rawls's theory, the individuals do not know their position in the proposed system, and that veil of ignorance ensures fairness in determining the system. Fair decisions made in positions of ignorance across the collection of individuals in the society, dampen individual differences and give rise to an emergent phenomenon much as the dampening of electron orbit differences of water molecules gives rise to an emergent phenomenon of surface tension.[12] Although the decisions by the individuals occur in the cultural-level system, the norm of justice can transcend the society if it impacts upon how those in the society interact with those outside the society.

Consider when a person from an individualistic society meets a person from a collectivist society and tries to reach an agreement or build a relationship. When they interact neither person would understand the underlying decision-making process in the other culture and conflict would likely occur. Perhaps the individualistic person may appear to dominate the interaction by interpreting an agreement as meeting their individual needs, and the collectivist person would interpret it collectively and that society would eventually ignore and "ostracize" the individualistic person.[13] Because each individual acts within the presumed value of their culture, they each appear to act justly, that is, under the emergent constraint of justice.

Something slightly different occurs with second-order emergence when the combination of components results in a novel property that facilitates or constrains the continuation of the relationship. A second-order emergent interaction occurs

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Systems Sciences (ed. Gary Metcalf; Rohnert Park, CA: International Society for the Systems Sciences 2006); available at http://journals.isss.org/index.php/proceedings50th/article/view/226 (accessed 2 December 2007).

12 John Rawls, *A Theory of Justice* (Cambridge, MA: Belknap Press of Harvard University Press, rev. edn, 1999).

13 Alfons Trompenaars and Charles Hampden-Turner, *Riding the Waves of Culture: Understanding Cultural Diversity in Global Business* (New York: McGraw Hill, 2nd edn, 1998).

between societies where the members of each society generally ascribe to a single virtue for that society.

Virtues arose from ancient Western society as the excellence of athletic, soldierly, and mental strength used by heroes in their actions. For Homer, a virtue is a quality that enables an individual to discharge his or her social role. Virtues were refined as ethical frameworks in Greek Athenian society, and Plato and others viewed virtues and goodness as indissolubly linked with happiness, success, and fulfillment of desire. Plato also viewed virtues as politically as well as socially relevant, and he understood that the virtues themselves were interdependent—the presence of one virtue requires the presence of all virtues. Thus, anciently, the virtues are interrelated characteristics of a person that effect choices between actions. Aristotle refined the virtues into a comprehensive system in the *Nicomachean Ethics*, and is credited as the classic figure in virtue ethics. Aristotle sees that virtue is a state of character concerned with a choice lying in a mean relative to us. The mean is determined by a rational principle as determined by a person of practical wisdom. The two extremes from which one determines the mean are one that depends upon excess of the state of character, and one that depends upon its defect. For example, courage is the mean between foolhardiness and cowardice. Thus, moral virtue is a mean between vices.[14] Aquinas further organized Aristotle's ethics and synthesized it with Christian teaching. For Aquinas, a virtue is a quality which enables an individual to move towards the achievement of the specifically human *telos*, whether natural or supernatural. Benjamin Franklin applied virtue ethics to utilitarian thought, and for him, a virtue is a quality which has utility in achieving earthly and heavenly success. More recently, Alasdair MacIntyre has re-examined virtue ethics in a contemporary philosophical context. As a working definition for this book, I consider *virtue* to be a moral excellence that a person may utilize to make choices in a desire to be (morally) good.[15]

Although virtues occur in people, one can ask what happens cross-culturally when a society of individuals who utilize prudence meets a society of individuals who utilize courage and expect a different sort of transformative answer than asking what happens when a individualistic culture meets a collective one or an efficient society meets an inefficient one. Although an individualistic and collective culture may conflict, and an efficient and inefficient society might find some average efficiency in their interactions, virtuous societies may become transformed. Some people in a prudent society might recognize the prudence of courage; avoid previously hidden cowardly or foolhardy behaviors as imprudent; and become more courageous. As some members of a prudent society become courageous, the society becomes more prudent, because the courageous members are avoiding imprudent cowardly and foolhardy behaviors. Similarly, some in a courageous society may recognize the necessity of prudence to courage; become more prudent; and the society becomes more courageous. The interaction of individuals in a society sharing some virtue transforms the individual's virtue and strengthens the society's norm.

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14 Aristotle, *Nicomachean Ethics*, II.6.1106b 36–1107a 8

15 Alasdair C. MacIntyre, *After Virtue: A Study in Moral Theory* (Notre Dame, IN: University of Notre Dame Press, 1984), pp. 122, 140, 142, 185, 228; Homer, *Illiad*, 15.642.

Something about virtue stabilizes the society and transforms the individual's ethical habits. Similarly, in some biological systems, a significant bond transforms the entire system. A phosphorylated protein, a conformational change to a protein structure, formation of a protein complex, and passage of calcium ions into a neuron have a biological consequence that cannot be modeled from a purely physical perspective, and because those differences constrain the whole, second-order emergence occurs. Similarly, when an individual in a cultural system makes a decision to act in certain ways, that person can transform the cultural system in the same way that a significant covalent bond can change a biological system.

Cultural-level systems can become transformed by their participation in transcendent-level processes from the interaction of cultural systems that support attributes which break symmetries in constraints, develop emergent boundary conditions that apply to the whole system, and create information meaningful only at the transcendent level. When an individual decides to participate in the cultural-level constraint on behavior named prudence, that person participates in the society of people who behave prudently. If those individuals interact symbolically and share language (and perhaps empathy, such as in stories), that society exists as a cultural-level system. In a diverse society, individuals may share some constraints and differ on others with enough redundancy and distinctions (often geographic or ideological) from other societies to form robust cultural-level systems. What differs between an individual changing their cause in a diverse cultural-level system and a transformation that creates transcendent-level information?

Royce's Philosophy of Community

The American pragmatist Josiah Royce developed a philosophy of community drawing upon C.S. Peirce's logic and semiotics that describes selected cultural-level systems as a whole from the perspective of transcendent-level systems. Royce articulates a philosophy of loyalty that supports the second-order emergence of cross-cultural relationships and initiates the formation of transcendent-level systems. His community of interpretation results in the emergence of spirit, that I claim results in third-order emergence and the emergence of the transcendent level.

Loyalty to Loyalty

What aspect of cross-cultural interaction leads to transformation and second-order emergence?

Josiah Royce suggests in *The Philosophy of Loyalty* that harmony between cultures can occur only when each culture's ideals and cause include "loyalty to loyalty," a commitment to the principle of commitment and dedication that demonstrates support and obligation to the loyalty of those in opposing cultures to their particular cause.[16]

16 Josiah Royce, *The Philosophy of Loyalty* (New York: Macmillan, 1908); citations from reprint: Josiah Royce, *The Philosophy of Loyalty* (The Vanderbilt Library of American Philosophy; Nashville: Vanderbilt University Press, 1995).

Royce argues convincingly that loyalty to loyalty not only provides harmony, but also suffices to distinguish the ethical or "true" causes as those that incorporate loyalty to loyalty. The cultural characteristic of loyalty to loyalty results in the emergent property of cross-cultural harmony and diversity at the transcendent level.

For Royce, all the virtues can be defined in terms of loyalty because developing virtuous habits requires commitment and loyalty. Though Royce may underestimate the differences in the virtues, one can define a principle of choice for guidance that one's loyalty becomes a good, not only for oneself but for all humanity. Because virtuous behavior depends upon loyalty, one can increase the good for humanity by increasing the loyalty amongst everyone. Although one has specific causes to which one commits loyalty, to increase the good among humanity, one should choose one's cause to include loyalty to loyalty, to the extent possible.[17]

In Royce's philosophy of loyalty, one commits to honoring the other person's commitment. Although a Christian may disagree with the attributions traditionally ascribed to another religion's founder, such as Mohammed or Buddha, the Christian supports the believer's loyalty to those beliefs. Some cross-religion beliefs conflict, such as when to worship, and others correspond, such as discipleship, and a few appear shared across all human religions, such as compassion, and are presumed universal. However, that "universality" still depends upon the context of the human condition. It seems good to show compassion because people feel pain. If an organism had no sensation, perception or representation of pain, then its social interaction would be unlikely to contain compassion as a response to suffering as its individuals would not know pain and suffering.

For Royce, a person chooses causes. One can choose causes for personal gain, such as greedy materialism or wealth preservation. One can choose causes for social power, such as oppression of an out-group. One can choose causes by default or indecision based upon external circumstances, such as family or culture of origin, random job or vocational choices, or social pressure. Personal, corporate, or political greed becomes predatory not for intrinsic reasons, but because it thwarts another person's loyalty to survival, sustainability, or family. A cause becomes evil when it becomes predatory and lives by overthrowing the loyalties of others. One discerns harmful causes through their relationship to loyalty itself. When one becomes loyal to loyalty one supports the loyalty of others even if one disagrees with their cause. This promotes harmony, and in interdependent systems, can strengthen one's loyalty to one's own cause. However, because one remains loyal to loyalty one cannot support another's cause to the extent it becomes predatory. Thus, in loyalty to loyalty, one attends to another's loyalty, avoids unnecessary conflict in the interest of harmony, and resists the other's cause to the extent that it undermines one's own loyalty to loyalty. This behavior increases harmony in the cross-cultural interactions regardless of the action of others.[18]

Non-violent resistance works in part because the resisters endure the behaviors inflicted by the others due to the other's loyalty to their cause. By allowing the cross-cultural system to run its course smoothly, the detrimental effects of the other's

17 Royce, *The Philosophy of Loyalty*, pp. 57, 61, 66.

18 *Ibid.*, pp. 56, 62, 63.

cause become amplified and illuminate previously hidden consequences that even the others recognize as oppressive. Loyalty by the resisters to the loyalty of the oppressors results in a sufficiently stable, though perhaps transient, system to change the regulatory mechanisms of the oppressing culture.

In the transformation of an individual's virtue within a virtuous society, loyalty to the right of another person to choose their virtue enables the possibility of the society's virtue becoming transformed by a different virtue's ethical norm. Dialogue among Christian neuroscientists and Tibetan Buddhists becomes informational to transcendent-level systems when Christian neuroscientists remain loyal to Christian cultural-level systems that already participate in transcendent-level systems and remain loyal to Western scientific claims about how the brain works; Tibetan Buddhists remain loyal to their Tibetan and Buddhist cultural-level systems that already participate in transcendent-level systems; and both groups become loyal to the rights of members of the other group to hold beliefs that conflict. Dialogue among scientists and scholars in cognitive science and religion requires similar loyalty to one's own (academic) cause as well as loyalty to the other participants' commitment to their causes.

Loyalty depends upon individuals having the ability to choose, and to represent a cause for which they can relate and make choices. As compassion depends upon the ability to feel pain (and empathize), loyalty depends upon the ability to choose, remember, and act. One could choose loyalty to compassion, beauty, honor, truth, or loyalty. However, loyalty to loyalty transcends loyalty, because it creates a constitutive absence in the system that enables novel interactions with other systems. By committing to another person's commitment (to the extent possible) without further constraining their cause, one increases stability and harmony between cultural systems because the other person has the maximum freedom to specify the cause to which they commit. The constitutive absence plants the seed for possible relationships that inform transcendent-level relationships and cannot be reduced to cultural-level systems. Mutual commitment to loyalty to loyalty across cultures increases the stability of the cross-cultural, transcendent relationship and initiates formation of transcendent-level systems. Loyalty is the cause to which one ascribes loyalty, and the emergent properties can transform cultural systems.

Although Royce's more mature ethics built upon his deeper understanding of semiotics, his community of interpretation, and CS Peirce's metaphysics,[19] his philosophy of loyalty still identifies a key aspect in the emergence of ethical systems that one cannot attribute to any particular constituent and thus occurs as a second-order constraint on the emergent whole, or form, of the transcendent-level system.

Community of Interpretation

In his later work, *The Problem of Christianity*, Royce explores the relationships between individuals and community. A community consists of a collection of selves

19 Frank M. Oppenheim, *Royce's Mature Ethics* (Notre Dame, IN: University of Notre Dame Press, 1993).

that share some particular cause, memory, expectation, or hope.[20] As Royce's logic included sets, classes, and the "epsilon" relation—an individual belonging to a set or class—one can model Royce's community using the tools described in Chapter 2 as a class of systems which share a particular constraint. However, as Royce's mathematics differs from contemporary mathematics, I must explain a much richer mechanism of "sharing" that Royce called interpretation.[21]

DNA and hemoglobin are physical-level molecules that also participate in biological-level systems of gene transcription and organization, among others. The interactions in a cell have physical-level descriptions, but some constraints on systems do not. They require the capstone of emergence in a level—the selection of information by a third-order process—to explain: namely, selection of possible genetic networks in the evolution of biological systems, selection of possible neural networks by psychological systems (learning by individuals), selection of individual linguistic (and empathetic) conventions by cultural systems, and selection of shared interpretations among communities by transcendent-level systems.

For Royce, in the type of community he called "a community of memory," each member accepts as part of one's life and self the same past events that each fellow member accepts. Any group of people who individually remember or commemorate the same past events, such as the founding of a nation or the death of a particular person, forms a community of memory with reference to that event (or events). Similarly, a community of expectation (or hope) consists of individuals who accept as part of the member's individual life the same expected future events. A richer type of community, as opposed to a collection of individuals, combines the sharing of past and future. A *community* depends upon the interpretation that each individual members gives to that individual's own self, past, and future.[22]

For Royce, and his student George Herbert Mead, an individual requires a community in order to define themselves in relation to society.[23] Through community, individuals extend their lives into the past and future by interpreting events which the individual does not personally remember. The community also provides, through language and history, a framework of interpretation by which the individual interprets personal events that otherwise would be a meaningless stream of perceptions, feelings, or thoughts, such as Lutherans interpreting Martin Luther's act of posting 95 theses on his Wittenberg church. Although the individual has direct access to individual sensations, the meaning of those sensations and the experience of the community occur through the same process of interpretation.

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20 Josiah Royce, *The Problem of Christianity: Lectures Delivered at the Lowell Institute in Boston, and at Manchester College, Oxford* (New York: Macmillan, 1913); citations from reprint: Josiah Royce, *The Problem of Christianity* (Washington, DC: Catholic University of America Press, 2001) (p. 248).

21 Josiah Royce, *The Principles of Logic* (New York: Wisdom Library, 1961).

22 Royce, *The Problem of Christianity*, pp. 248–9.

23 *Ibid.*, pp. 249, 253; George Herbert Mead, *Mind, Self and Society from the Standpoint of a Social Behaviorist* (Chicago: University of Chicago Press, 1934); Donald L. Gelpi, *The Gracing of Human Experience: Rethinking the Relationship between Nature and Grace* (Collegeville, MN: Liturgical Press, 2001), chs 5, 7.

From a systems perspective, individuals interact at the psychological level using (what Mead called) gestures that become sufficiently abstract to enable symbolic language. Interacting with symbolic language enables third-order emergence and the emergence of cultural-level systems. These systems include societies, ad hoc groups, organizations, institutions, and so on. The groups of individuals that share language, memories of past events, and expectations of future events form communities. An individual, as a psychological-level system, exists from the emergence of biological processes embodied in the brain—as other animals do. In addition, a human individual gains identity through the cultural-level interactions that form communities. That individual participates and helps constitute cultural-level systems of communities that then provide purpose and norms for the individual in terms of cultural identity or social "location." A group of individuals without a shared past cannot provide identity, and a group without a shared future hope cannot provide a norm. Only through certain interactions with others does one become different than most other animals.

However, the individual does not melt or merge completely with the community, but must retain distinction for the community to exist as relationships between the distinct individuals. Otherwise the community would degenerate into a single perception of the world—incapable of the differences needed to form diverse interpretations. A community requires unity in terms of pasts and hopes and requires diversity of its members.[24]

In terms of emergence, one may notice the dampening of difference that occurs through a common language, shared knowledge of past events, and shared hopes. This provides the necessary "order" among individuals necessary for first-order emergence, as surface tension requires synchronized electrons in water molecules. However, within that regularity, diverse individuals in their interactions provide different "shapes" and constrain differently the past, present, and future formal relationships of the community as a whole. As a snowflake incorporates ice crystals differently, depending upon physical conditions, in second-order emergence, the form of the community varies with the differing individual perceptions, conceptions, and interpretations.

For Royce, drawing upon Peirce, interpretation involves a *triadic* relation, that is, of three terms: the interpreter, the object (or event) being interpreted, and the person to whom the interpretation is addressed. The interpretation provides a relational structure of the individual within community by relating the individual perceptions and the community-provided conceptual framework embedded in language. Although one can perceive any physical object or develop mental models of biological processes, one can also interpret another individual's mind to a third person. When each person attempts to interpret a past event with a future hope while also interpreting each other's interpretation, Royce calls that ideal a *community of interpretation*. That process occurs in true loyalty as each attempts to become loyal

24 Royce, *The Problem of Christianity*, pp. 255–8.

to loyalty by examining the behaviors of each other to determine one's own action in remaining loyal to one's cause and most of all to loyalty.[25]

In contemporary social science, the interpretation of another person's mind involves a person's *theory of mind*. Theory of mind refers to a person's theory of *another* person's mind, in particular, the ability to reason about another person's beliefs and desires. It relates closely to empathy. Experiments on theory of mind often involve a false-belief task where a subject watches an experimenter hide an object under one of two boxes as a third person observes. The third person leaves the room, and the experimenter switches the location of the object. Where does the subject believe the third person will look when that person returns? Under the second box where the subject knows the object rests or under the first box where the subject knows the third person saw it placed. Adult humans know the third person will look under the first box, but human infants and very young children indicate (through a variety of experimentally verified nonverbal cues) that they believe the third person will look where the object now rests, not where the third persons thinks the object rests. Before a particular age, humans lack a theory of mind, and cannot separate their own beliefs about the world from the different beliefs another person might hold.[26]

Scientists do not yet know the relationship (if any) between the psychological-level constructs of language and theory of mind, but theory of mind may also play a role in the emergence of culture, that is, human ability to share language. In a community where similar individuals interpret similar events, a dampening of difference may occur, that is, first-order emergence. A community may share a common interpretation of a historical event (where the vast majority agrees on each particular aspect) but because of slight variations in interpretation and memory, no individual interprets all the aspects of the event as the majority does. The shared interpretation exists as an emergent property of the community, but not in an individual. Each individual notices differences between their individual interpretation and an emergent, consensual interpretation. People also notice differences between another person's interpretation and the consensus. Although each person may interpret those differences from their own perspective, nevertheless, just as an emergent interpretation occurs through dampened differences, a shared interpretation may also emerge, though perhaps bifurcated on controversial topics.

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25 *Ibid.*, pp. 286–7, 294, 312–15, 318. For Royce, a community also includes shared lives—where the members advance collectively toward proximate goals using their individual gifts—and atoning love—where the community is willing to forgive any repentant member and has the creativity to posit an atoning act that makes the world better than if the treason had never occurred (*ibid.*, p. 180).

26 Researches have investigated at what age that occurs, its relationship to autism, and whether chimpanzees or other primates have a theory of mind. Simon Baron-Cohen, *Mindblindness: An Essay on Autism and Theory of Mind* (Learning, Development, and Conceptual Change; Cambridge, MA: MIT Press, 1995); Peter Carruthers and Peter K. Smith, *Theories of Theories of Mind* (Cambridge and New York: Cambridge University Press, 1996).

Emergence of Spirit

Royce relates the community of interpretation to the early Christian churches, founded by Paul and described in the New Testament. Royce sees the essential teaching of Christianity as the progressive realization of the "universal community" (or as Martin Luther King Jr. preferred in his use of Royce, the "beloved community").[27] Following Peirce, Royce argues that nature has a "mind-like" quality capable of serving as interpreter, and calls spirit the "interpreter of the universal community".[28]

I borrow Royce's spirit of a community, avoid his universalizing of that spirit, and describe the interpreter of a community as emergent. Although Royce intended "spirit" to identify the Holy Spirit in Christian Trinitarian doctrine, I avoid that universalization to develop what theologians might call a "low pneumatology," where the theology of spirit depends upon human interaction and not the revelation of a primordial or personal divinity. Later, I describe how this might relate to (and clarify) a more traditional theology.

The interpreter of a community emerges from the mental processes of individuals, and occurs as in Royce's community of interpretation when each person interprets a past event with a future hope while interpreting another's mind to a third person. In other words, interpretation emerges from shared meaning, which, for a pragmatist, results from the effects of the constraints placed on the community by the individual members. Any community would have a "spirit", though some "spirits" would have more interesting emergent properties and relationships than others. This use of spirit resonates with an awareness of the "spirit" of a family, city, nation, church, organization, and so on. For Christian theology, communities of interest include the family, local congregation, all Christians, and all humans. In particular, one can talk of the emergent spirit of the Christian community (or beloved community for Royce and Martin Luther King Jr.) and the emergent spirit of humanity.

The spirit of a community emerges from a community, but transcendent-level systems require selection among information-bearing abstractions that emerge from cross-cultural interactions. In examining lower-level systems in previous chapters, several systems tools were described: constraints, dampening of difference in first-order emergence, systems as dynamic form, asymmetric propagation of form and constraint in second-order emergence, emergence of causal power in strong emergence of levels, and the creation of memory and information in selection of symbolic abstractions in third-order emergence. These hold for spiritual systems, too. When a community commits to loyalty to loyalty, that undergirds its cross-cultural interactions through creation of constitutive absence and provides the openness in harmonious interactions upon which spiritual selection may occur.

The cause to which one ascribes loyalty and the community to which one belongs impact upon the emergent transcendent system(s) in which one can participate. The

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27 The King Center, *The Beloved Community of Martin Luther King, Jr.* (2004); available from http://www.thekingcenter.org/prog/bc/ (accessed 12 November 2006); Royce, *The Problem of Christianity*, pp. 125, 377, 387.

28 Royce, *The Problem of Christianity*, pp. 89, 403. Royce identifies the divine mind (Logos) with Spirit (pp. 234–5) rather than with Christ (as Justin Martyr and Augustine did).

emergence of spirit from cultural-level systems retains information in memory, but because of an individual's inability to access those systems directly, one must refer to them through emergent cultural-level systems—typically religious ones. Atoms, DNA, neural networks, symbolic conventions, and shared interpretations remain one of the many subatomic, physical, biological, psychological, and cultural systems, respectively, whose significance only becomes relevant through their participation in the next higher-level systems of molecules, reproduction, conceptual thought, language, and spiritual communities, respectively again. Their central location in emergent systems depends upon numerous supporting and auxiliary systems—each of which also has lower-level constituents. The emergence of a level, however, depends upon the creation of information through abstraction and memory. Spiritual systems select among the possible interpretations of various communities. Or, through the cultural lens of Christianity, spirits reveal information to communities of interpretation in transcendent-level processes.[29]

An individual's participation in community depends upon decisions that an individual makes. From the cultural-level perspective, the dampening of difference in cross-cultural interaction leads to emergence of first-order constraints; the formation of organizations that constrain individual mental activity and behavior characterizes second-order emergence; some of those systems include constitutive absences that bear information (interpretations) used in selection processes by third-order emergent systems. From the transcendent-level perspective, transcendent-level systems select from cultural interpretations constituted by the decisions of individual members of a community. The next section looks at an individual's participation through decision-making in (Christian) spiritual systems. The first part of the chapter examined spiritual relationships from the perspective of its constituents, and the remainder of the chapter examines it from the perspective of the whole.

29 A systems approach clarifies what one can understand about spirituality without special revelation, i.e., a natural theology. There is another aspect of spirituality that is "natural" in the sense it is not revealed via special revelation, but it also is not knowable by humans, because systems do not emerge in a completely "blank" universe—the structures of nature select for aspects of emergence. Even though the levels do not exist until they "actually" emerge, the higher-levels have been in the "real possibility" of the relationships between lower-level systems and the absences that become constitutive, since the formation of subatomic processes. Thus, there is a type of luring that occurs in the selection process of third-order emergence, which requires metaphysics to examine, and I will comment upon it in Chapter 7 in comparison to process philosophy. With pragmatic philosophy and metaphysics, I extend the natural theology describable by systems to what Ian Barbour calls a systematic synthesis, though only applied to human systems.

Irenaean Spirituality

What traditional spiritual system, if any, correlates with what contemporary science says about spirituality?

Although one could attempt to develop a new spirituality based upon some aspect of science (as many do—with quantum mechanics becoming popular recently), the previous section described the importance of history or tradition to community and the formation of spirituality. History (of a system) and memory play significant roles in second- and third-order emergence (respectively), and examining spiritual relationships in the context of an early Christian writer focuses scientific study of transcendent systems by grounding it in an established cultural-level religious tradition.

