Articles

NEUROSCIENCE, ARTIFICIAL INTELLIGENCE, AND HUMAN NATURE: THEOLOGICAL AND PHILOSOPHICAL REFLECTIONS

by Ian G. Barbour

Abstract. I develop a multilevel, holistic view of persons, emphasizing embodiment, emotions, consciousness, and the social self. In successive sections I draw from six sources: *1. Theology.* The biblical understanding of the unitary, embodied, social self gave way in classical Christianity to a body-soul dualism, but it has been recovered by many recent theologians. *2. Neuroscience.* Research has shown the localization of mental functions in regions of the brain, the interaction of cognition and emotion, and the importance of social interaction in evolutionary history and child development. *3. Artificial intelligence*. Some forms of robotics use embodied systems that learn by interacting with their environment, but the possibilities for emotion, socialization, and consciousness in robots remain problematic. *4. Relations between levels.* Concepts that can help us relate studies of neurons and persons include the hierarchy of levels, the communication of information, the behavior of dynamic systems, and epistemological and ontological emergence. *5. Philosophy of mind.* Two-aspect theories of the mind-brain relation offer an alternative between the extremes of eliminative materialism and the thesis that consciousness is irreducible. *6. Process philosophy.* I suggest that process thought provides a coherent philosophical framework in which these themes can be brought together. It combines dipolar monism with organizational pluralism, and it emphasizes embodiment, emotions, a hierarchy of levels, and the social character of selfhood.

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I hope to show that it is consistent with neuroscience, computer science, and a theological view of human nature to understand a person as a multilevel psychosomatic unity who is both a biological organism and a responsible self. We can avoid both materialism and body-soul dualism if we assume a holistic view of persons with a hierarchy of levels. The themes I will consider are embodiment, emotions, the social self, and consciousness. In the first three sections I look at these themes from the standpoints of theology, neuroscience, and research on artificial intelligence in computers. I then examine concepts of information, dynamic systems, hierarchical levels, emergence, and some philosophical interpretations of consciousness. Finally I suggest that process philosophy can provide a conceptual framework for integrating these varied perspectives on human nature.

We should note at the outset that theologians and philosophers bring their own conceptual frameworks to the interpretation of scientific theories. The theologian draws from the experiences, rituals, stories, and beliefs of a historical religious community. The philosopher seeks a coherent view of religious, aesthetic, moral, and cultural as well as scientific features of human life. We cannot expect neuroscience to provide a complete or adequate account of human nature because there are so many kinds of activity and levels of organization between neurons and persons in communities—including the relationships studied by evolutionary biology; developmental, cognitive, and social psychology; anthropology; linguistics; and even history, literature, and the arts.

But the concepts of the theologian or philosopher are not simply brought to the interpretation of science; they are also influenced by science. Scientific theories have implications for theology and philosophy, which may need reformulation or modification in the light of science. Conversely, philosophers and theologians can offer scientists wider intellectual and personal contexts for their work, suggestions of ways to relate it to other disciplines, and analysis of ethical issues arising from scientific theories and their applications. They can also encourage scientists to examine the philosophical assumptions underlying their judgments as to what features of phenomena are important to investigate and what types of concepts might be plausible—even though they recognize that scientific theories must be judged by their scope, consistency, compatibility with empirical data, and fruitfulness in suggesting further research.

I. The Self in Theology

I have chosen some themes relevant to neuroscience and artificial intelligence to explore briefly in the history of Western theological reflection.

1. Biblical Views.

Four features of the biblical account of human nature are highlighted here.

a. An Embodied Self, not a Body-Soul Dualism. The Bible regards body and soul as aspects of a personal unity, a unified activity of thinking, feeling, willing, and acting. "It is axiomatic in Old Testament scholarship today that human beings must be understood in their fully integrated, embodied existence" (Green 1998, 158). According to Oscar Cullmann, "the Jewish and Christian interpretation of creation excludes the whole Greek dualism of body and soul" (Cullmann 1958, 30). In particular, the body is not the source of evil or something to be disowned, escaped, or denied—though it may be misused. We find instead an affirmation of the body and a positive acceptance of the material order. Lynn de Silva writes:

> Biblical scholarship has established quite conclusively that there is no dichotomous concept of man in the Bible, such as is found in Greek and Hindu thought. The biblical view of man is holistic, not dualistic. The notion of the soul as an immortal entity which enters the body at birth and leaves it at death is quite foreign to the biblical view of man. The biblical view is that man is a unity; he is a unity of soul, body, flesh, mind, etc., all together constituting the whole man. (Silva 1979, 75)

According to the *Interpreter's Dictionary of the Bible,* the Hebrew word *nephesh* (usually translated as soul or self) "never means the immortal soul, but is essentially the life principle, or the self as the subject of appetites and emotion and occasionally of volition." The corresponding word in the New Testament is *psyche,* "which continues the old Greek usage by which it means *life"* (Porteous 1962, 428). When belief in a future life did develop in the New Testament period, it was expressed in terms of the *resurrection of the total person* by God's act, not the inherent immortality of the soul. Cullmann shows that the future life was seen as a gift from God "in the last days," not an innate human attribute. Paul speaks of the dead as sleeping until the day of judgment, when they will be restored—not as physical bodies nor as disembodied souls, but in what he calls "the spiritual body" (1 Corinthians 15:44 RSV). There were diverse strands in both Hebraic and Greek thought, and their influence on Paul's writing in the cultural context of the Hellenistic world has been the subject of extensive discussion by biblical scholars (Green 1998; Childs 1993).

b. The Role of Emotion. "You shall love the Lord your God with all your heart, and with all your soul, and with all your mind" (Matthew 22:37 RSV). According to biblical scholars, these three terms—heart, soul, and mind—describe differing but overlapping human characteristics and activities rather than distinct faculties or components of the person. "The widely held distinction between mind as seat of thinking and heart as seat of feeling is alien from the meaning these terms carry in the Bible . . . the heart is the seat of the reason and will as well as of the emotions" (Blackman 1950, 145). Paul writes: "If I understand all mysteries and all knowledge, and if I have all faith, so as to remove mountains, but have not love, I am nothing" (1 Corinthians 13:2 RSV). Love is of course not simply a matter of emotion, because it involves intention and action. But clearly it is not primarily a product of reason. Some portions of the Bible, such as the Wisdom literature, express the outlook of the wise person reflecting on human experience. But in most biblical texts we are called to be responsible agents rather than simply rational thinkers. Sin is understood as a defect of the will, not of reason. In much of Greek thought, the basic human problem is ignorance, for which the remedy is knowledge. But in biblical thought it is our attitudes and motives that lead us astray.

c. The Social Self. In the biblical tradition, we are inherently social beings. The covenant was with a people, not with a succession of individuals. Some of the psalms and later prophets focus on the individual (for example, Jeremiah speaks of a new covenant written in the heart of each person), but this was always within the context of *persons-in-community.* Judaism has preserved this emphasis on the community, whereas Protestant Christianity has sometimes been more individualistic. In the Bible, we are not self-contained individuals; we are constituted by our relationships. We are who we are as children, husbands and wives, parents, citizens, and members of a covenant people. God is concerned about the character of the life of the community as well as the motives and actions of each individual (Eichrodt 1951; Grant 1950, 160–70). The religious community shares a common set of sacred stories and rituals. Even the prayer and meditation of individuals take place within a framework of shared historical memories and assumptions.

d. In God's Image, but Fallen and Redeemed. The biblical assertion that humanity is created "in the image of God" (Genesis 1:27) has sometimes been taken to refer to particular human traits, such as rationality, free will, spirituality, or moral responsibility, that distinguish us from other creatures. An alternative view in the history of Judaism and Christianity has been that the image of God (*imago Dei*) refers to the *relation* of human beings to God and indicates their potentiality for reflecting God's purposes for the world. Human creativity can be seen as an expression of divine creativity (Hefner 1989).

But the biblical tradition has also said that humans fall short of fulfilling these creative potentialities. In the light of evolutionary history, the fall of Adam cannot be taken literally. There was no Garden of Eden, no original state of innocence, free of death and suffering, from which humanity fell. But the story can be taken as a powerful symbolic expression of *human sinfulness,* where sin is understood as self-centeredness and estrangement from God and other people—and also, we might add, from the world of nature. Sin in all its forms is a violation of relationships (Suchocki 1994). Original sin is not an inheritance from Adam but an acknowledgment that we are born into sinful social structures, such as those that perpetuate racism, oppression, and violence.