Irenaeus (120–202 CE) was a major Christian theologian of the second century. Although Augustine played a larger role than Irenaeus in the development of Roman Catholic and Protestant thought, Irenaeus played a much more significant role in the Orthodox traditions. A native of Asia Minor, probably Smyrna, as a boy Irenaeus studied under Polycarp, who had known John and other apostles who personally saw Jesus. In the second century, direct transmission from apostles and witnesses to contemporary believers was no longer possible. For Irenaeus, the church no longer had firsthand knowledge of Jesus' life and teaching, and Scripture was needed to explain the role of faith by which true Christians lived. Even within Irenaeus' church, the Gnostics likely influenced people's beliefs in ways that troubled Irenaeus, and he believed a written Scripture would limit introduction of novel ideas to the Rule of Faith. Scripture as a whole—as a description of truth—would allow sounds transmission and interpretation of truth, and scholars credit Irenaeus as the primary proponent of the four Gospels. He opposed the Gnostic teachings and their influence on Christianity and wrote his major work, *Adversus haereses* (*Against the Heresies*), against the Gnostic teaching of Valentinus.[30]

The Gnostics believed in a radical ontological dualism in which the soul is trapped in a physical body. The human will is greater than the body, and the Gnostic used secret knowledge to escape the material and regain higher knowledge of the *pleroma*. Gnostic cosmology had three kinds of substance—material, psychic, and spiritual—and three corresponding classes of people. The spiritual person does not need salvation; the material person is incapable of salvation; and the psychic person is both vulnerable to the fall and capable of redemption. Irenaeus emphasized the unity of the human person and argued against the Gnostic belief in three distinct kinds of people. He also worked with the knowledge of the time and agreed that each person has material, psychic, and spiritual aspects of the self. Humans are one

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30 For a guide in English to Irenaeus' *Adversus haereses*, see Mary Ann Donovan, *One Right Reading? A Guide to Irenaeus* (Collegeville, MN: Liturgical Press, 1997). For a philosophical introduction to Irenaeus, see Eric Francis Osborn, *Irenaeus of Lyons* (Cambridge and New York: Cambridge University Press, 2001).

being composed of flesh, soul, and spirit, and those aspects should not be treated in isolation as separate persons.[31]

Irenaeus provides an anthropology of human moral development where humans begin imperfect and develop in successive stages. His moral anthropology differs from Augustine who believed people were born perfect and then fell from grace. Irenaeus' anthropology also differs from Thomas Aquinas', who believed the willing aspect of the soul is oriented toward a reified Goodness. Scholars have found Irenaeus' anthropology appealing for addressing "theodicy" (why evil appears in the world with an omnipotent and loving God) and reconciling overly optimistic and pessimistic views of human moral nature.[32]

For Irenaeus, God did not create humans in a perfect state. Like an infant not ready for strong food, humans are not ready for the full glory of God, so must mature in development. Irenaeus builds upon 1 Cor. 3:2, where Paul writes of feeding the Corinthians with milk, not solid food, as they were not ready. Irenaeus writes:

> For as it certainly is in the power of a mother to give strong food to her infant, [but she does not do so], as the child is not yet able to receive more substantial nourishment; so also it was possible for God Himself to have made man perfect from the first, but man could not receive this [perfection], being as yet an infant.

Humans obtain that nourishment through Christ who, though "the perfect bread [of God], offered Himself to us as milk." After being nourished by milk, people become accustomed to eat and drink the Word of God, and "may be able also to contain in ourselves the Bread of immortality, which is the Spirit of the Father."[33]

Irenaeus provides an optimistic anthropology because people can increase from their natural (fallen) state to perfection like an infant who matures. However, his anthropology does not overly optimistically presume a pre-existent divine state. For Irenaeus, God desires that humans transcend "perfection" because human development (with Christ) never reaches a limit. Rather than a perfection of being, graced existence is a continuous state of becoming.

Although Irenaeus, like his contemporaries, presumed creation of a fixed species and the Fall of humanity, modern cosmology, and biology suggest a more gradual development of the world and species in it. Irenaeus believed that the Fall resulted in the loss of human's spiritual likeness to God, but although the Fall is unsupported and contraindicated by scientific evidence, the *imago dei* ("image of God") may be reinterpreted rather than dismissed with the Fall.

Form captures much of Irenaeus' conception of the person as "image of God." For Irenaeus, form inheres only in matter and thus occurs in the flesh itself. Irenaeus emphasizes the importance of the body and explicitly rejects the image being in

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31 Irenaeus, *Adversus haereses* V.6.1.

32 See especially the work of John Hick on Irenaean theodicy: John Hick, *Evil and the God of Love* (New York: Harper & Row, 1966).

33 All quotes from Irenaeus, *Adversus haereses* IV.38.1; trans. Alexander Roberts and James Donaldson, *Ante-Nicene Christian Library: Translations of the Writings of the Fathers Down to A.D. 325* (Edinburgh: T&T Clark, 1868). Available in subsequent editions and online at http://www.ccel.org/fathers.html (accessed 30 November 2007).

the spiritual part of the person.[34] From a systems perspective, the form corresponds to the constitutive relationships comprising the systems of the human person. The image of God incorporates all that emerges through the lowest, subatomic level. Although Irenaeus would apply "image" only to human existence, and this book only examines the human soul, the broader, systems reading of Irenaeus corresponds to the panentheist view of Philip Clayton and other contemporary theologians, that God is more than the universe but also includes and interpermeates the universe. Thus, the entire universe would have a soul.[35]

Humans have a freedom to choose to follow the path that involves them in spiritual relationships and which relationships they wish to pursue. Irenaeus views that freedom as a "similarity" humans have to God.[36] As one chooses, one shifts one's flesh to participate in the spiritual relationships. Vision provides a key role for Irenaeus as one must see and follow "the light" to receive and partake of "the light."[37] In other words, seeing and choosing to participate in spiritual relationships involves the person in spiritual relationships and thus in spiritual systems. For Irenaeus, that ability to choose makes humans similar to God in ways other creatures are not.

As one chooses to participate in certain spiritual systems, one receives from those systems the gift of becoming more like God. That likeness to God, for a Christian, looks like Jesus Christ, and Irenaeus would call "spirit" the spiritual system that enables the human person to pursue the path of choosing to turn toward God. Although referring to an emergent human system as "spirit" appears to contradict many traditional Christian and Trinitarian doctrines, that paradox does occur in Irenaeus' writing.[38]

The Christian doctrine of the Incarnation claims that God, in the flesh, looks like Jesus Christ. In a Platonic, essentialist interpretation, that could occur with the infusion of divinity as an essence into human flesh. In an emergent interpretation, Jesus would typify the transcendent-level systems of spirit as best grounded in human physical, biological, and psychological-level systems and as constructed through the cultural-level systems of first-century Palestine.

As a system, those relationships would develop over Jesus' entire life, and in one emergent interpretation, Jesus would exist as fully human (with relationships at every level of human systems) and would be fully divine by fully participating in the transcendent-level systems emerging from the Christian community founded by his life. In a classical interpretation of those relationships, they form a cycle of Jesus typifying the cultural system defined by his life—which occurs in the life of any

34 Donovan, *One Right Reading?*, p. 133.

35 The World-Soul also resonates with neo-Platonic understanding of form, such as in the *Enneads* of Plotinus.

36 Irenaeus, *Adversus haereses* IV.37.4. See Donovan, *One Right Reading?*, p. 134 for a brief discussion of Irenaeus' use of *homiotes* "similarity" and *homoiosis* "likeness" as noticed by Jacques Fantino.

37 Irenaeus, *Adversus haereses* IV.14.4

38 For example, people receive a certain portion of God's Spirit to tend them towards perfection and preparation for incorruption (*Adversus haereses* V.8.1), thus people intrinsically have a spiritual capability, though Irenaeus would not have allowed all of spirit to emerge from human systems.

cult leader. In that case, humanity "divinizes" Jesus. However, with the structure to emergent levels provided by strong emergence and the selection dynamics of third-order emergence, the "supernatural" or "divine" orientation of Christ might occur because the "natural" structure of transcendent-level phase space would select for Jesus' life (in a way similar to how the "mind-like" quality of the universe selects for human mental abilities). In that case, those primordial qualities of the universe (Christ) would select for human transcendent systems (the church) and infuse it with "divinity" through human life (Jesus). As a Christian, one would take on faith the selection of the interpreter spirit of Christian community as a transcendent-level system and not merely a cultural-level one.

For Irenaeus, although God gives humans the spiritual aspect of God's "likeness", humans lost that spiritual likeness at the Fall and must be restored by Christ. Humans do retain the "image" of God as body and soul (form), but the person can only be made complete (perfect) with Christ (the second Adam) who has the perfect likeness of God.[39]

More consistent with modern science and Irenaeus' response against the radical dualism of Gnosticism, "God's likeness" may be interpreted as an emergent collection of human tendencies that is perfected by following Christ. Irenaeus describes graced existence as a continuous state of becoming, not a static perfection. Thus, God's "likeness" for a human would not be a static Platonic perfection, but an incremental process of development.

For Irenaeus, spiritual development occurs not by choosing between two paths, but continuing along one path where the person either follows the path or wanders lost. Such a process resonates with the independently developed Buddhist doctrine of the Middle Way, in which one does not choose between materiality and spirituality, one chooses whether or not to follow the path. One's material life cannot help but become transformed by spirituality, because humans choose what they value and value what they choose.

One can choose *how* one is transformed. What does spiritual transformation of one's physical, biological, psychological, and cultural self look like? One follows the path deeper into the thin space that paradoxically embodies an enormous gulf. The thin space comprises the path, and in emergent systems the path consists in ever-greater participation in spiritual systems. In more traditional language, one redeems one's (physical, biological, psychological, and cultural) self by deciding to pursue participation in spiritual activities.

One becomes transformed by noticing the spiritual processes occurring in emergent phenomena. As you see the words on this page, a social and cultural process occurs framed as reading a book in the English language. Language helps people communicate a mental construct from one individual to another. Simultaneously, a biological process occurs as neural networks in various regions of one's brain activate and respond. Those processes appear to depend upon ions and neurotransmitters crossing the synaptic cleft between neurons. And those processes depend in turn upon the physical and chemical properties of those atoms. As described in Chapters

39 Peter C. Phan, *Grace and the Human Condition* (Message of the Fathers of the Church, 15; Wilmington, DE: M. Glazier, 1988), pp. 49–50.

3 and 4, one cannot determine the biological processes merely by examining the atoms. The topological relationships between collections of atoms may determine biology, but one can only determine those relationships using biology, not physics. The intellectual content of these words are physically grounded in the connections between the atoms in our respective brains. However, one cannot determine that content using neurobiology, one must also examine the psychological and cultural interactions that emerge. What occurs is simultaneously a physical, biological, psychological, and cultural process.

Although one does not have direct access to transcendent level systems, spirituality—as culturally mediated—provides ways to examine one's life in terms of what one values most, to what one commits, and to what one remains loyal. Various religions provide rituals and practices for the individual to increase participation in transcendent level systems, and perhaps due to the constitutive absences needed for certain types of emergence, some aspects of those systems must be taken on faith. As one follows the path of faith into the transcendent gulf between human and divine, one changes who one is that is on the path. Each decision affects the self, and thus forms the person who next decides.

How does spirituality transform the human system to enable it to study spiritual transformation? Rather than choose culture or spirituality, one chooses both. As a scientist or scholar studying spirituality, one must choose both the academic discipline and spirituality to view transcendent-level phenomena through the cultural lenses of science or scholarship.

Irenaeus describes the process as:

> [A person] ascending towards the perfect, that is, approximating to the uncreated One. For the Uncreated is perfect, that is, God. Now it was necessary that man should in the first instance be created; and having been created, should receive growth; and having received growth, should be strengthened; and having been strengthened, should abound; and having abounded, should recover [from the disease of sin]; and having recovered, should be glorified; and being glorified, should see his Lord.[40]

If God's "likeness" has a non-dualistic interpretation, then one must address how the brain can ground a complex collection of tendencies and develop toward a theologically significant construct, such as the perfection of Christ.

In the next chapter, I suggest how the processes of the brain may frame decisions and permanently embody that decision-making process in the neural networks of the brain, resulting in a tendency to completion or "spiritual" maturation, but first I must relate a significant spiritual system which is at the transcendent level to the lower-level systems.

Abraham's Faith

Having related transcendent relationships and systems to established religious traditions, how do those traditions and their transcendent-level systems begin?

40 Irenaeus, *Adversus haereses* IV.38.3.

When Abraham stood on the mountain with a knife over his son, he acted in faith (Gen. 22). He had followed a path of gradual spiritual development beginning with leaving the land of his fathers in Ur and wandering the wilderness to finally having an heir. Abraham's wandering path led him to grow in God's "likeness." In the decisions Abraham made about his life, he made free choices that formed his self and led him to the mountain. He heard a calling out of Ur, developed loyalty to his God, and prepared to sacrifice his son and heir to the God to whom he had committed.

With the knife poised, Abraham heard a voice, perhaps an external sound or perhaps a voice from deep within. As the voice said "Stop," Abraham's faith shifted; he participated in a religious event that would greatly impact upon future generations; he heard the voice and stopped; neurons fired and actions potentials spread across several regions of his brain; calcium, other ions, and neurotransmitters crossed synaptic clefts between the neurons impacting his current mental state and initiating the genetic transcription of proteins to potentiate (make stronger) certain neural connections that would impact upon his future self and faith. At what level—transcendent, cultural, psychological, biological, physical, or subatomic—does one interpret that event?

Many religious scholars and historians doubt that Abraham existed as an individual, though many people believe in Abraham as a matter of faith. That faith has a real impact on the world both for constructive and destructive outcomes: was the sacrificial son Isaac or Ishmael? However, there were certainly figures in antiquity that had faith, drew upon the faith of others, and led others by example. Generations preserved Abraham's story as valuable, regardless of its historical context.

A systems analysis indicates a conflict at the cultural level between historical scholarship and religious tradition. However, numerous people prior to the current generation have acted in faith including historical founders of Christianity, Islam, and their disciples. One can examine the psychological-, biological-, physical-, and subatomic-level systems of those faith events as real without completely characterizing the cultural-level, historical context. In fact, if one includes subatomic-level systems in a characterization, no totally precise description is possible (because of the limits of Heisenberg uncertainty). One can only characterize the systems to the extent necessary to support relationships with other systems in the analysis. How can one study the necessarily incomplete analysis of any system, including the transcendent-level systems of faith?

In Royce's community of interpretation, once the interpretation coheres sufficiently to form a stable narrative, the group's loyalty to the process of interpretation provides stability for the group. The group continues to reinterpret the founding event, but over time also interprets the prior interpretations.[41] Eventually, the interpretative process gains sufficient stability that the founding event's characterization may shift or become lost. In long-lasting religions, direct interpretation of early events can become unproductive because later adherents may question the underlying, natural assumptions of the initial interpreters. Stories shift and merge and political

41 Jewish *midrash* provides an excellent example of the process of interpreting and reinterpreting interpretations.

motivations may skew reinterpretations. Eventually one's knowledge of details of the founding event becomes suspect.

However, at the same time, the social interactions through language as part of the interpretative process have led to the emergence of culture. The community has a culture that provides stability, the ability to interact with other cultures, form subcultures, indicate in-group/out-group boundaries, establish norms for individual behavior, and internal control. The community's reality at the cultural level depends upon the people currently in the group and their artifacts of tradition. The historical circumstance of the founding event and early interpretations do not directly affect the contemporary group, though of course they can affect the group's self-perception and perception of the group by outsiders. Numerous real cultural systems, such as the World Cup or New York Stock Exchange, depend primarily on the minds of contemporary participants and their memories of prior cultural-level events. The ability of cultural-level systems to constitute transcendent-level ones depend upon a variety of factors, but I suspect historical accessibility of the founding event is not essential. Because numerous individuals in Judaism, Christianity, and Islam have acted in faith using Abraham as a model, in a systems analysis of those communities, it may not matter whether Abraham lived as described.[42]

As described in the previous chapter, third-order emergence can occur when cultural-level systems provide memory and information-directed behaviors can accept selection influences. At such a point what Royce calls the spirit of the community begins to emerge. How do individuals value the interpretations of others and their predecessors? How does loyalty to loyalty influence interactions with other communities? Are the individuals mindful of the connections within and between communities? Questions of ancestry, commitment, and awareness influence the insights into the emergent spirituality that individuals can access, and thus the continual process of interpretation.

In Irenaean spirituality, the individual begins imperfect and develops in successive stages. Likewise, for a community, its spirit develops through the free choices of its individuals, the memories they create and share, and their interpretations of the communal process. Some interpretations may necessarily build upon other interpretations and conflicts between various interpretations may lead to group selection of the one (or ones) that resonate most closely with the group's ideal for itself and its future. The selection of interpretation can lead to third-order emergence and also provides growth and strengthening of the relationships comprising the community both interpersonally and via extended communication using writing and artifacts. As the interactions, self-organization, and selection of self-regulatory subsystems abound, the community can focus its activities on functional behaviors that increase the emergent qualities of the system and recover from prior processes that close the system off from continued emergent relationships that move the system toward its spiritual ideal.

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42 Royce would likely disagree, as he wants ongoing consensus in the community about the events that create the community and the events that link a community to its founding events.

According to a systems approach, an individual can only participate in spiritual systems as part of a cultural-level community that has an emergent spirituality. That observation resonates with prior religious observations. Even a monastic, or other isolated individual strongly immersed in a religious culture, continues to interpret the community with one's life as dialogue involving prior community members in writing, rituals, practices, and other artifacts. A monastic participates in the community, but minimizes the social interaction with contemporary individuals.

When one participates in a community founded on Abraham's faith, one interprets that and subsequent events with one's life decisions. As one decides, one changes who one is that is deciding. Who one becomes will shape the community to which one belongs and influences the community's path to its ideal and its emergent spirituality. One participates in the life of the spirit of the community by intentionally interpreting the community with one's life decisions. One participates in and defines the spirit with one's life.

The spiritual systems described here exist autonomously—dependent upon individuals for existence, but not controlled by individuals—as individuals influence, but cannot control a community, communities influence, but cannot control a spirit. One participates in a spiritual system through one's participation in a community and in contributing to the community's shared interpretation through one's life decisions. Christian theology depends not only upon autonomy of spirits—such as pre-modern scholars considered "angels" to have—but also upon revelation.[43] As special revelation, by definition, includes non-natural relationships, spiritual systems can only capture the constraints resulting from special revelation and not model the full processes that some Christians (by faith) believe create those relationships. A systems approach identifies and organizes spiritual relationships, but cannot answer the faith question of whether those transcendent-level systems exist naturally or gratuitously.

Cultural-level systems interact and result in the (first-order) emergence of constraints that affect the people in those communities, including economic and ethical constraints. Some of those constraints, such as loyalty to loyalty, facilitate the continuation of the relationship, incorporate a constitutive absence, and form a stable system. Those systems include communities of interpretation whose interpreter spirit provides sufficient abstraction for transcendent-level systems to retain, manipulate, and vary the collective memory of the community separate from its interpretation (third-order emergence).

The individual participates in the system through their memory and decision-making, and as the next chapter explains, both of those processes depend upon the human brain.

43 For example, Thomas Aquinas, *Summa Theologica* I.59a3.

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CHAPTER 6

Brain

> But where in my memory do you reside, Lord? Where do you dwell there? What manner of lodging have you framed for yourself? What kind of sanctuary have your built for yourself? You have paid this honor to my memory, to take up abode in it; but I must consider further in what part of it you reside.
> —Augustine, *Confessions* X.25

Introduction

Your brain determines who you think you are. Constrained by genetics and heavily influenced by culture and other environmental factors, the human brain, with its million billion identifiable connections, provides a malleable canvas upon which is painted one's self. Complex biological processes constitute distributed, interconnected systems of cells whose connections change with one's experience. Emerging from the biology, one's mind learns to become human through processes of sensation, memory, emotion, perception, interpretation, categorization, conceptualization, inference, elaboration, planning, decision-making, and action. One becomes conscious and aware of one's autonomy.

We all share the human brain. We each comprise part of what it means to be human. Each person can follow Jesus or Hitler, Buddha or Genghis Khan, Gandhi or Charles Manson. Although we cannot easily change our genetics, physiology, or history, we can change our minds. The decisions each person makes define who that person is, and thus defines what it means to be human, and there is nothing that the rest of humanity can do about it. Human freedom remains central to defining each person and the human species. Philosophers of mind call it free will; Irenaeus calls it "similarity" to God. Each person partially defines the category to which we all belong.

Human mind, culture, and spirituality emerge from the biological processes of the brain. Although one studies the systems of mind, culture, and spirituality using the sciences of their respective psychological, cultural, and transcendent levels, the human brain provides the individual platform upon which those distributed processes are implemented. By overemphasizing human individuality and attachment to self, one often misses the distributed processing of the brain and the integrated functioning of societies and spiritual forms. An understanding of the brain helps one relate the higher-level systems to contemporary science.

Although earlier modern theories of the mind and brain postulated that a person has an essential self and that the mind reasons in an abstract way, contemporary cognitive and neuroscientific investigations have accumulated significant evidence that a person's mind (and natural characteristics of the "soul") are embodied in the brain. Especially since the beginning of the National Institutes of Health's (NIH)

Decade of the Brain in the 1990s, advances in experimental techniques have enabled cognitive neuroscience to accumulate and integrate biological bases for constructs of thought that previously were examined only in the humanities including language, cognition, motivation, moral decision-making, aesthetics, spiritual experiences, and the imagination.

How does the brain embody psychological processes, such as perception, emotion, memory, learning, and decision-making? Before exploring the biological bases of those psychological-level activities, we must first examine some general findings of scientists who study the brain.

Brain Science

The physical and biological relationships that form the human mind connect together in the brain. Not only do the systems involved in sensation, action, and autonomic functions, such as breathing and circulation, depend upon brain structures, but the brain itself has a relational structure that appears well-suited to respond and adapt to the relational structure of nature. The variety of relational structures that neuroscientists have named—some of which are briefly introduced in this section—describe systems that constitute psychological, cultural, and transcendent-level systems.[1]

Although the variety of terms may confuse or overwhelm the reader not previously exposed to neuroscience, the key point is that the brain consists of complex relationships ranging in scale from individual atoms to the entire brain and provides a platform for learning, remembering, and deciding who one becomes as a human person.

Human Cognitive Neuroscience

Prior to 1990, psychology, medical lesion studies, animal experiments, cell cytology, and other areas provided perspectives on the brain, but no one understood the details of how the brain works. Beginning in the 1990s with improved neural imaging, advances in molecular genetics, the Human Genome Project, and the NIH Decade of the Brain research initiative, progress in the study of the brain in neurobiology and genetics began providing a detailed, biological framework that could contribute more precise models to cognitive neuroscience. It finally became possible to develop integrated scientific models of mental activity and behavior that were grounded in the genetics, chemistry, and molecular biology of the brain.

A sub-field of neuroscience, called cognitive neuroscience, arose in the 1970s to focus on the mental aspects of neuroscience. Cognitive neuroscience draws upon neurology, biological and cognitive psychology, computer science and artificial

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1 I use systems in the general sense of Chapter 2, though neuroscientists typically use "systems" only to refer to the "larger" systems responsible for basic psychological-level functions, such as sensation and motor function, and molecular biologists typically use "systems" to refer to the "smaller" systems of intracellular interactions often involving proteins, genes, and metabolic pathways.

intelligence, and the other sub-fields of neuroscience that study the mechanisms of the nervous system, such as neuroanatomy, neurophysiology, and neurobiology. Cognitive neuroscience bridges the border between biological and psychological-level systems in the brain (Chapter 3).

Researchers have examined several aspects of cognition. Antonio Damasio at the University of Iowa has developed an integrated framework of emotions. Joseph LeDoux at New York University has focused on the neuroscientific foundations of fear. Jerry Feldman and his colleagues at the University of California at Berkeley have developed a neural and computational model of language. Many scholars examine the neural correlates of consciousness and have made speculative proposals. Other researchers investigate integrated frameworks in other areas related to theology and ethics. Newberg and D'Aquili have examined the brains of meditating Buddhist monks and Franciscan nuns to understand what happens in the brain during meditation, and the Dalai Lama has encouraged Tibetan Buddhists to cooperate with neuroscience researchers at MIT. Nancey Murphy and Warren Brown have begun investigating neuroscientific foundations of ethical reasoning.[2]

Prior to the recent explosion in scientific understanding of the brain, the lack of detailed understanding of how the brain worked limited conversation between neuroscience and religion. Religion could dialogue with other disciplines of cognitive science, such as psychology, philosophy, linguistics, and social science, but dialogue between religion and neuroscience and between religion and artificial intelligence was limited to philosophical interpretations of human nature drawing indirectly upon results from those two fields. Now, dialogue about human nature can be more direct as the scientific models become more detailed, and in addition, the connections between the biology of the brain and cognition allow a deeper level of dialogue approaching what Ian Barbour calls integration about human religious experience and ethical decision-making.

For example, neurologists and neuropsychologists have known for years based on medical lesion studies and animal experiments that a part of the human brain, called the *prefrontal cortex*, is required for *executive control* of tasks that require the integration of information over time. These include planning and goal-oriented behavior. Now neuroscientists understand how the sub-regions of the prefrontal cortex interact with each other and other regions of the brain to perform tasks. Previously, neuroscience could only confirm that people make plans by providing evidence of a location in the brain where planning occurs. Cognitive neuroscience

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2 Antonio R. Damasio, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (New York: Harcourt Brace, 1999); Jerome A. Feldman, *From Molecule to Metaphor: A Neural Theory of Language* (Cambridge, MA: MIT Press, 2006); Michael S. Gazzaniga, *The Ethical Brain* (New York: Dana Press, 2005); Anne Harrington and Arthur Zajonc, *The Dalai Lama at MIT* (Cambridge, MA: Harvard University Press, 2006); Joseph E. LeDoux, *The Emotional Brain: The Mysterious Underpinnings of Emotional Life* (New York: Simon & Schuster, 1996); Nancey C. Murphy and Warren S. Brown, *Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility* (Oxford: Oxford University Press, 2007); Andrew B. Newberg, Eusene G. D'Aquili, and Vince Rause, *Why God Won't Go Away: Brain Science and the Biology of Belief* (New York: Ballantine Books, 2001).

can now begin providing models and processes of *how* people make plans. Most if not all theological and ethical theories have presumed that people make plans—though with much debate about free will and determinism—now neuroscience can begin explaining how people plan and make choices, which provides specific boundary conditions for scientifically plausible theological and ethical theories about human planning, such as discernment and moral decision-making.

Neurobiology

Biologically, genetics and early brain development provide a basic structure of cells in the brain, called *neurons*, which interconnect with each other and respond to stimulation by stimulating other neurons. Some neurons are stimulated by sensory inputs and others elicit a response by stimulating motor activity. Neurons connect to each other through very small gaps between them, called *synapses*. Thus, these synapses and the pattern of stimulation (or *activation*) between neurons significantly determine the cognitive and behavioral aspects of the human person.

The brain consists of billions of neurons, each of which connects to on average 10,000 other neurons. Each neuron has an output fiber called an *axon*, and thousands of input fibers called *dendrites*. The dendrites typically spread out like tree branches to receive input from the axon of other neurons. In a typical function, the neuron receives input from other neurons and if the input levels pass a threshold, the neuron fires, in a process called *neuronal activation*. Similar to a simple electronic counter, the neuron adds up the inputs and if inputs reach a certain threshold, it fires, passing a signal to downstream neurons, that is, *exciting* a downstream neuron. On the other hand, if the threshold is not reached, the neuron does not fire. As the neuron has only one axon, either all downstream neurons are signaled or none are. More complex functions also occur (as some neurons *inhibit* (or "subtract" from) the electrochemical processing of downstream neurons, and different molecules have various electrical charge); however, as a general rule, all neurons have many inputs, one output, and a threshold. Although most neuron cell bodies remain in the brain, the axons of neurons in the motor cortex, for example, extend down the spine to muscles throughout the body.

The axon of one neuron and dendrites of another neuron connect at a *synapse*. In the language of emergent systems, a synapse provides a constitutive absence by which the neurons communicate. The communication involves chemicals flowing across the gap from the axon of one neuron to the dendritic input of another neuron. Some of the chemicals, such as potassium, sodium, and calcium ions, are positively charged, and when received by the downstream neuron's dendrite, may trigger that neuron to fire depending upon its own threshold requirements. Other ions, such as chloride, have a negative charge and can inhibit, or reduce, the likelihood that the downstream neuron will fire. In addition to electrical transmission through ions, other chemicals, called *neurotransmitters*, may modulate and control the electrical firing.

The transmission of ions and neurotransmitters across the synapse from one neuron to another depends upon the selective permeability of the cell membranes. The cell membrane allows certain chemicals to flow either in or out of the cell more easily than others. Some "transmembrane" protein complexes open to allow chemicals to flow and others use energy to pump chemicals against the direction of their natural flow. Neurotransmitters control the downstream neuron by modulating its "gates" and "pumps." Neurotransmitters are synthesized and stored in the upstream or *presynaptic* neuron and are released when it fires. The downstream or *postsynaptic* neuron contains receptors for that chemical and responds in some way when it receives that neurotransmitter. After the firing, the neurotransmitter is typically degraded or transported back to the upstream neuron for reuse.

Neuroscientists have discovered over 100 neurotransmitters that modulate activity including glutamate, which typically causes the downstream neuron to fire, and GABA, which usually inhibits the postsynaptic neuron. The neurotransmitter serotonin causes a sense of well-being in most cases, and many anti-depressive pharmaceuticals operate by inhibiting the reuptake of serotonin; that is, rather than increase the amount of serotonin the person has, which is difficult to implement, the pharmaceutical delays the "reuptake" or transport back into the presynaptic neuron to extend the time that serotonin affects the postsynaptic neuron.

An important, but subtle, point in understanding the activity of neurotransmitters is that the function of the neurotransmitter is determined by the postsynaptic, or downstream, neuron. Some neurotransmitters, such as dopamine, can have opposite effects depending upon the location in the brain of the postsynaptic neuron. The postsynaptic neuron determines the effect of a neurotransmitter at the postsynaptic receptor. Thus one cannot accurately describe neuron activity as mechanistic, that is, using the language of efficient causation, because the source of the cause is irrelevant, the effect depends upon context, and physical-level theories of causation do not apply (Chapter 3). Serotonin has the same physical and biological effect on a neuron regardless of whether it came from a presynaptic neuron, was delayed in its reuptake, was delivered by a new pharmaceutical, or was placed on the neuron by an experimenter who removed the neuron from the brain. The effect of a neurotransmitter emerges from the interaction in the system of the neurotransmitter, receptor and postsynaptic neuron.

The billions of neurons each connect to an average 10,000 neurons, but some neurons connect more densely with each other in patterns called *neural networks*. Some functions, such as the representation of concepts, depend upon a collection of neurons that are highly interconnected and distribute their other connections to various parts of the brain. As a concrete example, consider a simple network of a hundred highly interconnected neurons where each neuron requires the firing of 25 presynaptic neurons for it to pass the threshold and trigger activation. Once other regions of the brain activate 25 neurons in the network, then the remainder of the 100 neurons in the network will quickly activate based upon their connection to the 25 neurons and to each other. The 75 recently activated neurons may then trigger networks in other brain regions. Note that because only 1 per cent of the connections of the neurons participate in a network, each neuron may participate in several networks.[3]

3 For a mathematical analysis, see Leslie G. Valiant, "A Quantitative Theory of Neural Computation," *Biological Cybernetics* 95(3) (2006): 205–211.

Neuroanatomy

Neuroanatomy, another sub-discipline of neuroscience, studies the anatomy or structure of the nervous system. Although somewhat dry reading as a summary description, the anatomy of the brain provides a structure in which to organize subsequent descriptions. Before examining the anatomical structure of the human brain, six geographical dimensions will help one navigate the three-dimensional space in which the human brain fits. From the perspective of one's brain, the *anterior* direction is toward the front and the *posterior* direction is toward the rear. One can associate "posterior" with rear. Toward the top of the skull is the *dorsal* direction and toward the bottom is the *ventral* direction. One can picture the dorsal fin of a fish on the top of its body. Going from side to side, the *medial* direction occurs in the middle, for example, between one's ears, and the *lateral* direction would be toward either side. Neuroscientists use a variety of additional terms and the meaning of some terms vary whether one refers to just the brain or the entire nervous system including one's spine, but these six terms will suffice for a basic overview of the human brain.

The brain's distributed processing organizes into large regions of the human brain. Two major regions important for cognitive science and religion are the *cerebral cortex*—the wrinkly outermost surface of the brain significant in perception, integration, recognition, and decision-making, and the *limbic structures*—significant in emotional processing, memory, and learning. Although other regions assist in important ways in these distributed functions, the interactions within the limbic structures and cerebral cortex have sufficient complexity to describe the biological foundations of emergent behaviors.

The cerebral cortex consists of two symmetrical hemispheres—each a large sheet of (mostly) layered neurons that form the outermost structure of the human brain. From Latin "*cortex*" meaning "bark," and like the bark of a tree the human cortex contains many bumps and dips. The cortex folds in on itself to squeeze a surface area about the size of a sheet of a newspaper (2200–2400cm^2) into the skull. The hemispheres complement each other performing similar functions, but the right hemisphere appears to emphasize the accuracy of experience (and thus perhaps its emotional depth) and the left hemisphere tends to elaborate and interpret the events (and thus appears slightly more analytical). However, the differences are only slight in comparison to their similarities. Each hemisphere has four main divisions or lobes demarcated by the deepest valleys in the folds of the cortex. The *occipital lobe* in the back of one's head, or posterior, performs vision processing. The *parietal lobe*, dorsally toward the top of the head, though still toward the back, associates different forms of data, such as sense data, internal representations, or actions. The parietal lobe also performs spatial processing and represents "where" something occurs especially with respect to "how" one would use it. The *temporal lobe* sits behind one's temple and processes "what" an object is. It also appears important in auditory processing and memory. The *frontal lobe* sits in the front of the skull above the eyes, the anterior part of the cortex, and performs processing associated with motor activity, planning, and decision-making. The prefrontal cortex mentioned earlier as required for executive control consists of the frontmost part of the frontal lobe. Parts of the frontal lobe also connect to limbic structures and coordinate emotional, memory and attentional processing. The processing in the four lobes of the cerebral cortex performs functions typically ascribed to the human mind, though very dependent upon the limbic structures.

The several limbic structures form a border (Latin *limbus*) around the central brain stem and are phylogenetically older, that is, are presumed to have evolved earlier, than the surrounding cortex. The *amygdala* is an almond-shaped collection of neurons implicated in fear and emotional learning. It plays a central role in detecting aversive emotional cues and appears activated in phobias and racial evaluation. The *hippocampus* sits directly behind (i.e., posterior to) the amygdala, and plays an important role in memory. Several regions of the brain connect with the hippocampus, and memories that require relational binding across regions such as sight, sound, and touch, use the hippocampus to form those connections. The *cingulate cortex* wraps around the "corpus callosum" that connects the two brain hemispheres together, and the cingulate cortex appears to help provide an interface between emotion and cognition such as emotional self-control. The front or *anterior cingulate cortex* connects to cognitive and affective areas, such as the frontal lobe of the cerebral cortex, and the rear or posterior cingulate cortex appears involved in the evaluation of emotional information and the integration with memory of events or "episodic memory." In particular, the anterior cingulate cortex appears involved in managing the allocation of resources to different brain regions depending upon situational cues and includes activities traditionally ascribed to the human will.

Cognitive Function

Human cognitive functions include attention (the ability to select among active stimuli), learning, memory, language, executive function, and subjective awareness (or consciousness). Cognitive neuroscience focuses on these and other mental aspects of neuroscience rather than perception or motor activity. Although all impact upon a person's ability to participate in cultural and spiritual systems, this chapter will focus on learning, memory, and decision-making as an aspect of executive function.

Given the emphasis on language earlier in the book, one might expect this chapter to describe language processing in the brain. Neuroscientists have distinguished between systems in the brain that understand language and those that produce language. When understood, a spoken or written word activates word forms that activate syntactic and semantic properties and their conceptual relationships. When produced, a related but separate system encodes and articulates the conceptual representation. For both understanding and production, the conceptual representation of language depends upon semantic memory (described in the next section). However, no one yet understands the neural correlates for the abstraction of symbolic language in "semantic reference" that is important for emergence of the cultural level and related to intentionality (or "aboutness").[4]

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4 Michael S. Gazzaniga, Richard B. Ivry, and G.R. Mangun, *Cognitive Neuroscience: The Biology of the Mind* (New York: Norton, 2nd edn, 2002), ch. 9; W. Tecumseh Fitch,

Consciousness is another cognitive function not addressed in this book, but which draws much discussion in philosophy of mind. Consciousness refers to the subjective awareness of an individual that as a person (a subject) he or she is the one aware of some particular experience. Consciousness plays a central role (if not the central role) in a Western individual's awareness of self in an individualistic culture and experience of the external world—to the extent that Descartes believed that "I" was beyond doubt—in fact (Chapter 1), the only thing beyond doubt. Scientists, scholars, and others have developed many theories of what the neural correlates of consciousness might be, though others hold the position, labeled mysterians, that consciousness remains beyond a person's ability to comprehend. From a systems perspective, consciousness might refer to an awareness of emergent cybernetic mechanisms that organize thought for certain linearizing systems, such as working memory, or a self concept relating to autobiographical memory, but in those cases consciousness would play only a very minor role in the overall functioning of human systems.[5]

Evolutionary psychologists and others describe mental "modules" of cognitive function, but that is an incorrect interpretation.[6] At the physical level, the neurons organize into cell types and regions of the brain. At the biological level, neurological functions depend upon organized biological structures, some of which are genetically determined, such as the location of the retinal nerve and vision processing, and others which depend upon the neurons that happened to be active or available when learning or other environmental change occurred. For example, the area of the brain responsible for generating speech is physically adjacent to the region responsible for hand movement, not the language area responsible for understanding speech. At the psychological level, mental functions can be characterized as systems, but those systems map in complex, flexible, "plastic" ways to the systems of the biological and physical level, not the direct one-to-one mappings proposed by evolutionary psychologists and others. By examining the systems at distinct levels, one can develop more accurate models of cognition and its biological basis.

The remainder of the chapter examines the functioning of the brain in perception, memory and learning, and human decision-making, which build upon each other to specify a neuroscientifically plausible model of spiritual development.

"The Evolution of Language," in *The Cognitive Neurosciences* (ed. Michael S. Gazzaniga; Cambridge, MA: MIT Press, 2004), pp. 837–45.

5 R.L. Gregory, *The Oxford Companion to the Mind* (Oxford and New York: Oxford University Press, 2nd edn, 2004), pp. 204–218; David J. Chalmers, "What Is a Neural Correlate of Consciousness?" in *Neural Correlates of Consciousness: Empirical and Conceptual Questions* (ed. Thomas Metzinger; Cambridge, MA: MIT Press, 2000), pp. 17–40; Colin McGinn, *The Problem of Consciousness: Essays Towards a Resolution* (Oxford, UK and Cambridge, MA: B. Blackwell, 1991).

6 Merlin Donald, *A Mind So Rare: The Evolution of Human Consciousness* (New York: Norton, 2001); Paul R. Ehrlich, *Human Natures: Genes, Cultures, and the Human Prospect* (Washington, DC: Island Press for Shearwater Books, 2000).

Perception

When one sees something on the ground, sensation and perception occur in the brain. Light reflects off the object and strikes the rods and cones in the retina of the eye. These rods and cones serve as receptors for the visual cues and trigger action potentials in neurons whose axons form the optic nerve. Most of the signal routes to the visual cortex in the posterior ("rear") of the brain. From there, preliminary feature extraction occurs, and the signals route along two primary pathways. The dorsal stream ("over the top") provides spatial orientation or "where" the object occurs using coordinate systems based on both orientation to the body and to the world, especially with respect to function and "how" the person would respond to the object. The ventral stream ("down under") determines "what" the object is. An observation, or memory, that "the stick is on the ground in front of me" requires several different parts of the brain, as the processing and representation of an object and its location occur in distinct cortical regions, such as the parietal lobe for "where" and the temporal lobe for "what." Memory uses the same mode-specific processing areas, such as color and shape, as perception does.

When the neuronal activation spreads to provide a representation for the semantic, or conceptual, memory of a stick lying on the ground in front of a person, some experimental evidence suggests it takes 350–500ms after initial sensation for the person to become consciously aware of the object. As the processing of a person's awareness of time takes place in yet another region of the brain, the perceived time of the event, like the other modes of perception, becomes properly coordinated in the episodic, or event, memory of seeing the stick on the ground. But that processing of time perception also takes brain processing time. Significantly, most processing of what one perceives and remembers occurs prior to one becoming conscious of it.[7]

However, if the object being perceived holds some danger to the person, an additional, simpler visual pathway becomes active. Some of the axons in the optic nerve trigger processing in the visual "thalamus" (a phylogenetically older part of the brain that routes sensory and motor interaction) rather than being routed to the visual cortex. The visual thalamus projects to the amygdala, which provides an important role in emotional processing with emotionally laden stimuli. The amygdala prepares the body and brain by triggering physiological changes, such as dilated pupils, increased heart rate, and open breathing passages, in a "fight or flight" encounter. The amygdala also triggers the inhibition of extraneous processing to enable more efficient processing of the primary visual pathways. In the couple of hundred milliseconds it takes for the visual processing to propagate through the visual cortex and the dorsal "what" stream, crude processing has occurred in the thalamus, and the amygdala has already prepared the body for action. If the person sees a snake, the body is prepared to respond, but if instead the body has prepared a "fight or flight" response towards a garden hose or twig, the person can ignore the stimulus. Again all this processing typically takes place prior to conscious awareness, as one may have noticed if one has become startled because of a misperception.

7 Benjamin Libet, *Mind Time: The Temporal Factor in Consciousness* (Perspectives in Cognitive Neuroscience; Cambridge, MA: Harvard University Press, 2004).

Strong emotions or stress limit ones ability to focus on mental constructs not directly related to the current selection of attention. This serves as an important defense and survival mechanism; for example, to ensure an animal attends to the sound of a broken twig, which it associates with a predator, rather than its current activity, such as foraging. Because the brain operates in a distributed fashion, different parts of the brain can indicate different actions. One part can suggest continuing to eat and another part can indicate a danger. Another limbic structure, the anterior cingulate cortex, resolves those conflicts.

The anterior cingulate cortex inhibits activity associated with one activity to provide additional resources to another activity. The same region helps one focus attention to a particular person's voice when conversing in a noisy or distracting setting. It provides the brain structures underlying the psychological ability to choose. Other parts of the brain (in the prefrontal cortex) help one reason and decide what to do.

Memory and Learning

Memory uses the same mode-specific areas and neural structure as perception does. When one remembers or imagines the color red, many of the same networks activate as when one sees the color red. Human memory does not store memories as a video recording might. Rather memory consists of separate line drawings and color swatches, audio tape, texture samples, stored taste and smell, a clock for time, programs for motor coordination, maps for spatial orientation, and a series of association areas that combine those mental modes. The neural connections that combine the different modes become permanent as memory forms.

Learning, as a psychological-level function, occurs throughout the areas of the brain, but with a similar biological process. Motor learning occurs in motor regions (where nerves to muscles in the body originate); spatial learning occurs in the parietal lobe where most spatial processing occurs. Memory appears to be a specific type of learning where connections between neural networks of concepts and events become permanent. Neuroscientists have identified the biological process called long-term potentiation that appears responsible for learning and memory.

Memory

Psychologists typically divide memory into three stages: working memory, short-term memory, and long-term memory.[8] Long-term memory consists of "explicit" memories, such as events and facts, and "implicit" (non-declarative) memories, such as motor skills, perceptual representations, conditioning, and habituation. Long-term memory can last a lifetime. Short-term memory retains information for a few seconds to a few minutes. Working memory represents a person's limited capacity to retain information as part of short-term memory and perform operations on that information. Typically, when a person has a sense perception, that perception is

8 Gazzaniga, Ivry, and Mangun, *Cognitive Neuroscience*, ch. 8.

retained by short-term memory. Some limited aspects of the short-term memory are available to working memory for additional mental operations. For example, a person can typically remember and repeat only about seven numbers without rehearsing them or using some previously learned pattern (a fact discovered by George Miller at the Bell Telephone Company research center in the 1950s.)

Explicit long-term memory consists of *episodic* (or event) memory and *semantic* (or fact) memory. Historical events, events in one's life, and generalized scripts of how one shops, visits the doctor, eats at a restaurant, and so on, form episodic memory. Concepts, locations of things, phone numbers, geography, and so on, constitute semantic memory. A subtype of episodic memory associated with one's self-concept forms "autobiographical memory."

Psychologists distinguish working, short-term, long-term, semantic, and episodic memory as separate cognitive functions based in part on the study of patients with dysfunctional memory, such as amnesia. People with amnesia have functioning working memory, but have difficulty retrieving or creating long-term memories of events. Their semantic memory also appears unaffected, at least in some cases. Popular novels and movies often include characters with amnesia, so the disorder may be familiar, and two main kinds of amnesia occur in humans. In *retrograde amnesia*, people have difficulty recalling events prior to the onset of amnesia. Popular movies that incorporate main characters with this type of amnesia include *Bourne Identity* (2002) or *The Long Kiss Goodnight* (1996). In *anterograde amnesia*, people have difficulty forming new long-term memories, though the older memories remain intact. Medically, anterograde amnesia occurs more frequently than retrograde amnesia, and movie characters with this type of amnesia include the main character of *Memento* (2000), Drew Barrymore's character in *50 First Dates* (2004), or Dori in *Finding Nemo* (2003).

Long-term memory also utilizes perceptual, spatial, and affective areas of the brain. Parts of the brain (hippocampus and other medial temporal areas) coordinate the consolidation of memories by strengthening connections between sense-modality-specific, affective, and spatial-orienting areas—storing the memories in a distributed manner, for example, connections between occipital lobe, amygdale, and parietal lobe respectively. During retrieval those distributed memories become activated as do areas of the brain associated with the executive functions of coordinating goal-directed behavior and working memory (in the dorsolateral prefrontal cortex).

The connections made in the hippocampus and other areas provide memory with its permanence. Although structural changes to neurons make a rich (episodic) memory of a significant event permanent, the sensory, motor, spatial, and other processing a memory activates when retrieved do not particularly differ between perceived, remembered, and imagined activations.

The same biological process of long-term potentiation appears essential for both learning and memory. The persistence of connections formed in the hippocampus and other association areas that form explicit memories are learned through the same reinforcement mechanism of neural connections that operates when one learns to ride a bike or learns a new language.

Neuroscientists have discovered that short-term and long-term memories describe biological processes occurring in neurons that may be distributed across regions of the brain. (No one knows how working memory works yet, though it also appears distributed with the prefrontal cortex controlling interference by inhibiting region-specific processing of external distraction.[9]) Short-term memory occurs from functional changes in the synapses, and long-term memory occurs from structural changes in the synapses.[10] Unlike sensory and motor processes that one can loosely associate with regions of the brain, learning appears to occur within potentially every neural network, and thus in every region of the brain. Fascinating, though somewhat complex, biological processes integrate the functional and structural changes that implement psychological-level short- and long-term memories as well as the ability of the organism to adapt to its environment.

Long-term Potentiation

In *long-term potentiation*, learning occurs by strengthening, that is, making more potent, the synaptic connections between neurons. Neuroscientists consider long-term potentiation as a process by which short-term memory becomes permanent.[11] In more personal or philosophical terms, this biological process describes the way that one's experience becomes a permanent part of one's self. When neurons signal each other, additional biochemical processes prepare the connection so that neurons that fire at the same time have their connections reinforced, or as neuroscientists say it, "neurons that fire together wire together."[12]

In the process of long-term potentiation, neurons that accidentally fire together in novel sensation, integrations, or behavior will strengthen their connections to each other and more likely trigger the other in subsequent situations that previously would have only triggered one of the neurons. "Long-term depression" (not related at all to the psychological condition) causes unused connections to slowly dissipate. Long-term potentiation and depression implement the cellular basis for learning and memory. These biological processes depend upon atoms and larger molecules, including genes and protein complexes, that implement the psychological-level process of learning and memory. The precise molecular details will not matter in subsequent parts of the book, but the fact that they exist connects all six levels of human existence.

The process begins when glutamate, a neurotransmitter, released by a presynaptic neuron crosses the synaptic cleft and binds receptors on a postsynaptic neuron. Glutamate binds both ionotropic receptors (which directly open a gated ion channel) and metabotropic receptors (which indirectly open an ion channel). Recall from above that opening an ion channel changes the likelihood that the neuron will fire,

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9 B.R. Postle, "Working Memory as an Emergent Property of the Mind and Brain," *Neuroscience* 139(1) (2006): 23–38.

10 Eric R. Kandel, *In Search of Memory: The Emergence of a New Science of Mind* (New York: W.W. Norton & Company, 2006), chs 16, 20.

11 To simplify the description of the complex process of long-term potentiation as much as possible, I will ignore other processes of synaptic plasticity that also impact upon learning.

12 Gazzaniga, Ivry, and Mangun, *Cognitive Neuroscience*, pp. 346–8.

and thus glutamate indirectly acts to excite the neuron. Both metabotropic and ionotropic receptors play significant roles in learning and memory. I will first cover the metabotropic process that primarily implements short-term memory, and then cover the ionotropic process that primarily implements long-term memory.

When glutamate binds a metabotropic receptor on a neuron at a synaptic cleft, it activates an enzyme called adenylyl cyclase which makes the molecule cyclic AMP for several minutes inside the neuron. Short-term memory depends upon the presence of the molecule cyclic AMP. Cyclic AMP then binds to several proteins that trigger molecular responses throughout the cell. (Because glutamate triggers the production of a *second* chemical, cyclic AMP, which then triggers subsequent activity, cyclic AMP is known as a "second messenger.") Cyclic AMP activates an enzyme (protein kinase A) that regulates other proteins by adding phosphate molecules to them, and it releases more glutamate to continue excitation. Another protein that cyclic AMP activates (through its binding to a protein kinase A) is called CREB (cyclic AMP response element binding protein) which helps implement long-term memory by signaling the transcription of certain genes to synthesize proteins to form additional synaptic buds and strengthen the synaptic connection. Typically, the neuron must activate multiple times to generate enough cyclic AMP to begin the protein synthesis necessary for long-term memory.

When the glutamate binds to an ionotropic receptor, specifically the NMDA receptor, positive calcium ions flow into the neuron. The calcium acts as a second messenger (like cyclic AMP) to trigger the molecular processes of long-term potentiation, by triggering another enzyme (protein kinase C) that then activates protein kinase A in the metabotropic process.

When CREB becomes activated, through either process, it promotes transcription of several specific genes by binding to regions of DNA (called CRE for "cyclic AMP response element") that occur on a strand of DNA immediately prior to the genes needed to build dendritic buds.

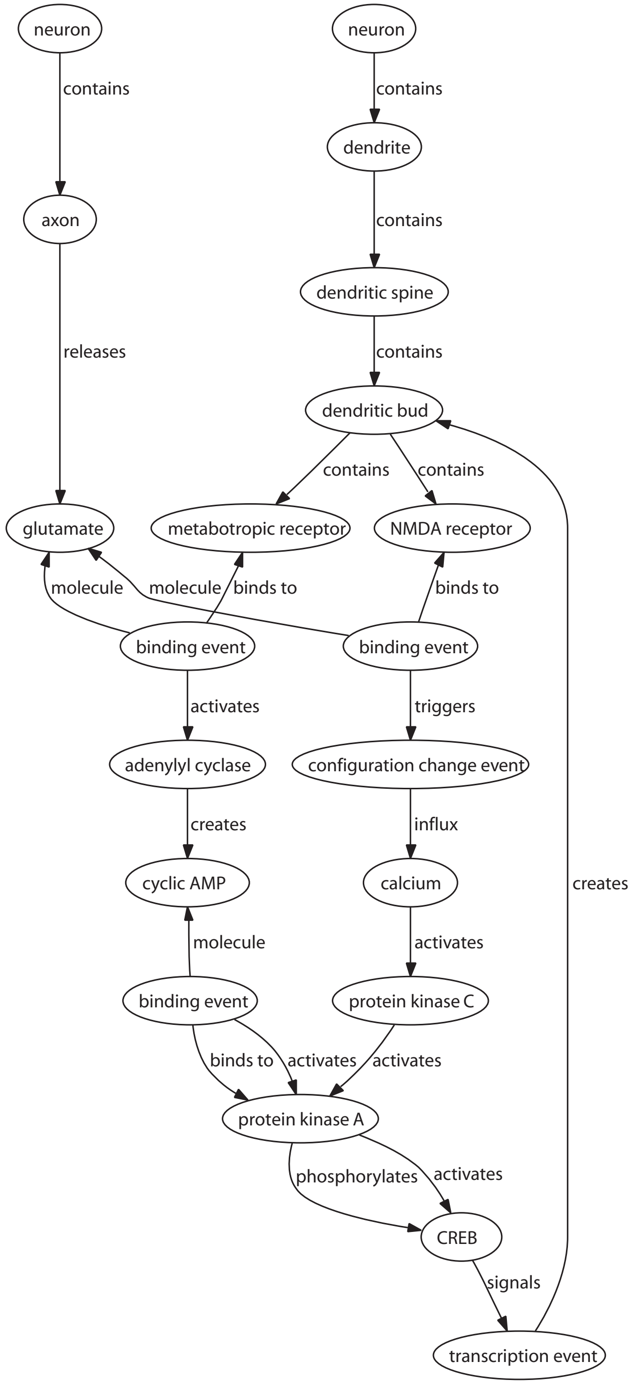

Figure 6.1 Graph of long-term potentiation processes

Figure 6.1 shows the processing of cyclic AMP and calcium flow through the NMDA receptor in the neuron. A neuron releases glutamate from its axon that binds to both a metabotropic receptor and an NMDA receptor (both of which are contained in another neuron's dendritic bud). The metabotropic binding event activates adenylyl cyclase that creates cyclic AMP which binds to and activates protein kinase A. In parallel, the NMDA receptor binding event triggers a configuration change event (of NMDA receptor) that allows an influx of calcium (into the neuron), which activates protein kinase C, which then activates protein kinase A. Protein kinase A phosphorylates and activates CREB that signals a gene transcription event creating new dendritic buds (that contain the same receptors).