Redemption is the restoration of relationships—with God, with other people, and with other creatures—when brokenness and alienation are replaced by wholeness, healing, and reconciliation. The Christian tradition holds that this redemptive possibility is most clearly seen in the life of Christ and in our response to God's love made known in Christ. The doctrine of Incarnation affirms Christ's full embodiment, underscoring again the importance of the body, while it also affirms his unique relationship to God and his total identification with God's will. *Imago Dei*, sin, redemption, and Incarnation can thus all be understood in relational terms rather than as attributes or states of individuals in themselves.

I suggest that the first three themes above—embodiment, emotion, and the social self—are supported by neuroscience. The fourth theme—sin and redemption—is not supported by neuroscience, but when interpreted in the light of the other three themes it is not inconsistent with neuroscience.

2. MEDIEVAL AND MODERN VIEWS. Greek thought included a diversity of views of human nature, and of these the greatest influence on early Christian theology was Plato's view that a preexistent *immortal soul* enters a human body and survives after the death of the body. The Gnostic and Manichaean movements in the late Hellenistic world maintained that matter is evil and that death liberates the soul from its imprisonment in the body. The early church rejected Gnosticism, but it accepted the ontological dualism of soul and body in Neoplatonism and to a lesser extent the moral dualism of good and evil associated with it. Other forces in the declining Greco-Roman culture aided the growth of asceticism, monasticism, rejection of the world, and the search for individual salvation. Some of these negative attitudes toward the body are seen in Augustine's writing, but they represent a departure from the biblical affirmation of the goodness of the material world as God's creation (Kelsey 1985).

Aquinas accepted the Aristotelian view that *the soul is the form of the body,* which implied a more positive appraisal of the body. He said that the soul was created by God a few weeks after conception, rather than existing before the body. Aquinas gave a complex analysis of human nature and moral action that included an important role for emotions ("passions") in carrying out the good that is known by reason (Keenan 1992). Medieval theologians expressed a sense of the organic unity of a world designed according to God's purposes. Nevertheless, the concept of an immortal soul presupposed an absolute line between humans and other creatures and encouraged an anthropocentric view of our status in the world, even though the overall cosmic scheme was theocentric. With few exceptions, the nonhuman world was portrayed as playing only a supporting role in the medieval and Reformation drama of human redemption.

Descartes' dualism of *mind* and *matter* departed even further from the biblical view. The concept of soul had at least allowed a role for the emotions, as the biblical view had done. But mind, in the Cartesian understanding, was nonspatial, nonmaterial "thinking substance," characterized by reason rather than emotion. Matter, on the other hand, was said to be spatial and controlled by physical forces alone. It was difficult to imagine how two such dissimilar substances could possibly interact. Descartes claimed that animals lack rationality and are machines without intelligence, feelings, or awareness (see Barbour 1997, chaps. 1 and 10). The idea of the soul may have supported concern for the value of the individual in Western history, but when understood individualistically it diverted attention from the constitutive role of the community.

3. CONTEMPORARY THEOLOGY. An immaterial soul would be inaccessible to scientific investigation. Its existence could be neither proved nor disproved scientifically. But many feminist theologians today are critical of all forms of dualism for other reasons. They see in our culture a correlation of the dichotomies of mind/body, reason/emotion, objectivity/subjectivity, domination/nurturance, and male/female. Male is associated with mind, reason, objectivity, and domination, which are given higher status than body, emotion, subjectivity, and nurturance. Feminists decry the denigration of the body in much of Christian history; they seek a more positive evaluation of embodiment and a more integral view of the person (for example, Ruether 1983). Environmentalist theologians have criticized the soul/body dualism which postulated an absolute line between human and nonhuman life and thereby contributed to environmentally destructive attitudes toward other forms of life.