The same molecular processes that implement neuron activation also trigger the functional change of the sustained activation over a few minutes in the generation of cyclic AMP and trigger the structural changes to the neurons and synapses through CREB signaling cascade and NMDA receptor activation. Those biological processes of sustained activation over a few seconds to minutes and the structural changes implement the psychological functions of short-term and long-term memory, respectively. Because the initial neuron activation triggers the functional and structural changes, the processes of short and long-term memory happen intrinsic to the cellular processing, not in separate brain structures.

Consider the psychological-level effects of the biological process underlying short-term memory. Because adenylyl cyclase makes cyclic AMP that releases glutamate which induces excitation, the activated neurons will remain excited for several minutes. As the network of activated neurons represents some aspect of the sensory or recollection event which triggered those neurons, the heightened activation putatively underlies short-term memory. In terms of constraints (Chapter 2), an activated neuron constrain the networks in which it participates to be at least partially activated. Several activated neurons in a network—through their additional connections—constrain the network to completely activate (at least in some platform of firing). Heightened activation also appears one of many aspects of consciousness (subjective awareness), thus a network could be inactive, partially activated but not conscious, or sufficiently activated for consciousness. Whether thoughts fading from awareness become permanent in long-term memory or disappear completely depend upon the levels of glutamate, activity of adenylyl cyclase and presence of cyclic AMP. One cannot reduce human memory to those constructs, as memory also depends upon their context in the neuron, neural network, area of the brain, and so on, but human memory does not exist separate from them either. When one concentrates on a task or meditates for long enough to minimize distraction or "enter the flow," likely the neural networks not relevant for the current task have become quiescent with reduced glutamate levels, adenylyl cyclase activity, cyclic AMP presence, and calcium flow.

In the biological process underlying long-term memory, the flow of calcium through the NMDA receptor and its activation by glutamate activate structural changes in the neuron that cause the synapse to strengthen, slightly change the network activation pattern, and result in the "memory" persisting. The delay in creating structural changes and cellular processes returning to quiescence may result in limitations of psychological-level learning. It takes time to learn something and then use what one learns to learn more. Biologically, one may locate that aspect of how a person acquires meaning or embodies the decisions they make in the time delay across signaling pathways, genetic transcription, translation, and transport. If those processes of long-term potentiation occurred over a period of seconds rather than minutes, human memory, culture, and education would likely function very differently.

In terms of orders of emergence (Chapter 4), learning is a third-order phenomenon emerging from the pattern of long-term potentiation across the neural network. Neurons have a selectively permeable cell membrane that distinguishes the interior from the exterior—a second-order system. The membrane separates the primarily positively charged ions on the outside of the cell from the primarily negatively charged ions on the inside of the cell. The relative difference in charge of all the ions results in a voltage differential—a first-order quality that emerges from activities of the second-order cell membrane. The neurons connect together through synapses into networks that propagate the action potential. The experience one learns (at the psychological level) selects from the possible configurations of neural networks, and that selection and persistence of the second-order systems (selectively permeable cell membranes at the possible synapses) results in the emergent system of learning.

Out of the myriad potential connections between neurons, something happened in one's experience to activate the particular (perhaps novel) network of neurons. If those connections persist because of heightened emotional significance or repetition, then subsequent activation of that network will recall the initial event, through activation of the connected sensory, motor, spatial, emotional, and other area neurons. Those "remembered" connections will then reconsolidate strengthening connections with similarly represented memories.

The biological-level process of long-term potentiation underlies the psychological-level functioning of memory and learning. Memory provides concepts for one to perceive and categorize one's environment and to remember one's identity. Memory not only plays a central role in defining the individual at the psychological level, it also plays a central role in defining the individual's role in society and culture.

Social and Transcendent Memory

Memory provides the conceptual knowledge that permits one to categorize experience, regardless of whether one categorizes that experience as natural, religious, or mystical. For a group of individuals, they may also share what the French philosopher and pioneering sociologist Maurice Halbwachs called a "religious collective memory."[13] In contemporary work, the cognitive sociologist Eviatar Zerubavel expands upon Halbwachs' work to identify *thought communities*—groups of people who perceive, remember, and think in a way that is distinctively different from the ways other groups do.[14] However, the thought community, and its religious collective memory,

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13 Maurice Halbwachs and Lewis A. Coser, *On Collective Memory* (The Heritage of Sociology; Chicago: University of Chicago Press, 1992 [1925]).

14 Eviatar Zerubavel, *Social Mindscapes: An Invitation to Cognitive Sociology* (Cambridge, MA: Harvard University Press, 1997).

still consists of human individuals with particular memories and experiences. It is through the individual minds that the shared community takes form. As described in the previous chapter, Josiah Royce in his *Problem of Christianity* describes a community as a group with a will to interpret a shared founding event that interprets itself as the individuals interpret each other. For Royce, the ideal goal of the community becomes the shared interpretation of each other in the context of the founding event.

Memory has a social character. The percepts, categorization, and concepts used to store and organize individual memories derive from shared biological functions across the species, socially constructed language, and cultural norms. As just described, the distributed human memory persists as neural connections in the hippocampus that connect to other neural networks in the modal-specific processing and association areas. Although Western individualism suggests encapsulating the individual brain as isolated from other organisms, each person's hippocampus has greater similarity to a different person's hippocampus than it does to the first person's perception and other functional brain areas. Communication within an individual's aggregated brain often occurs more quickly than across brains, which require verbal and nonverbal communication, but that is not always the case, as in brain damage, psychological intervention, or Socratic instruction. In many, though obviously not all respects, one may view the neural associations formed in the hippocampus of an individual's distributed memory as connecting to shared social memories across "larger synaptic clefts" from one individual's motor cortex to another individual's sensory neurons. Rather than direct biological activation through neurotransmitters and ion flow, social interaction occurs through behavior and sensation, and in the case of language, cultural systems can emerge. Although antithetical to American individualism and a challenge to traditional philosophical constructs of self, other cultures would find that interrelatedness and solidarity as confirming their presumed cultural norms.

Just as the glutamate levels, cyclic AMP presence, and calcium flow strengthen connections between neurons in a network crossing multiple brain areas, they also strengthen connections between events, concepts, and language shared across individual brains. Cultural memory is as real as individual memory and may persist for longer.

The pattern of synaptic connections in the individual's brain helps determine the cultural meaning of significant events through the process of interpretation. That processing occurs in the cortical and limbic structures of the individuals involved in both the interpretation and the events being interpreted. When those events participate in transcendent-level systems, such as interpreting the faith of Abraham, then the changes in synaptic structure implement not only individual long-term memory, but also implement cultural and transcendent memories as well.

Individual human memory remains important to eschatological (or "end times") beliefs. "Who am I to live a resurrected life if, as a retrograde amnesiac, I cannot recall any events prior to my death, or as an anterograde amnesiac, I cannot recall any new events after my death?" The contemporary, scientifically trained, theologian John Polkinghorne describes human eschatological existence as information-bearing patterns of the souls held in the mind of God.[15] Although this book does not address eschatological aspects of the soul, the natural soul characterized here appears compatible with Polkinghorne's view. As the borrowed concept of the Greek *logos*, meaning reason or the Word, has proven both fruitful and limiting to Christian theology, perhaps we can at least update our shared anthropocentric view of the "divine mind" to incorporate contemporary scientific findings about the human mind and cosmological time to revise the static Platonic realm of Ideas upon which the early Christians borrowed.

As human memory connects across an individual's mode-specific and association areas of the brain, and across individuals in shared social memories, perhaps the "divine mind" connects across all human experience. Royce's Christian beloved community shares episodic, semantic, and motor memories across individuals (events, concepts or doctrines, and rituals respectively). However, special relativity suggests that a strict notion of simultaneity does not exist, and by avoiding the physical-level concept of time most Westerners presume, and allowing for subatomic-level interactions, one can broaden human experience and human universal community to occur across spans of time. Rather than imagine God's memory of a person as one's memory of a dead relative, a more scientific metaphor suggests imagining a distributed, social memory not limited either by an individual's synapses or the "larger synaptic clefts" that occur between one person's motor cortex and another person's sensory neurons.

If one continues to form new memories, the new memories could involve one's existing memories, categorizations and concepts, and additional ones from the distributed divine memory. Ultimately, if all else passes away, then the valuable new connections can only occur with memories in the divine mind. One may understand the biblical admonishment to glorify God not as a narcissistic request but as the only way one's memory can connect to the eternal. Through prayer, love, and embodied service, a person creates experiences and memories in their lifetime that allow identification with the resurrected body's continued worship as a distributed memory in the divine mind. If, as theologians recognize, the divine mind occurs outside of current human mind and cosmological time, then rather than one's final identity at death entering the eschaton, the sum total of one's experience would participate in life after death. From a pragmatic perspective, as discussed in the following chapters, rather than hope for one's static, final memory to become resurrected, one may hope for the "conceivable practical effects" (Chapter 7) of one's entire life to become resurrected.

I will return to the soul (in Chapter 8) after developing a pragmatic framework in which to situate it (Chapter 7), but another key aspect of human cognition important to religion and spirituality remains to be explored in this chapter—decision making.

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15 J.C. Polkinghorne and Michael Welker, *The End of the World and the Ends of God: Science and Theology on Eschatology* (Theology for the Twenty-First Century; Harrisburg, PA: Trinity Press International, 2000); John Polkinghorne, *The God of Hope and the End of the World* (New Haven, CT: Yale University Press, 2003).

Human Decision-Making

To respond appropriately to possible choices, a person selects information relevant to the task. But how do people select relevant information? Neuroscientists have discovered evidence that the brain uses the same system to choose between conflicting choices as it uses to filter out irrelevant stimuli from ordinary tasks, namely circuits in the anterior cingulate cortex.

Understanding the brain's mode of controlling choice provides an important foundation for understanding the role of the "will" in moral decision-making. In addition, because of the brain's propensity to retain frequently used connections and discard unused connections in the process of long-term potentiation, repeated moral decision-making would naturally lead to an increased facility in moral decision-making via the formation of habits.

Neurological evidence suggests that the brain uses an inhibitory rather than excitatory mode to resolve conflict and that inhibitory conflict resolution interacts with decision-making. As a psychological-level system, I suggest a cognitive model of choice based on the current evidence that is neuropsychologically plausible and could function in moral decision-making.

Neuropsychological Model of Choice

A possible cognitive mechanism for choosing between two possible actions might have been that one choice would become more active and gain energy in the mind. Neurologically, that might occur by increasing the level of activation of one choice's associated neurons or alternatively the activated neurons might spread to activate a greater number of neurons. For example, if one were choosing between an apple and a bunch of grapes, the mental image of the apple might increase in clarity. However, neuroscientists have gained evidence that the brain uses a different mechanism for choice, which is more energy efficient. Rather than increase (excite) the activation of one possible selection, the brain decreases (inhibits) activation of the alternate selection. Thus, for example, a mental image of the choices not selected would dissipate, leaving only the desired choice activated. Cognitively, the mind chooses by eliminating the possibilities as one might filter sand in panning for gold—washing out the debris with only the desired nugget remaining.

The frontal lobe—one of the four regions of the cerebral cortex (at the front, outer part of the brain)—has been associated with *executive control*, that is, a person's ability to control and regulate information processing across the brain, especially as an aspect of goal-oriented behavior. The *prefrontal cortex* (PFC) in the frontal lobe and the limbic structure *anterior cingulate cortex* (ACC) affect and coordinate goal-oriented behavior by choosing between possible selections. The PFC and ACC are involved in activities other than choice, but the functionality of these two regions provides a plausible neuropsychological basis for understanding choice. (As a mnemonic, for the purpose of this section, the PFC may be considered to be the *primary* functioning center and the ACC may be considered to be an *additional* control center.)

The PFC dynamically filters information from working memory and attends to salient features relevant to the current task.[16] To perform a task, the PFC selects information relevant to the task and filters out irrelevant information. For example, when one reaches out to pick an apple seen on the tree, the PFC helps one keep attention on the red, round object and ignore the green, leaf-shaped objects.

The neuroscientists Knight and Grabowecky compared healthy people to patients with lesions in the PFC. Their (electrophysiological) studies indicate that healthy subjects attend to relevant information by excluding *irrelevant* stimuli rather than enhancing sensitivity to *relevant* stimuli. The patients with a damaged PFC were not as able to inhibit response to stimuli and thus failed to block the distraction.[17] Thus, the PFC appears to control goal-oriented behavior by inhibiting distracting stimuli.

The ACC helps monitor conflict between possible responses and modulates activities in other cortical areas to increase attentional resources and ensure that irrelevant stimuli are ignored.[18] For example, if a person hears too many sounds in a noisy environment, the ACC accentuates the auditory regions to address the conflict by inhibiting processing in other regions. One becomes less aware of other visual stimuli, body sensations, and so on, and more processing naturally occurs in the uninhibited auditory region. Or, if a person has too many options in obtaining a goal, the ACC might grant the PFC additional resources to resolve the conflict. This occurs by inhibiting other processing, that is, the person becomes "lost in thought."

Recently, neuroscientists have discovered in a particular inhibition task that ACC activation seems to follow the activation of PFC with some overlap between the two components. They interpret this finding as the PFC signals the ACC when executive control is required, and ACC implements the control.[19]

Although neuroscientists continue to investigate how the PFC and ACC cooperate in choice, I present a tentative psychological-level process of system interaction for choice based on the current neuroscientific evidence to explain how the brain operates in moral decision-making, through the process will likely require modification as scientists discover new evidence.

While a person performs a goal-oriented task:

1. If a choice arises, i.e., a conflict occurs as to which one should be selected, the PFC notifies the ACC of a conflict.
2. Because the conflict occurs in decision-making, the ACC increases resources in the PFC, by inhibiting other areas of the brain.

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16 Gazzaniga, Ivry, and Mangun, *Cognitive Neuroscience*, pp. 519–22; A.P. Shimamura, "The Role of the Prefrontal Cortex in Dynamic Filtering," *Psychobiology* 28 (2000): 207–218.

17 R.T. Knight and M. Grabowecky, "Escape from Linear Time: Prefrontal Cortex and Conscious Experience," in Gazzaniga and Bizzi, *The Cognitive Neurosciences*, pp. 1357–71. For an overview, see Gazzaniga, Ivry, and Mangun, *Cognitive Neuroscience*, pp. 522–4.

18 Gazzaniga, Ivry, and Mangun, *Cognitive Neuroscience*, pp. 530–35; J.D. Cohen, M. Botvinick, and C.S. Carter, "Anterior Cingulate and Prefrontal Cortex: Who's in Control?," *Nature Neuroscience* 3(5) (2000): 421–3.

19 J. Markela-Lerenc *et al.*, "Prefrontal-Cingulate Activation During Executive Control: Which Comes First?," *Brain Research: Cognitive Brain Research* 18(3) (2004): 278–87.

3. The PFC filters less relevant features until one selection remains.
4. If additional conflicts arise, the PFC notifies the ACC of the additional (sensory or decision-making) conflict, and the process repeats.

The interaction model provides a more integrated description of how the brain systems interact in the emergence of the human will as part of the goal-directed behavior of the person. Even in simple tasks, activation of the PFC may become necessary to attend to relevant sensory information. If picking grapes, the person (or an animal) must attend to the sweet, purple pieces of fruit rather than the distracting leaves and alternate clumps of grapes. This often happens subconsciously, and not until the conflict between options requires conscious thought (subjective awareness) does the person become aware of choice.

Moral Decision-Making

In moral decision-making, a person has additional features associated with the possible selections. For example, the apple is not only red and sweet, it may be forbidden by authority. The grape, not only purple and sweet, but approved by authority. Antonio Damasio has suggested that people use *somatic markers*, bodily feelings, that guide reasoning. Thus, the brain associates bodily feelings of pleasure or euphoria with memories of items it finds valuable, such as a desired fruit or associate items that invoke fear, disgust, or anger with those bodily feelings.[20] A person makes ethical decisions based upon the norms of the community in which the person participates guided by social and bodily emotional cues.

In the cognitive model of choice, a person's conflict between desiring the apple and desiring to obey the authority that forbids it, could be resolved either by inhibiting the desire to eat the apple (and acting on the desire to obey authority) or by inhibiting the desire to obey authority (and acting on the desire to eat the apple). The model explains that the person who disobeys authority does not decide *to* disobey authority but rather decides to eat the apple. The obedience to authority becomes inhibited by mechanisms similar to those that filter out the leaves on the tree or distracting noises.

Moral decision-making emerges from selection and filtering of stimuli in goal-oriented behavior. As a person makes decisions based on ethical norms, commitment to discipleship, loyalty to loyalty, and love of enemies and strangers, then responses associated with less moral options, such as pride, greed, lust, anger, gluttony, envy, and sloth, would be attenuated. Although different concepts and neural networks would underlie ethical decision-making than sensory-motor activity, the same process of choice may coordinate both activities. As additional decisions are made by faith and commitment to ethical behavior, the ability to make similar decisions would become reinforced, less conscious, and more automatic.

Over time, a propensity toward making moral decisions could develop in the individual through habituation and its biological process of long-term potentiation. As one makes decisions, one changes who one is. Long-term potentiation reinforces

20 Damasio, *The Feeling of What Happens*.

the synapses used in the decision-making which changes ones propensity to make similar decisions in the future. As Irenaeus described, one develops incrementally in a continual process of becoming. The same part of the brain involved in picking an apple or a bunch of grapes or listening to a conversation also implements deciding between good and evil or following a spiritual path.

The brain appears tuned to represent the relationships forming systems in the natural world and to make decisions based on those representations for the well-being of the organism. Human memory (individual and collective) structures itself based upon the systems of relationships occurring in nature, and the cybernetic aspects of executive function and decision-making provide the human autonomy at the psychological level. A human person can also make decisions based upon shared cultural norms and memories, and, through an intrinsic aspect of learning, slowly shift one's decision-making process to orient with cultural or transcendent-level systems.

Having examined some details of Western scientific research on learning and decision-making, it would be easy for one to lose the context of emergent systems of cognitive science and religion. The potentiated synapses that shift neural networks and inhibitory processes in decision-making are emergent constraints. As emergent constraints, they eliminate some possibilities and actualize others. They also interact to form a psychological-level system of the self with second-order constraints defining it.

Rather than a Cartesian mind making decisions that somehow affect the body, or the brain processing perceptions somewhat deterministically in the context of memory to determine one's self, one chooses between alternative behaviors by inhibiting undesired actions and that choosing strengthens the neural connections involved in that behavior and decision-making. Some of the consequences (remaining in the real possibility of the self) automate the process reducing the decision-making effort required for subsequent similar decisions. Other effects of the synaptic plasticity shifting neural networks in decision-making may emerge unexpectedly. Those emergent habits may shift the real possibilities of a person's future decision-making and the person's tendency toward certain behaviors in ways that support or disrupt other systems to which one belongs. A tragic aspect of human existence is learning bad habits without realizing their final consequences.

Some aspects of decision-making are determined by genetically specified features of perception and brain structure, and other aspects may be indeterminate and influenced by random quantum fluctuations or unpredictable "chaotic" processes. Much of decision-making depends upon earlier decisions that constrain the real possibilities from which one can subsequently choose. First-order emergence can only model the statistical influences upon decision-making, and not explain the continuity of a decisive self. The propagation of constraints in the series of decision-making and learning breaks the atemporal symmetry resulting in second-order emergence over the entire learning and decision-making system—biologically, the brain, and psychologically, the self. One cannot define the self without taking the time-dependent relationships between learning and decision-making into account, thus the self cannot be modeled as a static essence, but at least requires a narrative.

Because memory reconsolidates in the brain when retrieved, no relationships of the mind or self can exist as a fixed essence, but only dynamically. Human decision-making (and the will) depends not only on current circumstances, but also upon the history of the self that makes those decisions. All robust systems exhibit some type of self-maintenance, but the human psychological-level self appears suited to decide not only among actual alternatives but to deliberately, and perhaps consciously, decide to shift the person's real possibility. One can decide to influence who one becomes. That autonomy and sense of agency enriches the meaning that a person can bring to their life, the cultures to which they belong, and to transcendence.

To avoid projecting computational (or even biological) interpretations of systems onto nature, one must step beyond a philosophy of nature based upon relationship and examine relationality from a metaphysical perspective. As examined in the next chapter, the pragmatic tradition in American philosophy categorizes relationship and decision-making as foundations for understanding human systems in nature.

CHAPTER 7

American Pragmatism

The best ideal is the true
And other truth is none.
All glory be ascribed to
The holy Three in One.
—Gerard Manley Hopkins, "Summa"

Introduction

What consequences do one's actions have?

A pragmatist considers the practical consequences of their actions in making a decision. If an action makes no difference in the world, then what meaning can it have? In general, for a pragmatist, meaning consists of the results. Pragmatism derives from the Greek *praxis*, meaning "action." To clarify one's ideas—to make them clear—one considers the consequences of one's action. However, pragmatism goes beyond the apparent results or an individual's thoughts about consequences. Otherwise, one could slip into a mindset of the end justifying the means.

American Pragmatism began with the philosophical explorations of Charles Sanders Peirce and has taken several historical forms which are not always compatible. A practicing scientist, Peirce considered scientific philosophy and logic as his vocation. Peirce influenced his friend William James who popularized Peirce's pragmatism (Peirce would say misunderstood and oversimplified) and applied it to psychology. Another pragmatist John Dewey developed "instrumentalism" in response to transcendental philosophy, drawing upon Peirce's pragmatism and James's psychology. Josiah Royce also developed his "absolute pragmatism" from his interaction with Peirce and friendly disputes with James. One of Royce's students, George Herbert Mead, further developed pragmatic psychology with a less individualistic, more social concept of person in social psychology, which is coordinate with Peirce's and Royce's social understanding of the self.[1]

For James, pragmatism interprets reality by examining its practical consequences. Rather than speculate on abstractions in isolation, pragmatists consider the practical consequences that distinctions in those abstractions would have. If no differences in practical consequences exist, then the abstractions are considered equivalent. Richard Rorty, who draws on Dewey for his neo-pragmatism, places pragmatism in contrast between, first, the Platonists and transcendental philosophers—who

1 Israel Scheffler, *Four Pragmatists: A Critical Introduction to Peirce, James, Mead, and Dewey* (International Library of Philosophy and Scientific Method; New York: Humanities Press, 1974).

believed in more truth than could be discovered in the natural world—and, second, the positivists and empirical philosophers—who believed that the natural world contained all the truth there is.[2]

For Peirce, however, pragmatism involves more than a reference to how the world happens to exist, and I will deal primarily with Peirce's pragmatism. As a scientist aware of geology and evolution, Peirce attempted to incorporate the possibility of the world existing in very different ways while retaining continuity with the particular configuration it finds itself in. Peirce, Royce, and Dewey believed James missed this sometimes subtle distinction. James, for example, would find the hardness of a diamond a significant characteristic because it has practical consequences in the world, such as cutting glass. However, James's popularized approach to philosophical pragmatism missed the point that the hardness of a diamond is a significant characteristic regardless of whether that diamond ever cut a piece of glass; whether any diamond ever cuts any glass; whether any glass exists; and, significant to emergence, even whether any diamond exists. Hardness is a "real" property of organized matter even before the first carbon atoms were compressed into diamonds.[3]

For the human self, James describes experience as a stream of consciousness. However, missing from his stream metaphor is the analogous van der Waal force between atoms of water molecules that in large quantities give rise to the surface tension of liquid and makes a stream more than a disconnected collection of water molecules (Chapter 4). The continuous interrelatedness missing from James's account of a stream limits how one can conceive of the human person. A full account of the human person, nature, or reality requires *the general continuous interrelatedness that guides the actualization of possibility*, which Peirce called "Thirdness".

Peirce examines reality through a lens of three metaphysical categories: possibility, actuality, and generality. A pragmatist does not accept the categories as a priori metaphysical principles, like Aristotelian or Kantian categories, but considers them as falsifiable metaphysical hypothesis. One accepts the categories not by attempting to prove them as part of reality, but by accepting them until they are disproved by good reasons to doubt them, such as falsifying facts, logical contradictions, or the discovery of a more adequate theory or frame of reference: in other words, much as scientific hypotheses become accepted as (falsifiable) laws.

Kant called into question the relevance of a priori metaphysics and argued against speculative metaphysics. Even contemporary philosophers who recognize the necessity to be explicit about implicit metaphysical claims underlying many contemporary philosophical explorations may doubt Peirce's triadic categorization of the mind-like qualities of reality. For philosophical theology, or what Barbour calls synthetic synthesis, to cohere one must identify the (fallible) metaphysics one uses. However, as this book primarily addresses human systems, a non-theologically

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2 Richard Rorty, *Consequences of Pragmatism: Essays, 1972–1980* (Minneapolis, MN: University of Minnesota Press, 1982).

3 More specifically, it is a real property of the *possibility* of matter to organize, because possibility is an aspect of reality while matter typically refers to existing *actual* relationships of possibility.

inclined scientist or scholar does not need to commit to a complete pragmatic metaphysics, but only accept a relatively banal claim that the human mind has a "mind-like quality" and that human systems, as studied by scientists and scholars, are intelligible.

Pragmatic Metaphysics

Peirce's metaphysics categorizes reality into possibility, actuality, and generality. Those three categories provide a philosophical foundation for emergent systems theory by contextualizing the information in actual relationships existing in nature as constraints on the realm of possible relationships. Mathematically, one may model these possible configurations of relationships as constraints on phase spaces or lattices (Chapter 2). Systems—as they partially encapsulate constraining relationships—indicate general regularities, especially in how they interact with each other.

Although exploring metaphysics may appear to step outside the scope of this book's investigation of the human person, it remains necessary for three reasons. Firstly, the initial assumption at the end of Chapter 1 of nature as relational defines a philosophy of nature that can only be further explained in terms of metaphysics.

Second, Chapters 2 through 5 claimed that the relationships of nature include emergence; constraints; the possibility to combine into systems; existence not only as a physical object but as a dynamic form; and the distinction between levels of logical coherence and causal powers. Those claims place constraints on reality that can only cohere as part of a metaphysics. Finally, conclusions reached in Chapters 5 and 8 on the human person in relationship to God impact upon classical understanding of metaphysics, and as part of constructive science and religion dialogue, must be communicated as metaphysical claims.

Scientifically Oriented Metaphysics

Metaphysics formulates theories about the general nature of reality. Classical metaphysics claimed to grasp the nature of Being. The categories of a metaphysical theory, to be applicable, should interpret reality. However, classical metaphysics claimed a priori necessity, thus asserting that its hypothetical account of reality must necessarily apply to any reality whatever. By claiming necessity, speculative metaphysics claims logical infallibility, and the classical metaphysician claimed to know in advance and without testing that a particular set of metaphysical categories will apply to any reality whatever.[4]

Developing a scientifically oriented metaphysics requires one to reason "abductively," where one reasons from empirical evidence to the best hypothesis explaining the data. Peirce first suggested abductive reasoning as a way of explaining the reasoning done by scientists in generating hypotheses. It differs from deductive reasoning where one reasons from a rule and premise to a certain conclusion (a rule:

4 Donald L. Gelpi, *The Gracing of Human Experience: Rethinking the Relationship between Nature and Grace* (Collegeville, MN: Liturgical Press, 2001), p. 266.

if P, then Q; a premise: P is true; therefore the conclusion: Q is true) and inductive reasoning from a series of instances to a likely rule (instances P_1, P_2, P_3, … P_n are true; therefore as a rule all P are true). Abductive reasoning progresses from evidence to hypothesis (If P, then Q; evidence Q is true; maybe hypothesis P is true if there is not a better explanation). Cameron Shelley suggests viewing abduction as inference to the best explanation.[5] Neither reason nor sense data suffices to know reality completely. However, we experience reality in some way. Thus, through experience, one might have access to learn about reality, and, as argued by Peirce and Bateson, one may also learn from evolutionary responses to prior organizing experience.

Different philosophers have chosen different root metaphors to develop their metaphysics. Plato and Aristotle compared reality to an idea. Thomas Aquinas compared being to an Aristotelian act. The seventeenth-century philosopher Thomas Hobbes metaphorically compared it to a machine. The twentieth-century German philosopher Martin Heidegger imagined reality as the total pattern of meaning. Four additional philosophers examined in this chapter also have root metaphors. Peirce utilized his logic, phenomenology, and semiotics to develop a logical metaphysics that considers reality as semiotic. The twentieth-century philosopher and mathematician Alfred North Whitehead adopted an organic view of reality. The contemporary philosophical theologian Joseph Bracken develops his neo-Whiteheadean metaphysics by viewing reality as intersubjective. The contemporary philosophical theologian Donald Gelpi argues that because Peirce derives his metaphysical categories from his phenomenology, experience itself offers a legitimate pragmatic basis for understanding reality.[6]

Although finite people will probably never know reality in general or completely, by focusing on human experience as a basis for understanding reality, philosophers can hope to develop a metaphysics sufficient to explain all of reality that humans will actually experience. Since metaphysics grounded in a priori reason has proven inadequate with increasing knowledge of nature, a plausible metaphysics should interpret increasing knowledge by being *falsifiable*, and thus "verifiable" based on existing knowledge, until subsequent data prove current theories false.[7] Science

5 Charles S. Peirce, *Collected Papers* (Cambridge: Belknap Press of Harvard University Press, 1960), vol. 2, §§ 511, 623; vol. 5, §§ 145, 270; vol. 6, § 469. Cameron P. Shelley, "Visual Abductive Reasoning in Archaeology," *Philosophy of Science Association* 63 (1996): 278–301; Paul Thagard and Cameron P. Shelley, "Abductive Reasoning: Logic, Visual Thinking, and Coherence," in *Logic and Scientific Methods* (vol. 1 of the Tenth International Congress of Logic, Methodology, and Philosophy of Science, Florence, August 1995; ed. Maria Luisa Dalla Chiara; Dordrecht and Boston, MA: Kluwer Academic Publishers, 1997), pp. 413–27. For more information on abduction, see also Peter A. Flach and Antonis C. Kakas, *Abduction and Induction: Essays on Their Relation and Integration* (Applied Logic Series, 18; Dordrecht and Boston: Kluwer Academic Publishers, 2000).

6 Gelpi, *The Gracing of Human Experience*, p. 272; Stephen C. Pepper, *Concept and Quality: A World Hypothesis* (La Salle, IL: Open Court, 1967); Joseph A. Bracken, *The One in the Many: A Contemporary Reconstruction of the God–World Relationship* (Grand Rapids, MI: William B. Eerdmans, 2001).

7 Verifiable in the common sense can only be falsifiable by science, according to Karl Popper and other philosophers of science.

demonstrates how developing falsifiable models leads to improved hypothesis about nature.

Peirce described his scientifically oriented metaphysics as:

> The attempt of a physicist to make such conjecture as to the constitution of the universe as the methods of science may permit, with the aid of all that has been done by previous philosophers. I shall support my propositions by such arguments as I can. Demonstrative proof is not to be thought of. The demonstrations of the metaphysicians are all moonshine. The best that can be done is to supply a hypothesis, not devoid of all likelihood, in the general line of growth of scientific ideas, and capable of being verified or refuted by future observers.[8]

Whitehead argues that a metaphysics requires logical consistency, applicability, adequacy, and coherence. A theory is *logically consistent* when the terms employed in formulating it do not contradict each another. It is *applicable* when it interprets some of the realities one is seeking to understand. It is *adequate* when one encounters no reality that the theory cannot interpret. Coherence usually means that the theory holds together to form a whole. A metaphysical theory is *coherent* when all the key explanatory terms so imply one another that they remain unintelligible apart from one another. Coherence prevents entities from being abstracted away from the system, because the fundamental ideas presuppose each other in such a way that they are meaningless in isolation. Coherence (in this specific way) is required because the metaphysical theory must not only interpret all of reality, but also the theory itself. Whitehead claimed a metaphysics is rational when it is coherent and logically consistent, and empirical when it is applicable and adequate.[9]

Somewhat similarly, Ian Barbour, in his critical realism, proposes four criteria for assessing theories in scientific research: agreement with data, coherence, scope, and fertility. *Agreement with data* is Barbour's qualification of *correspondence*: a proposition is true if it corresponds to reality. Barbour qualifies correspondence because many theories postulate unobservable entities and the observation of data is affected by the presumed theory. A theory is *coherent* if it is comprehensible and internally consistent. However, for Barbour a theory cannot be evaluated in isolation, only as part of a network of theories. The *scope* of a theory assesses its comprehensiveness or generality, such as unifying previously disparate domains and supporting a variety of kinds of evidence. A theory is *fertile* when it not only explains previously gathered data, but guides future research by encouraging further theoretical elaboration, generating new hypotheses, and suggesting new experiments.[10]

Well-defined criteria provide a critical method for evaluating a scientifically oriented metaphysics. Peirce regards the promise of fertility as one good reason among others to adopt a hypothesis for testing. In a series of articles for the journal

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8 Peirce, *Collected Papers*, vol. 1, § 7 as quoted in Kelly A. Parker, *The Continuity of Peirce's Thought* (Nashville: Vanderbilt University Press, 1998), p. 190.

9 Gelpi, *The Gracing of Human Experience*, p. 268; Alfred North Whitehead, *Process and Reality: An Essay in Cosmology* (New York: Free Press, corrected edn, 1978), p. 3.

10 Ian G. Barbour, *Religion and Science: Historical and Contemporary Issues* (San Francisco: HarperSanFrancisco, rev. edn, 1997), pp. 109–110.

Monist, Peirce argued that the evidence supplied by the scientific study of evolution falsifies a mechanistic understanding of reality.[11] The insights of nature provided by quantum mechanics also invalidate a mechanistic view of reality.

One can define a fallible metaphysics in a way that one can measure the operational consequences of what the characterization asserts against the intended reality's actual behavior. Gelpi agrees with Peirce that the "collapse of a priori metaphysical thinking does not preclude the legitimacy of formulating fallible metaphysical hypotheses whose claims to universal applicability one tests systematically both against lived experience and against the results of close scientific and scholarly investigations of different realms of human experience."[12]

Peirce's Semiotic Metaphysics

Peirce developed an understanding of reality based on his logic, phenomenology, semiotics, and desire to treat metaphysics as a science. As described earlier, Peirce's semiotics includes three kinds of relations to objects: an icon which resembles the object, an index which represents the object through an existing connection, and a symbol which represents its object through a convention that governs how the symbol will be used. This organization abstracts the three ways a sign associates with its object—resemblance, existential connection, and testable convention. One can also organize the objects the sign represents, and Peirce distinguished between objects as feelings or qualities (e.g., joy), actually existing states of affairs, such as the temperature of an object, thirdly a general tendency or law or disposition of things to operate a certain way. Peirce also organized signs according to the nature of the sign itself, called the "representamen"—whether it is a quality (such as color, sound or taste) that does not exist in isolation; something that actually exists as a thing or state of affairs (e.g., a footprint); or thirdly, a general type, law, or pattern of behavior (e.g., a dog cowering at loud noises).[13]

Although it is very easy to get lost in Peirce's semiotic abstractions, he examined the phenomena of nature and created a semiotic model of those phenomena. His semiotic has a triadic structure—a sign has an object, interpretant, and the sign itself; and one can classify each of these into its own trichotomy.[14]

In examining the world as it appears to exist, or phenomenology, Peirce distinguished among three categories of appearance: quality, fact, or law. Quality refers to any instance or particular suchness like the sensations, red, bitter, or hard. Fact comprises action and reaction, matter, and that which resists. Only through facts can one experience qualities, and qualities make one present to both facts and laws. Law includes generality and requires a subject to represent the composition of qualities and facts. For Peirce, phenomenology not only includes what one

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11 Gelpi, *The Gracing of Human Experience*, p. 266.

12 *Ibid.*, pp. 266–70.

13 Peirce, *Collected Papers*, vol. 2, § 243. Parker, *The Continuity of Peirce's Thought*, pp. 155–9.

14 Due to limitations in how the possible and general object, representamen and interpretant can combine, Peirce ends up with 10 types of signs rather than 27.

experiences but also what one might experience (if the world were different), and thus depends upon and informs ontology and metaphysics.[15] In the modeling of objects in object-oriented analysis (Chapter 2), Peirce's phenomenological categories of quality, fact, and law provide a philosophical foundation for modeling attribute, object (instances), and classes, respectively.

Kelly Parker describes four main hypotheses for Peirce's metaphysics:[16]

1. There is a reality.
2. Reality is to be conceived as a process similar to the process of semiosis.
3. Modes of action or relation are fundamental to understanding modes of being.
4. The elementary metaphysical categories describing these modes of being are variations of the three indecomposable kinds of relation that are manifest in Peirce's phenomenology and semiotics.

Of particular interest in organizing the relational aspect of reality is the fourth hypothesis that metaphysics depends upon Peirce's trichotomy of organization into Firstness, Secondness, and Thirdness. In investigating a logical foundation for metaphysics, Peirce settled on three categories, which he called Firstness, Secondness, and Thirdness, that categorize relationships which refer to one, two, or many other entities, respectively. Firstness characterizes that which occurs not in relationship with another, such as the quality of something or its possibility for existence. Cognitively, Firstness also makes one present to reality and thus categorizes intentionality. Secondness characterizes two somethings in relationship, such as the fact of something or its actual existence. Thirdness requires three or more somethings and characterizes the habit or regularity of something or its generality, such as the relationship between actual objects and their possibilities.

In emergence, the actuality of the interacting systems give rise to the real possibility of emergent properties that become real as they habituate in the processing of a higher-level system. Although the categories occur in all phenomena, one may characterize some phenomena as typifying one category more than others, such as the quality of "redness" (Firstness); the uninterpreted and unexpected experience of one bumping into a piece of furniture in the nighttime (Secondness); and the tendency for an object to fall to Earth when one drops it (Thirdness). With Peirce, once could *prescind* (or abstract) emerging systems: first, the quality of a system as a whole; second, the actuality of acting and reacting entities; and third, the habituation of those interacting entities into regularities, which then form new systems.

Firstness is the mode of being which consists in its subject being what it is without regard to anything else. It is the realm of possibility and consists in the mere capability of existing getting thought. In Peirce's logic, Firstness is captured by monadic relations; phenomenologically, Firstness corresponds to quality. For

15 James Kern Feibleman, *An Introduction to Peirce's Philosophy* (New York, London: Harper & Brothers, 1946), pp. 146–50; Parker, *The Continuity of Peirce's Thought*, p. 104; Peirce, *Collected Papers*, vol. 1, §§ 297, 418–20, 476, 480.

16 Parker, *The Continuity of Peirce's Thought*, p. 197.

Peirce, the mode of redness is a positive qualitative possibility before anything in the universe was red. Firstness is a non-relative element and categorizes reality prior to actual relations, in the realm of possibilities. In Firstness, something is what it is without the power to act or be acted upon. However, possibilities may also lure experience and give it direction. As a more intuitive term, Gelpi uses "value" for Firstness in his metaphysics of experience, described in a later section.[17]

Secondness is a mode of being where one thing consists of how a second object is. Secondness consists of action and reaction, or effort and resistance, such as pushing against a door that remains stuck for an unknown reason or bumping ones shin on something while walking in the night. Secondness exemplifies an action and its corresponding reaction taken as a single event. Secondness is actuality, or phenomenologically, fact. Only two objects exist in the relation, and there is no reason or interpretation. Secondness is described in logic using dyadic relations. These relations are needed for identity and difference, accidental reactions between qualities, the order of time, and efficient causation. Gelpi calls his use of Secondness in his metaphysics "decision."[18]

Thirdness is a mode of being that consists in the fact that ways of responding evaluatively to Firstness or future facts of Secondness will take on a specific general character. Parker states: "Thirdness consists in the general tendencies or laws that guide the actualization of possibilities." Thirdness also consists of unexpressed evaluations. Thirdness is real generality. Logically, Thirdness is captured with triadic relations. Phenomenologically, it corresponds to law, or a tendency something has to be fulfilled. Unlike qualities, which may be embodied, laws exemplify habitual tendencies which respond to environmental stimuli under specifiable conditions, either evaluatively (Firstness) or efficaciously (Secondness). Thirdness is the regularity in experience, which Gelpi calls "tendency."[19]

Thirdness also governs continuity. Logically, triadic relations allow for interrelatedness, and carried to its limit result in a continuum. Thirdness may spread into a "thick set" or continuum, which can be infinitely divided. Continua can be made mathematically precise in a variety of ways. The continuous spreading of Thirdness, Peirce understands under the rubric of *synechism*, which holds together space and time.[20]

The triadic categories of Peirce's philosophy are summarized in Table 7.1, including his metaphysical and phenomenological categories; semiotics as the representamen relates to objects, and the number of relations, or "arity", of logical predicates. The table also includes the analogous metaphysical categories of Gelpi's metaphysics.

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17 Gelpi, *The Gracing of Human Experience*, p. 153; Parker, *The Continuity of Peirce's Thought*, pp. 113–14, 210; Peirce, *Collected Papers*, vol. 1, § 25.

18 Gelpi, *The Gracing of Human Experience*, p. 153; Parker, *The Continuity of Peirce's Thought*, pp. 114–15; Peirce, *Collected Papers*, vol. 1, § 24.

19 Gelpi, *The Gracing of Human Experience*, p. 153; Parker, *The Continuity of Peirce's Thought*, pp. 114–16, 215; Peirce, *Collected Papers*, vol. 1, § 26.

20 Gelpi, *The Gracing of Human Experience*, p. 155, Parker, *The Continuity of Peirce's Thought*, pp. 73–4.

Table 7.1 Triadic categories in Peirce's philosophy

Metaphysical categories	**Phenomenological categories**	**Semiotics (relation to objects)**	**Logic (arity of relations)**	**Gelpi's metaphysical categories**
Firstness	quality	icon	monadic	value
Secondness	fact	index	dyadic	decision
Thirdness	law	symbol	triadic	tendency

Although Peirce believed that the reality of Firstness and Secondness would be clear to anyone, he thought inference was necessary to demonstrate the reality of Thirdness, especially against the nominalist position. Peirce believed that philosophy since the sixteenth century succumbed to nominalism, including James's interpretation of pragmatism, and Gelpi argues for the inadequacy of Whitehead's process philosophy because of its nominalism. The next subsection briefly discusses nominalism, then I will describe limitations in cognitive science because of its nominalism, before returning to metaphysics.

Realism and Nominalism

Nominalism emerged in medieval philosophy as a speculative alternative to Platonic realism. Nominalism denied the existence of universals, that is, anything general, and reduced reality to concrete, sensible entities. In its most extreme formulation, universals were reduced to the repeated application of the same spoken word to sensible things. Conceptual nominalists allowed that universals exist in the mind, but they denied that they correspond to anything in sensible things.[21]

Peirce's recognition of Thirdness escapes conceptual nominalism and allows for real generality. *Nominalism* denies the existence of universals, and accepts only concrete sensible realities; *conceptual nominalism* allows for universals to exist in the human mind but denies their existence outside the mind. Although conceptual nominalism avoided the fallacies of reified substances and cosmological dualism, Donald Gelpi argues that it endorses a form of essentialism, promotes a form of subjectivism, and excludes real universality.[22] Although conceptual nominalism appeals to some, it fails to provide a framework for reality in light of modern physics and subatomic-level phenomena. Conceptual nominalism allows for "observers" (or large, real objects) that cause quantum super-positions to "collapse" and form physical objects, but it does not provide for the existence of the relationships comprising "observers" that form reality. Although Whitehead was familiar with early work in quantum mechanics when he developed his process philosophy, no one at that time understood insights such as non-locality and characterizations of the "observer." Because of the Western predilection toward essentialism or nominalism, understanding reality requires a metaphysics (even if implicit) that clearly

21 See Gelpi, *The Gracing of Human Experience*, pp. 88–9, 122–3.

22 *Ibid.*, p. 89.

characterizes both the constraining relationship that an "observer" has on (quantum) super-positions and the constraining relationship of a super-position itself.

Descartes moved philosophical speculation in a nominalist direction by portraying matter mechanistically, but John Locke's British empiricism of the seventeenth century gave conceptual nominalism systematic expression. Locke rejected Descartes' a priori deductive logic and gave a nominalist account of sense data, which drawing from Newtonian science, required the verification of all abstract theories in sense data. Hume developed the skeptical implications of Locke's thought. In a world devoid of real explanatory laws, he reduced the notion of causation to the mere succession of sensible phenomena. Although Kant initially endorsed a form of deductive rationalism, Hume awakened him from his "dogmatic slumbers," and he systematized conceptual nominalism even more thoroughly than Locke had. In his "second Copernican revolution," Kant transformed Aristotelian hylemorphism into a theory of knowledge. Concrete, sensible percepts supply the "matter" of human thought, while a priori, universal ideas supply its "form." In Kant's version of scientific knowing, the mind imposes on concrete sense data a universality which does not exist in nature. As Kant also endorsed the subjectivism of British empiricism, he equated knowing with the subjective interrelation of concrete percepts and abstract concepts. The Kantian intellect never knows the "thing in itself" (*Ding an sich*), only a constructed idea composed of the sense manifold and a subjective, a priori conceptual form of thought. Peirce reacted to Kant's nominalism with a refurbished realism in accordance with the results of scientific investigations of nature and his realization that no scientist wishes to impose unverifiable concepts onto nature.[23]

Nominalists claim that the laws of science are names attached subjectively to observed uniformity of experience. Realists maintain that the descriptions of laws are both real and universal. Peirce agreed with the nominalist that knowledge is a social construct subject to constant revision but claimed that an infinite process of inquiry will lead to an objectively verifiable truth. Peirce writes: "The opinion which is fated to be ultimately agreed to by all who investigate, is what we mean by the truth, and the object represented in this opinion is the real."[24]

Peirce, as a realist, took issue with nominalism and argued for the reification of Thirdness. Peirce states:

> You know what the question was. It was whether laws and general types are figments of the mind or are real. If this be understood to mean whether there really are any laws and types, it is strictly speaking a question of metaphysics and not of logic. But as a first step toward its solution, it is proper to ask whether, granting that our common-sense beliefs are true, the analysis of the meaning of those beliefs shows that, according to those beliefs, laws and types are objective or subjective. This is a question of logic rather than of

23 *Ibid.*, pp. 122–3, 168–9.

24 Parker, *The Continuity of Peirce's Thought*, pp. 191–3; quotation from Charles S. Peirce *et al.*, *Writings of Charles S. Peirce: A Chronological Edition* (Bloomington: Indiana University Press, 1982), vol. 3, § 273.

> metaphysics—and as soon as this is answered the reply to the other question immediately follows after.[25]

For Peirce, not only nature but also reality has a relational structure that he investigates phenomenologically, semiotically, and logically. Relationships, and the systems they comprise, have three aspects that make them real. Although some may believe scientists only examine actuality, they determine generality as laws and leave open possibility in developing scientific theories.

Before continuing with an examination of metaphysics and how an understanding of tendency and process metaphysics contributes to a pragmatic metaphysics of experience, Peirce's philosophy as described so far has application to unifying and cohering cognitive science and religion.

Application to Cognitive Science and Religion

Peirce's pragmatic approach to metaphysics has relevance to cognitive science, which has been limited by its prior philosophical foundations. Peirce's metaphysics helps identify philosophical limitations of the disciplines in contemporary cognitive science, and one way that religion can facilitate the study of mind through the language of soul.[26]

Peirce used his three categories to categorize everything, including other philosophical systems in his 1903 Harvard lecture on "The Seven Systems of Metaphysics." His seven systems consist of the possible combinations of his three categories:[27]

Table 7.2 Peirce's seven systems of metaphysics

Metaphysical Category	**Philosophical System**
Firstness	Nihilism
Secondness	Strict individualism (Lutoslawski)
Thirdness	Hegel
Firstness and Secondness	Ordinary nominalism
Firstness and Thirdness	Berkeley
Secondness and Thirdness	Descartes, Leibniz, Spinoza, and the metaphysics of the physicists of today [1903]
Firstness, Secondness, and Thirdness	Kant, Reid's philosophy, and the Platonic philosophy of which Aristotle is a special development.

25 Peirce, *Collected Papers*, vol. 1, § 16; as quoted by Parker, *The Continuity of Peirce's Thought*, pp. 190–91.

26 A portion of this section appears in Mark Graves, "Peircean Approach to Emergent Systems in Cognitive Science and Religion," *Zygon* 34(1) (2007): 241–8.

27 Charles S. Peirce and Edward C. Moore, *Charles S. Peirce: The Essential Writings*, vol. 2, (Great Books in Philosophy; Amherst, NY: Prometheus Books, 1998), p. 180.

I will only focus on the philosophical systems that he saw as having only two of the three categories—ordinary nominalism (Firstness and Secondness) and the philosophies of Berkeley (Firstness and Thirdness) and Descartes (Secondness and Thirdness). In particular, Cartesian and nominalist philosophy currently have an impact upon cognitive science.

In general, cognitive science still struggles from an overemphasis in the disciplines of cognitive psychology and social sciences on nominalism—or a lack of real generality where general ideas are mere names (or concepts) without any corresponding reality—and from an overemphasis in computer science (especially artificial intelligence) and neuroscience of Cartesian or mechanistic approaches to the mind. Although both approaches emphasize Secondness, they relatively neglect real generality (Thirdness) and real possibility (Firstness), respectively, as indicated by the fact that no one would be likely to argue that contemporary cognitive science has too much Berkelean idealism, that is, not enough actuality (Secondness). For cognitive science to mature, it needs to de-emphasize its action/reaction approach of empiricism and mechanism and capture the real possibility inherent in the regularities (or habits) of mind.

Stuart Kauffmann makes a similar claim about self-organizing systems needing to balance order and possibility at what he calls the "edge of chaos".[28] Kauffmann distinguished between systems moving toward too much possibility and drifting into chaos and other systems moving toward too much order and shifting into rigidity. Neither direction can support life (or emergence). As Kauffmann refers to actual systems, his chaos and order both include Peirce's metaphysical category of Secondness, but have parallel limitations with cognitive science's incompatible digressions into nominalism and Cartesian materialism. To model the range of human emergent relationships, systems must capture the real possibility in the midst of habituated, regular processes (pursued further in Chapter 8).

Peirce's categories and relational logic describe the constitutive relationships actually occurring within a system, and his metaphysics provides a philosophical foundation for how those emergent systems may relate. By escaping conceptual nominalism and reductive materialism, Peirce's categories and tools capture the possibilities of emergent phenomena within a habituated system.