The theme of *the social self* is prominent among contemporary theologians. H. Richard Niebuhr defends "the fundamentally social character of selfhood," for "every aspect of every self's existence is conditioned by membership in the interpersonal group" (Niebuhr 1963, 73). Niebuhr draws from George Herbert Mead and the social psychologists who say that selfhood arises only in dialogue with others in a community of agents. We are not impartial spectators but members of communities of interpreters. The social context is also evident in the idea of *the narrative self.* Alasdair MacIntyre and others maintain that our personal identities are established by the stories we tell, the narratives of which we are each the subject. These stories always involve other people (MacIntyre 1984, chap. 15). Advocates of "narrative theology" insist that our personal stories are set in the context of the stories of the communities of which we are members. Religious beliefs are transmitted not primarily through abstract theological doctrines but through the stories told by the religious community that provide the wider framework for our own life stories (Wiggins 1975; Goldberg 1982). We will see some parallels in the concept of the narrative self as it appears in recent writings by neuroscientists.

The theologian Keith Ward (1992) maintains that soul and body represent not two entities but *two languages* for talking about human beings. In the tradition of British linguistic philosophy he asks us to consider the uses of differing types of language and their functions in human life. He concludes that talk about the soul is a way of asserting the value and uniqueness of each individual and also a way of defending human openness to God. Language about persons is used to interpret the lives of embodied agents capable of responsible actions.

A two-language approach is also adopted by several psychologists with strong theological interests. Malcolm Jeeves (1993; 1997) holds that mind and brain are two ways of talking about the same events. He cites Donald MacKay's (1991) claim that the first-person agent's story of mental events is complementary to the third-person observer's story of neural events, and not in competition with it. Jeeves says that science and religion also present complementary perspectives or ways of perceiving the world. In other passages he suggests that there are different levels of activity in the brain to which differing concepts are applicable, and that activities at higher levels causally affect activities at lower levels. Contemporary theologians have thus sought in various ways to recover the biblical themes of embodiment, emotion, and the social self.

II. Neuroscience and Selfhood

Neuroscience can make important contributions to our understanding of embodiment, emotions, conscious and unconscious processes, and the social self.

1. EMBODIMENT. *Perception* is an evolutionary product of bodily action. Humberto Maturana and Francisco Varela (1987) maintain that historically the needs and actions of an organism affected the type of perceptual system it developed. In a frog's visual system, certain neurons respond only to small dark spots—undoubtedly an advantage in catching flies. So, too, human neurophysiology evolved in parallel with distinctive human goals and interests. Michael Arbib argues that perception is not passive reception of data but an action-oriented restructuring of the world. Mental representations ("schemas") provide information relevant to possible actions that could be carried out by motor programs under the guidance of perceptions, expectations, and goals (Arbib 1989, chap. 2).

Other studies have shown that the development of visual perception in newborn cats is dependent on bodily movement.

The influence of biochemical processes on mental events is evident in many types of research on the effects of hormones, mind-altering drugs, and therapeutic medications. For example, Peter Kramer (1993) examines the use of Prozac in the treatment of depression. He defends its value in correcting chemical imbalances (especially in the neurotransmitter serotonin), but he concludes that the most effective therapy combines medication with consideration of traumatic experiences and psychosocial factors in the patient's personal history.

The correlation of brain sites with particular cognitive functions can be studied by data on brain lesions or strokes occurring in human subjects or laboratory animals. PET scans can be used to monitor blood flow in small regions of the brain while the subject is carrying out an assigned cognitive task. Damage in a particular brain area has been found to prevent language acquisition without harming other skills. One patient with a brain lesion was able to write lucid prose but could not read it. Oliver Sacks (1985) describes patients who were unable to recognize faces but had no problem recognizing animals or objects. Extensive research has been done on epileptic patients whose right and left brain hemispheres had been severed to control their seizures. Such patients might be able to follow instructions to pick up an object with the left hand, for example, but be unable to name it. But other mental functions seem to be widely distributed, and a given site may serve more than one function. Memory is distributed over many locations, and short-term memory differs markedly from long-term memory. Neural networks function globally and exhibit distributed properties. In all these cases, mental events are radically dependent on physiological processes at a variety of levels.