Emergent system theory (Chapters 2–4) provides an abstract, virtual, "non-actual" tool to relate the generality of systems to the possibilities inherent in their emergence. Using constraints abstracts from the actual existing material entities and characterizes the relationships as information. Peirce's categories illuminate nominalist and Cartesian influences on cognitive science and contemporary understanding of mind, and they refine the ontological distinction of being and becoming underlying dynamic form.

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28 Stuart A. Kauffman, *At Home in the Universe: The Search for Laws of Self-Organization and Complexity* (New York: Oxford University Press, 1995), p. 26.

Jonathan Edwards's Tendencies

Peirce's semiotic metaphysics and three categories allow for real generality and escapes a nominalism that limits scientific discovery to mere social construction of ideas independent from nature. Science studies dynamic forms that exist and contain information about nature. Unlike substantial form, dynamic forms capture the tendency of attributes to function in habitual ways without requiring a fixed essence.

The approach to viewing system stability and form as a collection of tendencies builds upon the writings of the eighteenth-century American Puritan and philosophical theologian Jonathan Edwards. Edwards developed his conception of tendencies from Greek habits, and incorporated the regularity and character of behavior and redefined habit as an active causal power that combines the dynamic with the permanent.

In *The Philosophical Theology of Jonathan Edwards*, Sang Hyun Lee traces Jonathan Edwards understanding of habit, that is, tendency, back to Aristotle, Aquinas, and Hume (among others). In Aristotle's metaphysics and in scholastic thought, habit functions as a dynamic principle that perfects the operations and powers of human beings. Habits dispose one toward (or away from) some behavior. Habit, for Aristotle, is primarily an acquired propensity toward a determinate type of behavior. Aristotle wrote in his *Metaphysics*: "Habit means a disposition according to which that which is disposed is well or ill disposed." For Aquinas, habits are neither fully actual nor purely potential and do not occur on the level of substance. (However, Aquinas amplified Aristotle's conception of habit by designating sanctifying grace as a habit that functions on the level of being, which allows supernatural enhancement of one's being through the infusion of supernatural habits of being.) Edwards attempted to redefine the Aristotelian conception of habit to incorporate seventeenth- and eighteenth-century science's demand to see the world in terms of power and motion rather than substance and form. Hume also influenced Edwards by dismissing such traditional categories of being as substance and causality. For Hume, the world experienced by the mind could only be described as "constant conjunctions" or "customary associations," and the experiencing self could only be described as "nothing but a heap or collection of different perceptions." Edwards anticipates Peirce and replaces substance metaphysics with a dynamic and relational conception.[29]

Sang Hyun Lee pieces together various statements of Edwards's idea of habit scattered throughout his writings. Habit for Edwards is more than mere custom or the regular way something happens. Habit is "an active tendency that governs and brings about certain types of events and actions." As a causal and purposive power, habits are active laws that prescribe that if certain conditions are given, a certain type of action would certainly result.[30]

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29 Sang Hyun Lee, *The Philosophical Theology of Jonathan Edwards* (Princeton, NJ: Princeton University Press; rev. and exp. edn, 2000), pp. 17, 19, 21, 29, 34, 47; quote from Hume, *A Treatise of Human Nature* I.4.2.

30 Lee, *The Philosophical Theology of Jonathan Edwards*, p. 35.

Edwards's conception of being as essentially law-like habits means that being is essentially relational. Reality is a permanent process of the multiplications of relations (actualities). An entity is inseparable from its relations, and relations determine the existence of an entity. The mutual relations of all entities are absolutely comprehensive. In Edwards's conception of reality, the universe consists of a network of laws and habits of (divinely established) relationships, which exist virtually as tendencies. For Edwards the laws of nature describe and govern the "relations among certain occasions and the actions or events that occur on those occasions."[31]

For Edwards, solidity is nothing other than the activity of resisting annihilation. As being is persevering, Edwards equates solidity, resisting, existing, and being. He dismisses a material entity as a hidden substance or subject to which solidity or the activity of resisting belongs. "The solidarity of bodies and the beings of bodies is the same," and solidity is the activity of resisting annihilation. In terms of our systems model, the ability of systems to resist annihilation into component parts defines their existence.[32]

By defining the structure of being as laws or habits, Edwards presents a relational conception of being where one cannot separate the structure or essence of an individual entity (or system) from its relations. In Aristotle's framework, substantial form may exist prior to any of the accidents (e.g., relations) being actualized, but in Edwards's ontology, an entity does not exist in any sense unless its relations actually exist. The system's relations determine its existence on the level of Aristotle's substantial form. The actual existence of an entity remains impossible unless all of its essential relationships move from being real possibilities to becoming actual.[33]

Sang Lee understands Edwards's being as an "ordered power of tendency to actions and relations" where actions and relations are internal to the being of an entity. Unlike Aristotle where entities first exist as substances and then flow out into operations through their operational potencies, for Edwards, operational potencies and the substantial form are the same principle of dispositional powers. Entities exist only as they act and relate.[34]

Peirce's categories of possibility and actuality clarify Edwards's description of tendencies. One may understand Edwards's "being" as the movement from possibility to actuality. An entity does not first fully exist and then engage in operations, but its existence consists in its operations, that is, movement, from a real possibility to being an actuality through the operations of its dispositional essence. An entity moves from possibility to actuality when it exerts its disposition. Existence is an action.[35]

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31 *Ibid.*, pp. 35, 50, 77, 79–80, 95.

32 *Ibid.*, p. 52; quote from Jonathan Edwards, "Of Atoms."

33 Lee, *The Philosophical Theology of Jonathan Edwards*, pp. 89–90. Note, in terms of pragmatism, Edwards's view resonates more with James than Peirce.

34 *Ibid.*, p. 96.

35 *Ibid.*, p. 106; John F. Boler, *Charles Peirce and Scholastic Realism: A Study of Peirce's Relation to John Duns Scotus* (Seattle: University of Washington Press, 1963), pp. 99–107.

In emergent systems theory, the shift from possibility to actuality occurs as the system's relationships interact and reinforce each other. For example, a collection of chemicals becomes a metabolic pathway as the chemical reactions and catalytic processes reinforce and supplement each other and resist external influences that would disrupt or annihilate that biochemical process.

Edwards clarifies the question of whether being or becoming (permanence or change) comprises the most basic character of reality and helps us reinterpret Aristotelian form. As reality is an ordered tendency, a disposition has permanence as a structured or ordered power apart from its actual operation, and one may consider being as essentially permanent; but, since a disposition has causal power, such as to resist annihilation, being is becoming. Sang Lee argues that Edwards' position is neither that of Parmenides nor that of Heraclitus, but that "being as essentially ordered power combines the dynamic with the permanent."[36] However, Aristotle also provided that combination, and for this work, Edwards provides a way to shift away from Aristotle's bias of permanence and toward the dynamic. When one recognizes the movement of resistance inherent in stability, one reinterprets form as tendency.

Process Metaphysics

Although Alfred North Whitehead is not considered a pragmatist, I examine his process philosophy for four reasons. He developed a metaphysics of event and process that highlights the temporal aspects of relationships underemphasized in my structural approach to systems. His Platonic approach to form (as "eternal objects") appears inadequate for contemporary scientific investigations of evolving organisms, but it can highlight a kind of top-down "luring" of emergent systems on their constituents. His abstract, conceptual pole provides a structure to real possibilities prior to their existence in nature, such as the hardness of diamonds before diamonds exist. Finally, several theologians and philosophers exploring science and religion use Whitehead, and throughout the book I have tried to highlight those connections. In particular, Donald Gelpi draws upon both Whitehead and Peirce for his metaphysics of experience which grounds a pragmatic theological anthropology (described below).

Whitehead's Process

Whitehead's process philosophy developed a metaphysics based on experience which he called a "philosophy of organism." He endeavored to frame a system of general ideas in which "every element of our experience can be interpreted."[37] Whitehead built upon James's exploration of experience, and developed a metaphysics based on event and process rather than substance and immutable being. Whitehead denied the "primary substance" of Aristotelian thought and the equating of being and immutability.

36 Lee, *The Philosophical Theology of Jonathan Edwards*, p. 96.
37 Whitehead, *Process and Reality*, p. 3.

William James suggested that experience consists in the interrelation of concrete percepts and abstract concepts. The human mind explains reality by the correct correlation of a perceptual "this" with a conceptual "what." James suggested that experience grows in "buds or drops of perception":

> We either perceive nothing, or something already there in sensible amount. This fact is what in psychology is known as the law of the "threshold." Either your experience is of no content, of no change, or it is of a perceptible amount of content or change. Your acquaintance with reality grows literally by buds or drops of perception. Intellectually and on reflection you can divide these into components, but as immediately given, they come totally or not at all.[38]

Whitehead transformed these observations of James's into a systematic metaphysical statement. In formulating his revised subjectivist principle, Whitehead endorsed James's suggestion that experience grows in drops, and he transformed the term "experience" into a universally applicable metaphysical category. Instead of equating reality with immutability, Whitehead identified reality with process stating "process is the becoming of experience."[39]

Whitehead rejected the materialistic, mechanistic physics of Newton and Descartes to assert the organic character of reality. Mechanism, he complained, eliminates subjective experience from reality and results in an actuality devoid of subjective experience. He called such an activity "vacuous actuality." His philosophy of organism adopts the scheme that Locke's account of mental substance embodies a more penetrating description than Descartes' account of corporeal substance.[40]

In Whitehead's subjectivist account of experience, finite created realities have immediate access within experience to the ideas that exist in the mind of God. In Whitehead's original thought God is not a personal God, but more of a metaphysical placeholder that perhaps offers the world possibilities without forcing them on anyone or anything.[41]

His philosophy of organism denies two assumptions that he claims Hume mistakenly assumed: "that the datum in the act of experience can be adequately analyzed purely in terms of universals" and "that the primary activity in the act of experience is the bare subjective entertainment of the datum, devoid of any subjective form of reception."[42]

Whitehead's reformed subjectivist principle asserts that being-in-general and experience coincide: "that apart from the experiences of subjects there is nothing,

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38 William James and Horace Meyer Kallen, *Some Problems of Philosophy: A Beginning of an Introduction to Philosophy* (New York: Longmans, Green, and Co., 1911), ch. 10, p. 155; cf. pp. 47–74; cited by Gelpi, *The Gracing of Human Experience*, p. 276 and Whitehead, *Process and Reality*, p. 68.

39 Whitehead, *Process and Reality*, pp. xii, 68, 166.

40 *Ibid.*, pp. xii, 19, 69–77, 157, 167, 309. See also Gelpi, *The Gracing of Human Experience*, p. 128.

41 In Whitehead's reformulation of Plato the mind of God holds the eternal objects much like the Ideas of Middle Platonism.

42 Gelpi, *The Gracing of Human Experience*, p. 277; Whitehead, *Process and Reality*, pp. 157, 167.

nothing, nothing, bare nothingness." For Whitehead, the emerging subject exemplifies a particular occasion or drop of experience, rather than underlying an accidental experience, as it does in classical substance philosophy. Although Whitehead endorses a subjectivist account of experience, he reduces the objects of experience to concrete sensible things and describes immediate actual experience in the language of actual entities, prehensions, and nexus (defined below).[43]

His *Process and Reality* describes the becoming, being, and relatedness of what he calls "actual entities," which are the primitives of reality. Whitehead's *actual entity* (or *actual occasion*) is an event, like a frame of film or the paused image of a DVD, that also has a dynamic reality and perishes in a fraction of a second. It is the "final real thing of which the world is made up." His actual entity is similar to Descartes' substance, but with the emphasis on "relatedness" over "quality." Thus, for Whitehead, *how* actual entities are related is more central than *what* they are. His "philosophy of organism" equated Being with process and described how reality is composed of actual entities. Whitehead believed that every entity, including the tiniest subatomic particle of the universe, has two poles: a concrete, physical pole and an abstract, conceptual pole. Actual entities have a pure potential that determines the shape, pattern, quality, and so on of the world that Whitehead called *eternal objects*. An eternal object "does not involve a necessary reference to any definite actual entities of the temporal world." Eternal objects are Whitehead's reinterpretation of Platonic forms.[44]

In Whitehead's understanding of reality, two things do not change: the past—eternally fixed in its actuality—and the eternal objects which constitute the pure potentiality luring the universe forward. Spatio-temporal experience exists only as long as the process of synthesis between the concrete and abstract poles remains incomplete. Once a particular spatio-temporal occasion of experience has reduced the abstract pole of experience to concrete actuality through decision, the occasion of experience perishes and joins all the other objectively immortal memories in the mind of God which constitute the past.[45]

Prehension relates to the movement from the past to the present. It relates each actual entity to the antecedent universe. Every prehension contains an emerging, that is, developing, subject which does the prehending, what the subject prehends, and how the subject prehends its object. The emerging subject prehends as object its immediate past, a drop of experience which has just perished and become objectively immortal. If the new emerging subject prehends only the conceptual elements already made concrete in the perished drop of experience, it will repeat the preceding experience in a different part of the space-time continuum. However, if the emerging subject also prehends a novel possibility, then the emerging subject may incorporate into its object the novel possibility which will then turn the subject into a new kind of reality.[46]

43 Whitehead, *Process and Reality*, p. 20.

44 *Ibid.*, pp. xiii, 18, 22, 44.

45 *Ibid.*, pp. 48–51, 194; cited by Gelpi, *The Gracing of Human Experience*, p. 128.

46 Gelpi, *The Gracing of Human Experience*, p. 129.

The incorporation through decision of a novel possibility into the object of a prehension makes the resulting subject a new kind of individual, since the introduction of the novel element forces a rearrangement of all the relational elements which constitute it. The previous elements need to readjust to relate differently to one another, because now they must interrelate among themselves in the light of their relationship to the new element.

The overlapping drops of experience which constitute what most people designate as an individual exemplifies what Whitehead called a "*nexus*." A nexus exemplifies an overlapping multiplicity of actual entities interrelated by their prehensions of one another.[47] A person is a particular kind of nexus, called confusingly a *society*. A person consists of a series of overlapping drops of experience which come to be and perish in a fraction of a second and which stretch from the moment of conception to the moment of death. The only thing that allows one to view the nexus of overlapping occasions as a single reality is that when the first drop of experience we call a person emerges, God assigns it a purpose, as captured by an eternal object, which carries forward from one drop of the person to the next.[48]

Neo-Whiteheadean Systems

Whitehead, in his process philosophy, draws upon James's suggestion that experience grows in "buds or drops of perception"; but because James missed the general continuous interrelatedness of Thirdness, Whitehead had only a "stream" of overlapping drops of experience in which to revise his "subjects." Because James missed that Thirdness guides the actualization of possibility, Whitehead posited "eternal objects," based on Platonic forms, to lure reality forward.

However, because the eternal objects are fixed as pure potential, they determine the direction of reality and remove real possibility. Whitehead's eternal objects introduce many difficulties of dualism that this book attempts to overcome. However, if one could move eternal objects out of a separate Platonic realm, in a way similar to how Aristotle incorporated form in his hylemorphism, then Whitehead's metaphysics could highlight differences between the unknowable relationships of nature and the systems of constraints studied by scientists.

Joseph Bracken revises Whitehead's societies in a neo-Whiteheadean scheme using insights from systems theory, fields, and scholarship on intersubjectivity. By proposing regularity and generality at the nexus of events (as grouped into societies) rather than only in eternal objects, Bracken's approach, in a sense, increases real possibility and regularity to address (at least in part) the limitations of Whitehead's metaphysics.

Bracken combines Whitehead's process philosophy with Ervin Laszlo's system theory into a neo-Whiteheadean framework. Although Bracken agrees with Whitehead that actual entities (or actual occasions) comprise the ultimate unites of reality, he agrees with Laszlo that systems (Whiteheadean societies) comprise

47 The production of novel togetherness is called *concrescence.*

48 Gelpi, *The Gracing of Human Experience*, p. 130; Whitehead, *Process and Reality*, p. 20.

ontological wholes not only more than but other than their constituent parts or members. For Bracken a society (and thus a system) consists of any non-random grouping or "nexus" of actual entities "which perdures through time and is governed by a *common element of form*." Bracken's societies do not exist objectively, but intersubjectively. Rather than existing in reference to the external world, they exist in ongoing exchange with each other. To model these societies (systems) Bracken utilizes "fields" rather than "substance."[49]

In physics, a *field* refers to a region of space with a quantity defined at every point. A "force" refers to the direction in the field in which acceleration occurs. Process philosophy developed through Whitehead's followers who based them upon his Gifford Lectures in 1928–29. While Whitehead was familiar with the early work in quantum mechanics, considerable work remained to integrate quantum mechanics with the four fundamental forces in nature: weak, strong, electromagnetic, and gravitational. Although working philosophically, Bracken's extension to Whitehead parallels further development in physics to formulate quantum theories to incorporate fields, especially quantum electrodynamics.[50] Quantum electrodynamics appears to resolve the wave–particle paradox, but physicists continue to work on completing the development of a theory to incorporate the well-tested, but theoretically incompatible, findings of current quantum field theories and general relativity (i.e., gravity). Because of the sophisticated mathematics, counter-intuitive interpretations, and incomplete development of a consistent theory, scientifically plausible metaphysics incorporating phenomena of the subatomic-level remains tentative at best.

Bracken's neo-Whiteheadean approach informs the philosophical foundation of systems theory by incorporating events, fields, and intersubjectivity in a metaphysics of intersubjectivity which incorporates scientific dimensions of subatomic-level phenomena. His focus on intersubjectivity highlights the important influence of higher-level systems on lower-level systems not implied by the term "emergence."

Process metaphysics highlights the temporal aspect of dynamic forms necessary for adequate description of second-order emergence, but not obvious in Peirce's Thirdness. From a systems perspective, one can describe dynamic forms as partially encapsulating slower-changing relationships, that encapsulation depends upon the self-maintenance of boundary constraints that occur in nature. Metaphysically, Bracken's revised societies suggest an alternative integration of change (as process) and continuity (as intersubjective societies).

Now, we return to American pragmatism using the contribution of process philosophy.

Pragmatic Anthropology

Donald Gelpi provides a unified metaphysical foundation for his theological anthropology of the self as an emerging collection of tendencies created by a

49 Bracken, *The One in the Many*, pp. 4, 132–7, 221.

50 For a classic, accessible introduction, see Richard Phillips Feynman, *QED: The Strange Theory of Light and Matter* (Alix G. Mautner Memorial Lectures; Princeton, NJ: Princeton University Press, 1985).

person's experiences and decisions. Gelpi adapts Peirce's phenomenology and metaphysics and Whitehead's understanding of reality as process to develop an emergent anthropology rooted in experience. Recall that Peirce's triadic metaphysics builds upon his logic, phenomenology, and semiotics, and that he proposes three metaphysical categories: Firstness, the realm of possibility; Secondness, the realm of actuality; and Thirdness, the realm of generality. The categories depend upon each other, and Thirdness consists in the general interrelated tendencies that guide the actualization of possibilities. Gelpi borrows Whitehead's emerging subject as the basis for experience; acknowledges that for Peirce, the subject of change evolves and emerges from change; and uses the tendencies (i.e., habits) of Jonathan Edwards for combining the dynamic with the permanent.

The key to Gelpi's anthropology are *tendencies*, which incorporate a person's past conscious or unconscious decisions; endow experience with reality, generality, and a dynamic orientation toward the future; and provide a foundation for autonomy. Gelpi's metaphysical tendencies derive from Peirce's Thirdness, which describes the generality and interrelatedness of reality.

Utilizing his metaphysics of experience, Gelpi develops an anthropology of an autonomous, social, sentient being that experiences the world and develops through decision-making. As described in the previous chapter, such a model has neurological plausibility, given current research in learning and decision-making in neuroscience. Gelpi's anthropology draws from George Herbert Mead's description of a self emerging from social interaction within a group or community (Chapter 1), and Gelpi's utilization of Thirdness connects past decisions, present experience, and future development of a person.

Emergence of Subjectivity

Western language tends to acquiesce in the presuppositions of essentialism and substance philosophy, assuming some kind of self must underlie the experience in order to have it. Typically, an experience means something which somebody has rather than something one exemplifies. If, with James, Whitehead, and Gelpi, one views experience as reality, then the whole of reality divides into a "what" and a "how." The "what" of experience provides it with its object, and the "how" of experience provides it with an evaluative shape, that is, with a way of experiencing.[51]

Gelpi equates reality with process and relegates form to the "how" of experience rather than objectifying it as "what." Although Whitehead believed that eternal objects become ingredient in things, Gelpi views Whitehead's philosophy as acquiescing in the classical (Middle Platonic) fallacy of transforming ideas into principles of being, that is, essentialism. Peirce's modified Scotist realism restricts reality more carefully than Whitehead to modes of sensation and perception.[52]

Gelpi views change in Whitehead's philosophy as operating on an aesthetic model rather than on a hylemorphic one as in Aristotle, similar to how the addition of a new daub of color to a painting results in a completely new painting not just the

51 Gelpi, *The Gracing of Human Experience*, p. 277.

52 *Ibid.*, pp. 277–8.

old painting plus the daub. After the addition one must perceive everything else in the painting in the light of their relationship to the daub and of it to them.[53]

In an aesthetic model of change, the subject of change emerges from change rather than underlying it as a fixed and unchanging essence. If subjects emerge from change, then, one can legitimately conceive them as self-organizing or self-creative, that is, as the growing together of different kinds of relationships. History defines the real "essence" of finite things, that is, their "whatness." If people are created out of the stuff of experience and exemplify the sum total of their conscious and unconscious decisions, then each person is in the process of becoming the kind of person that person chooses to become. With essences relegated to the "how" of experience, reality is functional, dynamic, and relational.[54]

In substance philosophy, selfhood derives from one's possession of an individuated substantial essence, which serves as the source of every self's activity. However, in a world of developing experiences, history rather than fixed metaphysical forms defines one's essence, and selfhood must be reconceived as "autonomous functioning which enables every self not only to initiate its own activity but to create itself from one moment to the next through interaction with its world."[55]

Metaphysics of Experience

Gelpi's metaphysics of experience rests on four solid assumptions: human experience provides access to reality; abductive reasoning based on experience leads to falsifiable metaphysical hypotheses; if those falsifiable metaphysical hypotheses are systematically tested against lived, scholarly, and scientific investigations of reality as experienced by humans, then the verified hypothesis will result in a metaphysics that explains reality as experienced; and the resulting, verified, yet still falsifiable, metaphysics is as consistent, applicable, adequate, and coherent as any other scientific theory.

Although Peirce did not invoke experience as a foundation for his metaphysics as Gelpi does, Peirce's phenomenology explores descriptively whatever appears in experience. If whatever appears in experience enjoys reality, then reality and experience would appear to coincide, and Peirce's phenomenological categories of quality, fact, and law exemplify different kinds of reality, namely possibility, concrete actuality, and real generality. Thus, Peirce's logic allows Gelpi to identify a triadic construct of experience with the real.[56]

Although Peirce tended to restrict the meaning of "experience" to the impact of the world of fact upon thought and linked the experience of the present moment to the category of Firstness, he recognized that Thirdness endows experience with its dynamic shape. Peirce wrote: "An 'Experience' is a brutally produced conscious

53 *Ibid.*, p. 129.
54 *Ibid.*, p. 278.
55 *Ibid.*, p. 279.
56 *Ibid.*, p. 280.

effect that contributes to a habit, self-controlled, yet so satisfying on deliberation, as to be destructible by no positive exercise of internal vigour."[57]

Gelpi argues that Peirce's thought tends to support the legitimacy of invoking Peirce's basic metaphysical categories for developing a systematic metaphysics of experience. Peirce characterizes his metaphysics as "objective idealism" which asserts that reality resembles a "mind," and Gelpi interprets that assertion in light of Peirce's doctrine of synechism and "law of mind," or the mind-like quality of nature. Synechism, or "the law of continuity within development," discovers an evolving spectrum of tendencies linking non-living things to living ones, and living things to conscious reasonableness. Thirdness provides synechism the explanation of continuity within emergence. "When living things act efficaciously on themselves, their activity tends to build into themselves new habits which develop in vital continuity with those they already possess." Consequently, living things possess an enhanced capacity to create new generality. In Peirce's mind-like quality of nature, the evolution of sensate life at the biological level prepares the emergence of higher-level systems. Peirce's synechism traces the roots of conscious mind all the way back into the laws of physics. Peirce's assimilation of reality to "mind" lends sanction to invoking his triadic, semiotic realism in developing a metaphysics of experience because a mind exemplifies a certain way of experiencing, with experience rooted in basic biological and physical functioning.[58]

In Whitehead's prehension, the emerging subject prehends as object its immediate past, a drop of experience which has just perished and become objectively immortal. This objectification of the past encapsulates the history of the current entity. Peirce's Firstness captures Whitehead's novel possibility, and Gelpi views the past not as objectified in a single sensation but in the complex of tendencies a person has chosen to become.

Gelpi incorporates into the emergence of "subjectivity" (on the part of a system) the system's external environment. Each of Gelpi's metaphysical categories—value, decision, and tendency—make a different contribution to the dynamic structure of human cognitive experience. Evaluation contributes a feeling of presence, of qualitative particularity, and of possibility. Decisions make experience actual, concrete, and both environmentally and socially rooted. Tendencies endow experience with reality, generality, and a dynamic orientation toward the future. Dynamic tendencies grow and spread in an incremental continuum that provides access to transcendent reality. [59]

Gelpi's metaphysics of experience corrects a Aristotelian philosophy of substance in three ways: [60]

1. It rejects the essentialism of substance philosophy by restricting essences to

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57 Gelpi, *The Gracing of Human Experience*, p. 280, discussing Peirce, *Collected Papers*, vol. 1, § 321; vol. 2, § 138; vol. 5, §§ 41–4, 160; quote from vol. 6, § 454.

58 Gelpi, *The Gracing of Human Experience*, pp. 280–82.

59 *Ibid.*, p. 291.

60 *Ibid.*, p. 353.

the *how of experience* rather than the what.
2. It replaces a substantialist notion of subsistence with a *functional subsistence*. Anything that initiates its own activity, i.e., functions autonomously, subsists in its own right.
3. It extends the notion of *mutual inexistence*, the existence of realities in one another, to every exemplification of subsistent being. In Christian Aristotelianism, mutual inexistence characterizes the divine persons only, but by insisting that the object of experience stands within the experience in a metaphysics of experience, mutual inexistence is extended to all created substances.

American pragmatism incorporates the relational logic and pragmatic maxim of Peirce to define a philosophical foundation for systems theory as a model for nature and the relational memory and decision-making process of systems describing the human person. Rather than merely psychologizing pragmatism as did James, Gelpi shows how to use Whitehead's insights into process, subjectivity, and experience to better incorporate human experience of nature into human understanding of nature and its metaphysical foundations. Bracken, with his revision of Whiteheadean societies using systems and intersubjectivity, suggests a direction for further incorporation into metaphysics of what I call the subatomic aspects of nature. Together they provide metaphysical foundations for the shift from the remnants of Platonic essentialism in Aristotle's philosophy of nature to a process of becoming suggested by Jonathan Edwards's tendencies.

Pragmatic Foundation for Systems

Systems theory provides tools and methods for analyzing the relationships between constructs, while pragmatic philosophy provides a system for determining how to distinguish the constructs. The conceivable practical effects of a construct determine its meaning. How do decisions to model phenomena as one system or two, or determine a system boundary here or there, affect the rest of the system? What configuration of a system leads to a more consistent, coherent, applicable, adequate, fertile, and robust theory?

Every scientific theory makes simplifying assumptions, and systems science is no exception. Pragmatism minimizes the consequences of those simplifying assumptions by making the assumptions and their effects explicit. What patterns lead to the effects under study? Could one discover evidence to falsify the selection of systems boundaries and relationships chosen?

In Peirce's realm of possibility (Firstness) everything has potential, but nothing actually exists. Although Peirce saw none of his three realms existing in isolation, a quantum vacuum provides some indication of a realm of possibility. Probability waves interact in superpositions and occasionally particles come into existence and then become annihilated. When particles (or particle pairs) exist, they become actual. A particle, as any other entity, separates itself from what is not itself. The boundary, however amorphous, creates a dyadic relationship between the entity and what is not the entity within the ground in which the entity exists. Peirce called Secondness the dyadic relationship of actuality. For the particle to continue existing past the moment in time, it requires a habit of existing which connects not only the particle against its contrasting ground, but also to its prior movement's existence.[61] Reality requires Peirce's Thirdness to relate something to what it is not and to its generality. Only when entities have that generality can they interact with other generalities, such as humans. To be general, an entity must also have a particular and a distinction. Thus, none of Peirce's three categories exist in isolation. Even femto-second-lived particles last long enough for physicists to measure them.

In a classic vacuum, one determines how something appeared where nothing previously occurred. In a quantum vacuum or Peirce's realm of possibility, one determines how that particular thing occurred rather than something else. One may add to a classic vacuum, but in a quantum vacuum one must constrain the possible to the actual. Although a ball could have any color (or an electron either spin), actuality constrains the possible actions. Reality overflows with possibility until it becomes constrained. After becoming constrained to actuality, those constraints and other constraints with which they interact provide stability to the entities—an aspect of generality. Thirdness describes the connections between the actualities modeled by constraints.

Juarrero's two types of constraints in self-emerging systems, part–part interaction and whole–part interaction, capture the interactive and formal aspects of constraints in emergent relationships. However, Deacon's third-order of emergence requires information from which the systemic processes select, and Peirce's Thirdness captures the persistence of habitual functioning. The connection of constraints along lines of identity provide the stable structure that varies with the influence of higher-level processes, in other words, dynamic form.

Emerging Purpose

Peirce's three categories, Firstness, Secondness, and Thirdness, also represent the three principles of chance, reaction, and the tendency toward regularity. Kelly Parker describes the tendency toward regularity, or habit-taking, as a teleological factor in Peirce's metaphysics: if reality were only brute reaction (Secondness) broken up by occasional chance variation (Firstness), there would be no discernable order. Parker states: "The teleological influence of habit is essential to Peirce's conception of realism."[62]

Stuart Kauffman, however, is useful for clarifying Parker's assumption of teleology. In his *At Home in the Universe*, Kauffman describes the self-organization of brute reactions with occasional chance and the emergence of order, such as periodic

61 Here Gelpi points out the limitations of Whitehead's concrescence to only capture the dyadic relationship of actuality, but not the real generality of Peirce's Thirdness. But also note Joseph Bracken's extension of Whitehead's societies to capture the necessary "whole" of identity across time.

62 Parker, *The Continuity of Peirce's Thought*, pp. 200–202; quote on p. 200, referring to Peirce, *Collected Papers*, vol. 6 § 201.

behaviors and power law regularities. Clearly, it is not the teleological influence of habit that is necessary, but habit's *autopoietic* or self-organizing influence. To provide an explanation of teleology (goal-seeking) from teleomatic (end-producing) behaviors, teleology should emerge from habits rather than be intrinsic to them.[63] Peirce describes how his metaphysical categories might have evolved cosmologically.[64] Kauffman presents computational models that could be interpreted as showing how natural systems predominated by Firstness and Secondness give rise to those predominated by Thirdness.

One of the characteristics of tendencies is that a complex of tendencies may develop and evolve over time. The complex of tendencies, referred to as an entity, may slowly shift the particular collection of tendencies and develop (with an individual over a relatively short time period) or evolve (across a population over a long time period). Living things grow by efficaciously incorporating into their "bodies" food from the environment. Without incorporating food, the complex of tendencies will decay. A living body's efficacious incorporation of ingested chemicals transforms them into the integral parts of the body that absorbs them.[65] The digested elements cease to function autonomously but are now constrained by the person that they help constitute. As described by organic chemistry, chemicals function differently as integral parts of a living body from when in isolation. Tendency supplies a world of developing experiences with a "spontaneous dynamism." Tendencies, whether relatively simple or complex, that initiate their own activity have the character of functioning selves and are a component of biological life, that is, they become autonomous.[66] Tendencies provide a metaphysical description of the relationship between entities and their emergent properties. However, even if one denies a complete metaphysics, tendencies provide a way to model system stability and identity.

One may interpret the collection of tendencies of an object as its form. The form of the object consists of the information contained by the constraining relationships. Tendencies structure the possible behaviors of an object and thus provide structure to its purpose.

The arrangement of components defines the form of the system in Tatarkiewicz' definition A (arrangement). The second-order constraints formally cause (in an Aristotelian sense) the interactions and first-order constraints within the system. The second-order constraints result in the arrangement (organization) of components. For example, the "laser beam coherence" formally causes the component waves to vibrate at a particular frequency, and a "cardiac rhythm" formally causes an individual cardiac cell to contract at a certain rate. The coherence causes the components to take similar paths through their individual phase spaces. Initially, external factors and component activity set the parameter of the organization (laser frequency or

63 Kauffman, *At Home in the Universe*.

64 Parker, *The Continuity of Peirce's Thought*, pp. 206–215; e.g., Peirce, *Collected Papers*, vol. 6 §§ 196–200, 215–20.

65 In an Aristotelian sense, the form of the chemicals transforms to the form of the body by participating in a different constellation of tendencies.

66 Gelpi, *The Gracing of Human Experience*, pp. 291–300.

heart rate). After creation of the second-order constraint and "form," external or higher-level factors affect the overall system parameter and the system's stability. The parameter of the system (new degree of freedom) indicates the *telos* of the system, and thus the higher-level manipulations of the system parameter "finally" cause (control) the components parameter. For example, the "frequency of the laser beam" "finally" causes the individual atoms to operate at that frequency, or one's heart rate "finally" causes other heart cells to operate at that rate.

Freedom as Constraint

Paradoxically, constraining relationships also provide greater possibility in an emergent system. Physically, a person's body consists of a couple of dollars worth of chemicals in a puddle of water. Without the constraints of biology, one has greater freedom to swap chemicals around, add chemicals, remove chemicals, and thus greater potential to create something new. Typically, the constraints of a person's body resist the addition and removal of chemicals such as potassium and chlorine, and thus one has fewer choices for physical manipulation with a biologically constrained body than with a pile of chemicals. Additionally, the presumed physical environment constrains the pile of chemicals in a puddle of water by the atmospheric pressure, high absolute temperature, gravitational pull of Earth, electromagnetic forces, and so on. The "freedom" reduced by the "constraining relationships" is the freedom of potentiality. In an information-theoretic sense, "freedom" refers to uncertainty in the system. Although the pile of chemicals has greater potential—perhaps they might combine into a large dog or a small horse—humans value a different freedom. Humans value the freedom to live rather than die, to exist awake rather than comatose, to exercise free will rather than live enslaved—the freedom of real possibility rather than potentiality. Humans value the greater freedom of the higher-level than potential actions of a lower-level process. As a higher-level, organized system, people have greater "degrees of freedom in phase space" than their lower-level components.

The systematic context selectively constrains the component's behavioral repertoire and curtails their degrees of freedom. Unlike electrical generators and other allopoietic devices that utilize externally imposed governors, the emergence and formation of a system establishes second-order constraints on its components. As distributed wholes, emergent systems virtually govern themselves, for example a coherent laser beam controls its component waves even though no external controller exists. The orderly relationships that characterize the structure of the overall laser beam as a whole provide the context that controls its components. The controller confers a particular identity to the system resulting in an informational demarcation, though not a physical one. As a biological example, the systematic context of the overall heart confers an otherwise absent stability on individual cardiac cells.[67]

Constraints that wholes impose on their parts reduce the number of ways in which the parts can be arranged, and those previously independent parts acquire new

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67 Alicia Juarrero, *Dynamics in Action: Intentional Behavior as a Complex System* (Cambridge, MA: MIT Press, 1999), p. 144.

functional roles as components of the larger system. The overall system has greater possibility than the independent, uncorrelated components through the restriction on the individual components.[68]

Self-organization constitutes the appearance of the remarkable and "unpredictable" properties of the global level, such as the cauterizing ability of the laser beam or the enzymatic capabilities of a protein. These emergent properties of the higher level are the phenomenological manifestation of those dynamic relationships. The higher level of organization—as a second-order, top-down constraint—is causally effective and not epiphenomenal.[69]

Thomas Aquinas described being as an act. Existence and potentiality have a converse relationship. As something progresses in how it "actually" is, its potential to exist otherwise decreases. Constraining relationships provide a stepwise increase in actuality by restricting the potential to exist otherwise. A constraining relationship might restrict potentiality without increasing actuality, but some constraining relationships provide an "actuality" that appears to emerge as a new property.

For example, the folding of a particular complex organic molecule into a specific shape may appear green when illumined with white light, or the precise location of amino acids in one folded protein (kinase) may facilitate the addition of phosphorus into another molecule (phosphorylation). The simple emergence of a property, where the whole is greater than the sum of its parts, provides a building block for an emergent process. Although an emergent property by itself may not appear significant, when a system with one emergent property combines with other systems with other emergent properties and that new combined system also gains constraining relationships, the original emergent property may become an essential property of a higher-level emergent process.

Some of these higher-level relationships may have lower-level constituents that provide inputs or other resources needed by the original lower-level system, thus increasing overall system stability. For a human in an affluent society, cultural systems provide transportation of food, and psychological-level decisions involve what to eat. When those economic systems break down, humans must search for food directly. When a human or an animal does not or cannot find food, certain biological processes change. Those changes in biological processes will trigger other processes that will conserve energy, burn fat repositories, and signal primitive structures in the brain that the organism needs food. Although most of these processes occur in biological-level systems, several physical-level systems will also change as necessary functional and structural nutrients fail to appear. Eventually a lack of essential nutrients (at the physical level) would shut down essential biological-level processes, and all psychological-level activities of hunting food would cease followed by all biological-level processes, leaving only a physical-level, but biologically nonfunctioning system.

Only when lower-level systems have constraints to support higher-level functions can a system exist (subatomic constraints); stably (physical constraints); alive (biological constraints); sentient–responsive–animate, that is, "conscious"

68 *Ibid.*

69 *Ibid.*

(psychological constraints); engaged in communal “life” (cultural constraints); and spiritually “alive” (transcendent constraints).

Constraints at one level frame a constitutive absence or “empty space” from which new constraints may emerge. In previous chapters, I have described the empty space in protein configuration, synaptic clefts, and abstractions of symbolic language. In the next chapter using the writings of Thomas Merton, I describe empty space in the psychological-level systems of the self framed within the cultural-level construct of Christianity that constitute transcendent-level systems of spiritual development. How do those “empty spaces” (as constitutive absences) relate and form “real possibilities”?

CHAPTER 8

The Elusive Soul

O Lord my God, When I in awesome wonder,
Consider all the worlds Thy Hands have made;
I see the stars, I hear the rolling thunder,
Thy power throughout the universe displayed.
Then sings my soul, My Saviour God, to Thee,
How great Thou art, How great Thou art.
—Carl J. Boberg and R.J. Hughes, 'How Great Thou Art'

When God had made The Man, he made him out of stuff that sung all the time and glittered all over. Then after that some angels got jealous and chopped him into millions of pieces, but still he glittered and hummed. So they beat him down to nothing but sparks, but each little spark had a shine and a song. So they covered each one over with mud. And the lonesomeness in the sparks made them hunt for one another, but the mud is deaf and dumb. Like all the other tumbling mud-balls, Janie had tried to show her shine.
—Zora Neale Hurston, *Their Eyes Were Watching God*

Mere suffering exists, no sufferer is found;
The deed is, but no doer of the deed is there;
Nirvana is, but not the person that enters it;
The Path is, but no traveler on it is seen.
—*Visuddhi-Magga* XVI

Introduction

From the depths of human experience, one's soul feels joy and suffering. Science can describe the biochemical processes of the brain involved in emotional response, but suffering and joy have a real personal depth that affects more than one's thoughts on the matter. Neither suffering nor joy is restricted to the psychological, and the human experience of suffering and joy infuse the world through our participation with it. As I suffer, my entire body suffers—joints, lungs, and neurotransmitters. As I feel joy, my entire body feels joy, as do the social and cultural systems I constitute. Not that one's emotions directly transcend individual existence, but they infuse one's relationships with the world. Through the constellation of relationships in emerging human systems, a person exists in the world. Neither the internal nor external relationships constituting the person have independent existence, but the emerging systems mutually support, stabilize, and form the person, and respond to one's experience.

Philosophy provides the useful abstraction of form to capture the individual's constitutive relationships. As described in Chapter 2, form describes the configuration, shape, or essence of an object. In addition to aesthetic form in art and architecture, substantial form captures the configurations described here as relationships in systems, especially physical, biological, and psychological systems going back to Aristotle. In addition, a person's existence and meaning receive definition, interpretation, and purpose from the larger systems in which the person participates. One's family, tribe, culture, and transcendent experience also define and inform one's soul. The individual has greater control over lower-level biological systems and receives the most direct influence from cultural systems, then one chooses through one's behavior how one's soul becomes defined. One defines oneself through decision-making, and those decisions affect the definition of one's community, which then in turn helps define one's soul.

As information, one defines the soul both as the patterns of constitutive relationships as well as by relationships missing. Does one have a relationship with one's parent, child, community center, high-school sweetheart, political party, old friend, investment bank, church, siblings, neighbor, or close friend overseas? Absence also forms the soul, whether the relationship never existed or became lost. Especially in the context of higher-level social systems, both presence and absence of relationships form one's soul.

The systems of constraining relationships and constitutive absences form the soul. The coherent theories of each emergent level model the interaction in human systems, and together unify perspectives on the human person. Those levels include the subatomic systems full of the possibility of existence and the transcendent level in which humans in religious systems aspire to participate. Those embodied human systems are grounded in the brain, but expand the limits of individual, historical existence by forming stable religious and spiritual systems whose tendencies guide further human development. The collection of constitutive relationships that enable real possibility forms the soul.

In Western usage, the "soul" would refer to the collection of relationships in humans or other animals; the term "form" would refer to those relationships in physical-level objects and some biological entities, such as plants; and for the relationships of higher-level systems, one might refer to the "soul of a community" or the "spirit of a church." However, as I use "soul" it refers to a systems constellation of constitutive relationships regardless of emergent level. A rock, mountain, or lake may have a "soul"—correlating with some indigenous cultures. Plants have a soul—consistent with pre-modern Western usage. In addition to animals and humans, higher-level social and cultural systems have souls, such as a community, institution, church, corporation, or government. Transcendent-level systems have a soul, such as in Josiah Royce's spirit of the Christian church, where the church (a collection of cultural-level systems) would constitute Christ's body.

The "human soul" refers to the constellation of constitutive relationships that enable real possibility in a human person. However, the philosophical question of how one defines the dynamic form of a system impacts upon what one considers an aspect of one's soul.

Where lie the boundaries of the system? Where does the mountain, person, or community end?

From a pragmatic perspective, one may define the meaning of a system as the sum total of all conceivable practical effects rather than analytically. The limits of a person's soul, the contour (from Tatarkiewicz's form C) of a person's dynamic form, and the boundaries of a system depend upon the practical effects one can have in the world (from Jamesean pragmatism) and the conceivable practical effects (from Peirce). As an emergent system, a person's participation in higher-level systems influence and constrain a person's *real* possibility.

Does my cultural location as a twenty-first-century, American Christian constitute an aspect of my soul?

When I eat a meal, the nutrients become constituents of my physical body and participate in biological-level processes. Do its cultural-level economic preconditions in sustainable or unsustainable agriculture also form my soul?

What makes a person more than a collection of parts?

So far, we have examined answers to that question from the perspectives of emergent systems theory, pragmatism, mind–brain relationship, and spiritual relationships enculturated by communities. Historically, the question has centered on the nature of the human soul. How do contemporary investigations in cognitive and brain science, pragmatic philosophy, and emergent systems theory impact upon a theological understanding of soul and spirit?

I identified the information content of systems (Chapter 2) with form, and the symmetry breaking of second-order emergence (Chapter 4) describes how forms emerge. Using pragmatism (Chapter 7), I defined form non-substantially as a constellation of constitutive relationships that enable real possibility. These relationships define the human person across levels (Chapter 3), and the decisions one makes determine the person one becomes in one's cultural situation. Not only do decisions affect one's "natural" self, but through a willingness to participate in transcendent-level systems, one connects one's self to spiritual systems historically considered "supernatural."

Decisive Self

How do one's decisions constrain one's self?

One way to approach the self in a spiritual context occurs in contemplative psychology. Gerald May, a psychiatrist who supervises the training of spiritual directors, defines *contemplative psychology* as "an approach to human experience that maintains that wisdom depends upon a full cooperation of all ways of knowing: observation, logical inference, behavioral learning, and intuition."[1] May provides a model for the will that distinguishes between willfulness, which sets the individual apart from more meaningful life, and willingness, which surrenders to the processes of life in trust. May's model provides a psychological-level theory of the human will embedded in religious systems that refer to transcendent relationships.

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1 Gerald G. May, *Will and Spirit: A Contemplative Psychology* (San Francisco: Harper & Row, 1983), p. 26.

Willfulness and Willingness

According to May, there are two shapes of the will: willfulness or willingness. *Willfulness* is "a setting of oneself apart from the fundamental essence of life in an attempt to master, direct, control, or otherwise manipulate existence," and *willingness* implies "a surrendering of one's self-separateness" and "an immersion in the deepest processes of life itself."[2] Because May's work involves helping others discover the spiritual processes acting in their lives, it correlates with a spirituality immanent in human systems. In May's model of the self, a person's will forms either individualistic or relationship-oriented shapes.

The choices made by the will in attending to the desires of the person affect how the self attaches to earthly life. Desires are necessary as they signal a person's biological needs and spur people to constructive action in the world. However, attachment to a desire adds a driven quality that distorts the person's perception of reality and interferes with their ability to respond to the world. A feeling that a given desire (or fear) is important indicates attachment, and the sense of importance derives from one's self-image. People invest little energy in what does not matter to their self-image (or self-concept), but they will invest a great deal of energy when something threatens their self-image, even to the point of violence.[3]

Sin for May occurs "when self-image and personal willfulness becomes so important that one forgets, represses, or denies one's true nature."[4] Being willful closely associates with attachment to desire. Relinquishing attachment releases the self-fueling cycle of suffering that occurs in the cycle of willfulness and self-importance that separates one from others. May's model of attachment resonates with (and acknowledges) similar teachings in Buddhism.

May suggests that a person's spiritual experiences may pose a threat to ones self-image. Self-defining activities both are threatened and feel threatened by the approach of a unitive experience or any of its components. Fear or spiritual narcissism are typical responses of the ego to the threat of identity that occurs when overwhelmed by God's presence. Fear can result in withdrawing or trying to escape the situation. The condition of "spiritual narcissism" occurs when one uses one's faith to accomplish one's personal aims rather than allowing oneself to be used by one's faith to accomplish the will of God (to participate in the purposes emerging in transcendent-level systems).[5]

To destroy one's attachments would destroy the very relationships that need transformation. However, when one has a choice, one can choose "to *allow* attachments to come and go rather than constantly clinging to them."[6] May views self-image as a possible instrument of divine will, and one should not try to eradicate the self-defining process but only keep it in perspective (a view that resonates with Irenaeus). Thus, spiritual growth dissolves unhealthy attachment, reduces fear, and

2 *Ibid.*, p. 6.
3 *Ibid.*, pp. 226–30.
4 *Ibid.*, p. 233.
5 *Ibid.*, pp. 95, 100, 113–14, 119.
6 *Ibid.*, p. 242.

shifts the relationship of the self to mystery—a more constructive “true” orientation. From an Irenaean perspective, a “true” orientation would lead one further down the path of spiritual development.[7]

For May, the true self lies beyond the qualities of self-image, and for that May drew upon the writings of Thomas Merton.

Merton’s Perspective

According to twentieth-century monastic and contemplative writer Thomas Merton, each person knows who they are through their relationships with others. This identity of personality does not constitute one’s total being, but only a part of one’s true self. When one considers the personality-oriented aspects of the self to comprise the entire self, then one creates a false self of egocentric desires, as the rest of the (true) self that exists in God is cut off.[8]

As Merton describes, the true self:

> Is not something outside of you … it is an abyss opening up in the center of your own soul. And this abyss of interior solitude is a hunger that will never be satisfied with any created thing. The only way to find solitude is by hunger and thirst and sorrow and poverty and desire, and the [person] who has found solitude is empty, as if [one] had been emptied by death … Yet it is in this loneliness that the deepest activities begin … act[ion] without motion … and beyond all desire, a fulfillment whose limits extend to infinity.[9]

Merton defines the true self in opposition to a false self. For Merton, the social and spiritual aspects of the false self were intertwined, and he wrote of struggling between two vices: an asocial emphasis on a false, supernatural spirituality; and a social engagement that depleted a person’s spirituality.

For Merton, the spiritual false self calls us to withdraw from the world, our concern for others, and the concrete realities of daily life. The spiritual face of the false self often rejects this world under the guise of ‘spirituality’ with a false supernaturalism that imagines the supernatural is “a kind of Platonic realm of abstract essences totally apart from and opposed to the concrete world of nature, [that] offers no real support to a genuine life of meditation and prayer. Meditation has no point and no reality unless it is firmly rooted in *life*.”[10] Contemplation may increase awareness of another, unknown place, but this should confirm and establish a person’s daily relationships and commitments rather than annihilate them.

Merton struggled within the cultural systems of the Christian monastic life as he forged social relationships, wrestled with his literary desires, and explored Buddhist

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7 *Ibid.*, pp. 112–13, 122–4.

8 Or, systematically, the true self that exists in the real possibility of participating in transcendent-level systems of Spirit.

9 Thomas. Merton, *New Seeds of Contemplation* (New York: New Directions, 1972), p. 81.

10 Thomas Merton, *Contemplative Prayer* (Garden City, NY: Image Books, Doubleday and Company, 1971), pp. 38–9; cited by James Finley, *Merton’s Palace of Nowhere: A Search for God through Awareness of the True Self* (Notre Dame, IN: Ave Maria Press, 1978).

thought. In the systems model, Merton struggled to discover cultural systems that would support transcendent-level relationships. He found the abstractions of the Platonic realm purely a cultural-level system not "rooted in life" and unable, in Merton's social and historical context, to support emergent transcendent relationships. In other words, transcendent relationships should build upon and confirm a person's social relationships.

Social myths lead to the development of a collective false self when we "pool all our lies together and believe them … as ultimate truth."[11] Each person moves with society's collective false self: as each self changes, the other individuals adjust to continue the myth and avoid falling into nothingness. The problem with "progress" is that everything known will be lost as all knowers will eventually die. Authentic religion (a culture's true self) frees people from the tyranny of complying with society in order to remain real. In willingness to live in the face of death, one dies to the self. In the death of one's (false) self, the Christian participates in the death of Christ. In participating in the death of Christ, one chooses Christ by choosing the world the way it really is, "we renounce our alienated and false selves in order to choose our own deepest truth."[12] Christians do not choose either the world *or* Christ; they choose both the world *and* Christ.

Merton's resolution of the potential social and spiritual false selves led him to discover that true solitude leads one into communion with others and that true communion with others draws one into solitude: the monastic (hermit) finds others in solitude and the lay person finds solitude in the midst of the world and relationships. The true self embraces solitude and others and rejects the false self turning solitude into "ego-centered isolation" and relationship with others into mindless exploitation.[13]

I interpret Merton's "solitude" as the empty space in religious practice or social engagement that builds true community and provides a constitutive absence in transcendent human systems. One can only participate in transcendent systems through community. For Merton, true solitude is a solitude that is really shared by everyone: "There is only one true flight from the world: it is not an escape from conflict, anguish and suffering, but the flight from disunity and separation, to unity and peace in the love of other[s]."[14]

For the individual as a psychological-level system, participation in transcendence must involve constitutive absence formed by cultural-level systems. If there were no constitutive absences at the psychological level, religion and spirituality could only exist at the psychological level. It is the psychological and cultural level constitutive absences—that appear empty to the individual—from which transcendent-level processes may select for information. Not all absences are selected—any more than at lower levels—so absence is not sufficient, but absences are necessary.

11 Merton, *Contemplative Prayer*, p. 71.
12 *Ibid.*, p. 155.
13 Finley, *Merton's Palace of Nowhere*, p. 44.
14 Merton, *New Seeds of Contemplation*, p. 78.

Individual Sin

Merton writes: "All sin starts from the assumption that my false self, the self that exists only in my egocentric desires, is the fundamental reality of life to which everything else in the universe is ordered."[15] Thus, the false self does not necessarily result in sin, but the attachment to the false self as fundamental results in sin. As a system, one creates a robust constraint between one's self-concept and one's desire (perhaps embodied in the brain by a robust neural network). For May, strong attachment intimately relates to willfulness, and one can understand sin in terms of willfulness. [16]

The student and scholar of Merton, James Finley, describes the false self as standing between the true self and God. The false self constructs "its own dark universe of disorientation and nothingness," which it claims as its creation and glory. However, we frantically struggle to verify our reality and worth in an attempt to avoid haunting fears of our unreality. The false self intuits that "it is but a shadow, that it *is* nothing, it begins to convince itself that it *is* what it *does*." Thus, temporarily, the false self increases its sense of reality as it "does, achieves, and experiences," but this increases the fear that we are nothing for which we are loathe to explore. [17]

From a Christian perspective informed by Buddhism, Merton makes clear that the self-proclaimed autonomy of the false self is an illusion.

> Every one of us is shadowed by an illusory person: a false self.
>
> This is the man that I want myself to be but who cannot exist, because God does not know anything about him. And to be unknown of God is altogether too much privacy.
>
> My false and private self is one who wants to exist outside the reach of God's will and God's love—outside of reality and outside of life. And such a self cannot help but be an illusion.
>
> We are not very good at recognizing illusions, least of all the ones we cherish about ourselves—the ones we are born with and which feed the roots of sin. For most of the people in the world, there is no greater subjective reality than this false self of theirs, which cannot exist.[18]

This illusionary person wants to escape the reach of God's will and love. Sin is believing the reality of the illusory false self. Some people worship their false selves which is idolatry. But, "the only true joy on earth is to escape from the prison of our own false self, and enter by love into union with … Life."[19]

Relinquishing attachments of the false self releases the illusions. According to May, it is the willingness to detach that leads to self-surrender and becoming true to God's will. Trying to destroy attachments is damaging, but we can choose "to *allow* attachments to come and go rather than constantly clinging to them."[20] Merton writes: "To sink into the unknown depths of God's call to union with himself is to lose all that the false self knows and cherishes."[21]

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15 *Ibid.*, pp. 34–5.

16 May, *Will and Spirit*, pp. 231, 233.

17 Finley, *Merton's Palace of Nowhere*, pp. 34–5.

18 Merton, *New Seeds of Contemplation*, p. 34.

19 *Ibid.*, p. 25.

20 May, *Will and Spirit*, p. 242.

21 Finley, *Merton's Palace of Nowhere*, p. 26.

From a systems perspective, deciding to focus on the cultural and lower-level relationships at the nexus of one's self and identity leads to an increased illusion of autonomy for one's false self. By recognizing the dynamic and transient nature of these relationships and allowing one's attachments to come and go, one surrenders attachment to lower-level relationships constituting the individual self and participates in elusive cultural and transcendent-level relationships emerging from community (while avoiding attachment to them as reified essences).

Self-Surrender

For May, willingness to detach is the beginning of self-surrender.[22] However, choosing detachment is not sufficient as Buddhism makes clear that striving for non-attachment is also an attachment.[23]

Merton writes:

> If, then, we want to seek some way of being holy, we must first of all renounce our own way and our own wisdom. We must 'empty ourselves' as [Christ] did. We must 'deny ourselves' and in some sense make ourselves 'nothing' in order that we may live not so much in our selves as in [Christ]. We must live by a power and a light that seem not to be there. We must live by the strength of an apparent emptiness that is always truly empty and yet never fails to support us at every moment.[24]

For Merton, we do not detach from everything, but learn through grace to surrender to the unknowable mystery. For May, this surrender leads to less definition rather than more attachment.[25]

The true self is hidden in (or towards) the mystery and is not knowable in a similar way to how God is unknowable. "Our reality, our true self, is hidden in what appears to us to be nothingness and void … The way to reality is the way of humility which brings us to reject the illusory self and accept the 'empty' self that is 'nothing' in our own eyes and in the eyes of [others], but is our true reality in the eyes of God."[26]

As Finley aptly describes: "Merton leads us along the journey to God in which the self that begins the journey is not the self that arrives. The self that begins the journey is the self that we thought ourselves to be. It is this self that dies along the way until in the end 'no one' is left. This 'no one' is our true self. It is the self that stands prior to all that is this or that. It is the self in God, the self bigger than death yet born of death. It is the self the Father forever loves."[27]

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22 May, *Will and Spirit*, p. 299. Detachment does not mean isolated, or pushing against, but "unattached" in an open way.

23 Striving for non-attachment is an attachment to a psychological or cultural-level absence precluding its use by higher-level systems.

24 Merton, *New Seeds of Contemplation*, p. 62.

25 May, *Will and Spirit*, p. 304.

26 Merton, *New Seeds of Contemplation*, p. 28.

27 Finley, *Merton's Palace of Nowhere*, p. 17.

The true self may be understood as dynamic form not knowable at the psychological level but highly informative to transcendent-level processes. One shifts actual lower-level constraints to increase the real possibility in systems formed from higher-level constraints. According to Merton, if we are true to the concept God utters, we become full of God's actuality, and are saved. Although we cannot go to heaven to find God, God comes to us, and we know God as we are known. "We become contemplatives when God discovers Himself [*sic*] in us."[28] To know and love God, God must dwell within us in God's power, mercy, and grace. God's presence within us corresponds to our true decisions between the fiction of our false self and our loving consent to God's mercy.

For Merton, the discovery of identity begins and becomes perfected by being drawn into God's love and being one with God through Christ. The identification with the true self begins with baptism and develops meaning through conscious (willing) acts of love. God's presence in us corresponds to our own free decisions: our life "becomes a series of choices between the fiction of the false self … and our loving consent to the purely gratuitous mercy of God."[29]

One's identity asserts itself in humility. According to Merton, "humility consists in being precisely the person you actually are before God, and since no two people are alike, if you have the humility to be yourself you will not be like anyone else in the whole universe."[30] In contrast, pride is "the inordinate attribution of goods and values and glories to one's own contingent and exterior self."[31]

In Merton's view, each thing gives glory to God by being what it is: a tree gives glory to God by being a tree, as does most of creation that naturally *is* what God created. However, humans have a choice to be ourselves or not. We may live as a true expression of ourselves or via a way of falsity. Sanctification is the process of "finding out who I am and of discovering my true self."[32] We actively participate in God's creative freedom and "share with God the work of *creating* the truth of our identity."[33] Although my identity is hidden from me, if I desire it, I can work with God in faith to cultivate the seeds of my own identity.

Since nothing that can be seen or imagined can be God, then to find God one must pass beyond everything that can be seen or imagined and enter into an obscurity without images and without likeness to any created thing.[34] Each person has the choice of two identities: an external self that seems to be real but lives by a shadowy autonomy for a brief earthly existence and a hidden, inner person who seems to be nothing, but who can give itself to the eternal through the mystery of Christ.[35]

From a systems (and cybernetic) perspective, one shifts one's nexus of control from one's individual self to a spiritual system emerging from a community that

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28 Merton, *New Seeds of Contemplation*, p. 39.
29 *Ibid.*, p. 41.
30 *Ibid.*, p. 99.
31 *Ibid.*, p. 286.
32 *Ibid.*, p. 31.
33 *Ibid.*, p. 32; Merton's italics.
34 *Ibid.*, p. 131.
35 *Ibid.*, p. 295.

interprets the life of Christ. One retains decision-making but operates under principles such as Royce's "loyalty to loyalty" to define oneself on a path where one becomes (for Irenaeus and Merton) like Christ.

Dynamic Form of the Body

How do one's relationships inform one's soul?

Aristotle's form provides one means to abstract from actuality, but substantial form cannot evolve. Rather than a Thomistic essential soul informing the body, the constellation of the subatomic, physical, biological, psychological, cultural, and transcendent relationships capture the information content of the emerging human person. In reinterpreting Thomas Aquinas's definition of the soul as the form of the body in terms of information content of the relationships constituting the human person, systems theory elucidates connections between one's individual body, mind, culture, and spiritual relationships.

However, by examining the constitutive relationships that habitually form the person, one can model not only actual relationships but also relationships that could possibly become part of the systems, but which are absent. The real possibility in the midst of habits characterizes what is typically termed the "soul". Some of these absences may be constitutive, for example, the spokes of a wheel supporting an empty space at the hub around which the wheel turns, the space for iron and oxygen at the center of hemoglobin, or the juxtaposition of wood and empty space that form the open window of a house.

Buddhist Form

Merton's understanding of the person's true and false self develops in his exploration of Buddhism. Although not a direct influence on Western concepts of form, the historical Buddha, Siddhartha, (northern India, sixth century BCE) apparently noticed a very similar category at approximately the same time as Plato and Aristotle, which is captured in one of the central Buddhist texts, the *Heart Sutra*. It states:

> Form is not different from emptiness;
> Emptiness is not different from form.
> Form, this is emptiness;
> Emptiness, this is form.

Although Buddhism tried to hold the enigma open by proposing the identity of form and formless, it emphasized the ever-changing aspects of nature rather than stability as the Greeks had. In particular, the doctrine of *anatta* (or no-soul) suggests "the idea of self is an imaginary, false belief which has no corresponding reality."

Specifically, a person is composed of five aggregates (*khandas*) that occur together temporarily to which we mistakenly attribute stable existence.[36]

Although outside the scope of this book, the Buddhist doctrine of emptiness provides a mechanism to escape the dualism, subject–object dichotomy, and essentialism of many Western philosophies. *Rupa* (Pali) captures corporeality (similar to Greek "matter") as one of the five groups of existence (*khandas*). *Nama-rupa* (loosely name-matter) captures mentality and corporality. Emptiness (Sanskrit *shunyata*) as developed by Nagarjuna in Madhyamika philosophy expresses the dependent origination of presupposed entities, and his logic of four-cornered negation (*tetralemma*; Sanskrit *catushkoti*) denies that any thing originates from itself, from a thing other than itself, from itself and from a thing other than itself, or from neither itself nor from a thing other than itself.[37]

Although with 2,500 years of hindsight and science, one can describe Aristotle's philosophy as overemphasizing the stability of being and Buddhism as overemphasizing the process of change, we do not have direct access to either philosophy as developed and understood then, only through their subsequent reinterpretations. However, the dialectic of the two ancient philosophical approaches provides a frame for situating a contemporary pragmatic understanding of form.

Pragmatic Tendencies

In terms of Peirce's categories, the soul relates to the Firstness that occurs in Thirdness—the possibilities that occur in generality. Thirdness provides the laws and general regularities of a system. Secondness—in its action–reaction—provides clear, distinct decisions within the process of a system (as typically studied by science). Firstness opens up the space in what would otherwise be a rigid, mechanistic process. A functioning, organic system requires all three categories. Stuart Kauffmann describes a region in self-organizing systems between order (too much Secondness in Thirdness) and chaos (too much Firstness in Thirdness) that he calls the "edge of chaos."[38] In terms of a person's soul, one can make decisions that increase the order and rigidity of one's life—and close in on one's self through creation of self-serving constraints (too much Secondness)—or one can deny one's needs for regularity and open one's self up to chaotic existence in an overly ascetic life (too much Firstness). Both of these approaches lead to what Thomas Merton called the "false self." However, Gautama Buddha suggests a third way (Thomas Merton's "true self") between the two extremes of self-service and denial where one lives open to real possibility.

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36 Walpola Rahula, *What the Buddha Taught* (New York: Grove Press, 2nd edn, 1974), p. 51.

37 Nyanatiloka, *Buddhist Dictionary: Manual of Buddhist Terms and Doctrines* (Kandy, Sri Lanka: Buddhist Publication Society, 1997); Troy Wilson Organ, *The One: East and West* (Lanham, MD: University Press of America, 1991), pp. 319–31, Rahula, *What the Buddha Taught*, pp. 20–21.

38 Stuart A. Kauffman, *At Home in the Universe: The Search for Laws of Self-Organization and Complexity* (New York: Oxford University Press, 1995), p. 26.

In cognitive science and religion, the concept of soul refers to the emergent transformation of habituated processes into new qualities of possibility capturing the deemphasized Firstness and Thirdness in contemporary cognitive science. One way to articulate the relationships obscured by the actuality of Secondness is to describe them virtually using the language of information rather than matter or energy, that is, using the language of emergent systems. From an information perspective, one can model the absent matter or energy constitutive to higher-order systems. These constitutive absences in the lower-level relations may constitute what appears as an emergent property from the higher level. From an information perspective, one may define the soul as the constellation of constitutive relationships that enable real possibility.

Constraining relationships capture the regularities of its behavior and processes—they describe its structure and constrain its possible function. Each constraint captures an aspect of Secondness by delimiting what can and cannot actually occur. The relationships of constraints (like the graphs of Chapter 2) form a network which through feedback processes provide order and regularity to a system. That structured stability may give rise to new (emergent) qualities—such as hardness, viscosity, or shape. These emergent properties bring with them new possible functions and regularities—such as a diamond cutting a piece of glass or a diamond cutting most natural materials. In a sense, the Firstness of new qualities brings along new possibilities of Secondness (as function) and new possibilities of Thirdness (as regularities). Purpose occurs for the qualities and decisions within the framework of regularity that emerges as it organizes the previously emergent properties.

An atom occurs because constraints between its constituent's probability waves provide persistent relationships sufficient for the atom's stability at "moderate" temperatures and gravitational influences. Proteins and other complex molecules occur because constraints of configuration and chemical bonds restrict the free flow of their constituent atoms. Biological processes occur because cell membranes, chemical gradients, enzymes, transport mechanisms, and other constructs place the constituents of the biological process in an environment where it can persist. Thought and other mental behavior occur because the learned pattern of synapses provides coherent, repeatable networks for spreading neuron activation. Societies occur because interpersonal relationships, personality characteristics, and historical participation constrain the interaction of individuals, and those individuals communicate using the arbitrary symbol systems of language, which constrains how the individuals perceive the world.

Dynamic form captures the interrelatedness of an object, and its ability to evolve with respect to slower changing relationships. One approach to describing form requires detailing all the parts and all the relationships, such as graph systems analysis. However, something remains missing even as more detailed analysis occurs. The human mind with limited perceptions and finite categories remains inadequate to describe the infinite conceivable practical effects of how a particular object could behave in unforeseeable contexts. One cannot succeed in modeling reality by beginning with an empty description and incrementally adding information with the unjustifiable hope of adequately capturing infinite constructs. Merton and Buddhist practitioners would argue that the "building up" approach only increases one's delusion. If one takes seriously quantum mechanics, Heisenberg uncertainty, Bose–Einstein condensation, general relativity, and other findings of modern physics, a more adequate approach to modeling reality requires modeling the subatomic level with constructs like Peirce's continuum where space remains full of interrelated, pregnant possibility constrained to actuality by emergent phenomena. One finds that possibility of higher-level emergent systems within the actualized constraints, for example, for a person within one's self.

Informative Soul

The soul has no substance as typically understood in a materialistic (or Aristotelian) way. Yet the soul does inform the body: both classically, as the form of the body, and also in an information-theoretic sense. Unlike the one-dimensional information of classical information theory (as described in the decisions encoded by a bit string), the soul captures the general regularities of tendencies (in all its complexities and interrelationships), which enriches the neo-Aristotelian form with "real possibility." The "real possibility" points to all possible emergent systems that could occur using the entity of focus and thus alleviates the necessity of using actual higher-level systems to define purpose or value, which begins a chain of circular definitions and precludes adequate descriptions of change. Thus the soul performs a semiotic function for the human person, signifying either a self-serving (or self-denying) false self or an open, relational (self-surrendering) true self, which unfolds over time. For the human soul, the constraining relationships exist as informing the body (and its subatomic, physical, biological, psychological, cultural, and transcendent relationships), and, dialectically, they also do not exist (reductionistically) because they would reduce to nothing but empty space. The soul has no substance, but exists informatively, like the iron in hemoglobin. But, paradoxically, in that configured and informed "empty" space, lies the real possibility of becoming fully human.

The informed "empty" space refers to the possible higher-level systems in which the person may participate. Because of the relational nature of the self, the self incorporates social and cultural aspects of the person, which one claims as one's own (as described by James and Mead). The soul signifies the future self that one develops by new constraining relationships made through decisions (in the process described by human learning and spiritual formation). Because the space of real possibility refers to a multitude of future and higher-level systems, *one actualizes one's self through the addition of constraints*. Those constraints may occur through decisions one makes in pursuing ones' "true" or "false" self, and those constraints become solidified through the steady asymmetrical progression of time (Deacon's second-order emergence) and through the incorporation of those constraints—and their possible consequences—in the current system (as memory and information in Deacon's third order of emergence).

The organized collection of constitutive relationships in a dynamic form provides information which one may formalize in a mathematically precise manner by modeling the constitutive relationships as constraints. As one formalizes the collection—moving the Aristotelian form into a separate Platonic, mathematical realm—one loses the connection with reality and may lose the "real possibility" inherent in the self. The pragmatic tradition suggests ways to discuss the form (as a constellation of tendencies), which retains the "real possibility" by interpreting constraints as actuality constraining the realm of possibility rather than classic equations in Cartesian space. Tendencies retain the dispositions of systems by framing the real possibilities inherent in the regularities the system of constraints provides. Systems theory formalizes relationships as constraints to enable scientific study of the soul. By retaining the framework of form and relating it to both information (in systems theory) and tendencies (in pragmatism), one can formalize tendencies (as emergent dispositions of systems of constraints) for scientific investigation, thus illuminating where the ephemeral "real possibility" can infuse science as it needs.

Cognitive science and religion provides perspectives on human cognition and spirituality, and this book has explored perspectives on the apparent mind–brain dichotomy from systems theory in computer science, Peirce's pragmatism in philosophy, semiotics in linguistics, learning and decision-making in neuroscience, the concept of self in cognitive psychology, community in social science, and the soul in religion. Rather than disjoint or conflicting perspectives, each independently coherent perspective complements and illuminates each other. Emergent systems theory describes the subatomic, physical, biological, psychological, cultural, and transcendent relationships constituting the human person. By abstracting from the actual human systems, one can define the human soul as the constellation of constitutive relations that enable real possibility, and the form of the body becomes the constellation of constraining relationships.

The definition of soul has practical application. A person's real possibility in habituated constitutive relationships open up the person to participate in relations in higher-level emergent systems. For a physical body, lying there dormant or lifeless, one's soul would open oneself up to biological processes of life, such as oxygenation and movement. For a biological body with a brain, one's soul would open oneself up to learning novel modes of thinking, feeling, and behaving, that is, creativity. For an individual in isolation, one's soul would open oneself up to participating in cultural activities dependent upon human interaction. For a person participating in religious culture, one's soul would open oneself up to participating in transcendent, spiritual relationships.

The soul consists of the dynamic form of the body and serves as a nexus of relationships across all six levels of human existence. In addition to the relationships that form the systems of the person, the person also has autonomy to make decisions about social, cultural, and transcendent systems in which the person may participate. Those decisions orient the person in willfulness misguided by the sin of attachment to an illusionary false self or orient the person in willingness to self-surrender that illuminates one's true self.

The true self decides to embody constraints imposed by cultural-level systems that actualize the real possibility of spiritual development through habit-making and learning of new ways of existing. These tendencies are embodied in the brain in systems of perception, action, decision-making, memory, and other cognitive functions and are formed by biological-level processes that shift the neural networks representing the person's way of experiencing nature and the cultural systems emerging from human interaction.

Spiritual Dimension of Soul

Where does God fit?

When one becomes baptized, confirmed, or participates actively in a church community, one gains constraints from the community and provides constraints to the community. Like the daub of paint in an impressionist painting, both the entire painting and the daub of paint become transformed. Likewise, when one participates in systems traditionally identified as referring to God by religious systems, one gains additional constraints (laws, conscience, social expectations, and insights) and provides additional constraints to that system (hopes, personal limitations, past experiences), and both become transformed.[39] The informed "empty" space of the soul constrained by the prior experiences of one's self signifies (refers to) not only the subatomic, physical, biological, psychological, and cultural systems in which one may participate in the future, but also signifies ineffable, spiritual systems in which one may participate and draw actualizing constraints. Because one can neither know the myriad possibilities of one's soul nor know what lies beyond language (using thought limited by language), one may only *know* the spiritual systems (or the God which their real space of possibility further signifies) by participating in those systems, and that participation occurs through faith.

Mortal Soul

Reinterpreting soul as information carried by the arrangement of relationships in a system provides a foundation for dialogue in cognitive science and religion and explains how a non-material construct may fully exist in a non-reductive physicalist worldview. One can reframe old questions of life and soul in a contemporary scientific framework to facilitate their answer or more fertile debate.

"When does life begin?" becomes "when does a human system form?" Answers to that question depend upon the level of human systems considered. At the physical level, perhaps at conception. At the biological level, shortly after conception, when cellular processing becomes stable and autonomous. As a psychological-level system, when viable outside the womb. In a cultural-level system (with symbolic language), at a few months to a few years of age. An individual might influence the conceivable practical effects of a transcendent-level system in exceptional circumstances at a few years of age, typically much older, and possibly never.

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39 If God participates in human life both as the ground (lower sub-atomic level, perhaps panentheistically after Russell) and as spirit (transcendent level, after Clayton), then "God" at least partially identifies systems in which a person necessarily participates (through physical existence) and may choose to participate (though psychological and cultural decisions). Clayton, *Mind and Emergence: From Quantum to Consciousness* (Oxford and New York: Oxford University Press, 2004); Robert J. Russell, Ted Peters, and Nathan Hallanger, *God's Action in Nature's World: Essays in Honour of Robert John Russell* (Ashgate Science and Religion Series; Aldershot and Burlington, VT: Ashgate, 2006).

"When does life end?" becomes "when does a human system cease having an effect?" Physically, when decomposed. Biologically, shortly after death when all cell function ceases. Psychologically, when autonomous sentience–response–animation ceases, such as brain death. Culturally, when no cultural system responds to the person, which may occur before or after individual death. Transcendently, a person may never live, or if continued in the interpretation of a community, never die.

These reframed questions and hypothesized answers provide a framework for investigating whether the soul (as it identifies a person) consists only in the lower-level systems or at all levels of human existence. If one defines the human soul as the systems of an individual at the psychological level and below, humans do not significantly differ from other animals. If one defines the human soul as the nexus of relationships at all levels of human existence, then the human soul appears to exist at an emergent level of no other animals.[40] However, then one's neighbor and one's transcendent-level system of choice also define one's soul.

Although this book has focused on the natural and mortal aspects of the human soul, that suffices to indicate that scientific and religious integration of perspectives on the human person cannot occur in a reductionist or dualist framework. To become human and acquire meaning as a human person requires acknowledgment of all the relationships by which one becomes human. To deny community and the transcendent-level systems that may emerge from them means to deny one's humanity.

Recalling the original questions from the beginning of the book, a human person becomes meaningful by acknowledging and perhaps identifying with relationships at all six levels of human existence, but without becoming attached to those relationships, as those relationships require constitutive absences for existence. Although the six levels individually cohere, they cannot unify without accounting for the form of the whole person (not just the dynamic forms of systems at each level) and that form identifies the soul.

The person uses their mind to understand the relational structure of nature. The mind (and brain) have evolved to facilitate human appreciation of nature, and systems theory describes one way that those relationships may be modeled. General systems theory, by itself, cannot capture all the relationships of nature, and in particular, how certain systems emerge from other ones. In particular, the distinctions between subatomic, physical, biological, psychological, cultural, and transcendent levels of human systems indicate abstractions that cannot be reduced and require distinct models of causality (i.e., strong emergence). Humans participate in social/cultural and transcendent-level systems, but those systems (as they strongly emerge) have their own autonomy and causal power; thus an individual cannot control them, but only choose how to participate in them. In particular, for transcendent systems of spirituality, such as emerged from the community formed from the life of Christ, the decisions one makes in willingness and self-surrender shift one's self in relationship to transcendence. Those new relationships also form an aspect of one's soul (as form of the body) and create constitutive connections that extend beyond the individual into the transcendent.

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40 Future studies of pre-historical hominids, other primates, or ocean mammals may discover non-human cultural-level systems.

The theological construct of soul identifies the form of the body that exists and does not exist in the tendencies of real possibility constrained by the informative systems of the person. Those systems include the systems of mind capable of deciding upon possible behaviors and oriented toward a willingness to surrender (or "lose" one's life) to a true self or a willful, non-emergent agency of the false self, called sin. For the human person, the learning and decision-making processes in the brain form that agency, and thus human autonomy depends upon the evolved characteristics of the brain and one's cultural context. Within those relationships constituting human existence, one chooses the path upon which one travels including participating in elusive systems which appear empty, but whose processes slowly shift one's soul.

Imagine being involved in a system where subatomic, physical, biological, psychological, cultural, and transcendent-level interactions occur: involved in the world, using one's body, aware of one's environment and making challenging decisions about oneself in a culture not entirely one's own for a cause requiring awareness and loyalty to the different causes of others. In that place of grounded transcendence where levels melt away, one behaves in a way open to real possibility, actuality, and interrelationship in relation with others where stable, robust systems emerge that facilitate tendencies toward personal, social, and spiritual growth. Through one's actions and constraints on what previously was merely possible, one creates cultural systems incorporating open, and apparently empty, spaces for further emergence and growth of transcendent systems. In the thin spaces that identify a path, one finds one's soul, and as one decides, one steps down the path to further identify with and participate in transcendent-level systems of the divine, and spiritually develop in faith.

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