2. EMOTIONS. Five approaches to the scientific study of emotions can be identified.

a. The Evolutionary Perspective. Darwin held that emotional behaviors are remnants of actions that were functional in evolutionary history. A dog's anger is evident in growling and baring the teeth, which embody a physiological readiness to act aggressively and signal such readiness to other creatures. A legacy of such behavior is seen when an angry person shouts and grimaces. Darwin claimed that a common evolutionary origin accounts for the universality of facial expressions of emotions in diverse cultures. Subsequent studies have found considerable cross-cultural consensus in the identification of photographs of faces expressing six basic emotions: anger, fear, happiness, sadness, disgust, and surprise. Proponents of sociobiology and evolutionary psychology have offered hypotheses concerning the adaptive value of many behaviors associated with emotions (Darwin [1872] 1965; Izard 1977; Tooby and Cosmides 1990).

b. The Body-Response Perspective. William James held that emotions are internal perceptions of physiological processes in our own bodies—tense facial muscles, sweaty palms, and especially the effects of the autonomic nervous system, such as a pounding heart, faster breathing, and higher blood pressure. He claimed that emotions are the result (and not the cause) of physiological changes that we perceive directly. More recent studies of patients with spinal cord injuries showed that the feedback from internal organs does affect the intensity of a person's experience of emotions (James 1890; Levenson, Ekman, and Friesen 1990).

c. The Cognitive Perspective. Whether an animal (or a person) flees in fear or fights back in anger may be partly instinctive, but it also reflects a cognitive appraisal of the situation and a judgment about its potential danger. Authors in this tradition talk about the meaning of events and the expectations and goals that people bring to their appraisals. They insist that emotion cannot be separated from cognition. They also go beyond the six emotions studied by the physiologically oriented authors above to consider complex human emotions such as guilt, shame, and embarrassment, or anxiety in the face of uncertainty (Arnold 1960; Lazarus 1991).

d. The Social Perspective. Here the role of culture in the social construction of emotions receives strong emphasis. Emotional feelings and their expressions are shaped by cultural meanings learned in infancy and throughout life. Anger at another person is often related to the belief that the other person is to blame for an offending action. Feeling guilt is an acknowledgment that one has violated one's own norms, whereas shame is the feeling that one is not worthy in the eyes of others. Historians and social psychologists have described the role of emotions as a means of social control (by shame and guilt, for example, in Puritan New England). Other studies suggest that when children learn words for emotions and culturally approved actions to express them, their emotional experience is itself affected (Averill 1985; Harré 1986).

e. The Neural Perspective. Research on the physiological structures of the brain can help us understand the functioning of emotions. The amygdala and hypothalamus in the limbic system have been shown to be crucial in several emotions. Some examples of such research are discussed below.

These five approaches are often viewed as competing theories. Research does sometimes yield data that support one approach rather than another. I suggest, however, that they should be viewed as alternative perspectives using *different levels of analysis* that are not necessarily incompatible with one another. Emotions are multifaceted: they are at the same time adaptive mechanisms, bodily feelings, cognitive appraisals, social constructions, and neural processes. Nevertheless, we must go on to ask how these levels are related to one another.

The work of Joseph LeDoux (1996) is conducted at the neural level, but it is entirely consistent with analysis at evolutionary, body-response, and cognitive levels. He uses elevated blood pressure and heart rate as indicators of the emotion of fear in rats when they hear a sound to which they have previously been conditioned by association with an electric shock. He finds evidence of *direct* neural paths from the auditory system to the amygdala that allow a rapid response (which would have been valuable in evolutionary history). He also finds *indirect* paths to the amygdala by way of the cortex that are slower but provide for interpretation and discrimination among sounds (as proposed by the cognitivists).

Antonio Damasio has studied the relationships between *emotion* and *cognition* in people who have undergone damage in the prefrontal cortex. In a classic case, Phineas Gage recovered from a severe injury and retained his intellectual abilities but underwent a personality change in which he was unable to make decisions or observe social conventions. One patient with a prefrontal brain tumor was totally detached emotionally. When he viewed films depicting violence, he could describe appropriate emotional reactions but said he could not feel them, and he was unable to make decisions in daily life. Damasio argues that the cortex and limbic system work together in the construction of emotions. He suggests that both Descartes and modern cognitive scientists have neglected the role of emotion in cognition. Damasio also holds that consciousness and continuity of identity is provided by self-representation and the construction of a narrative that includes personal memories and intentions. He describes the self as a many-leveled unity. "The truly embodied mind does not relinquish its most refined levels of operation, those constituting soul and spirit" (Damasio 1994, 252).

3. THE ROLE OF CONSCIOUSNESS. Mental activity clearly involves both conscious and unconscious processes.

a. Unconscious Information Processing. Many instinctive responses and changes in the hormonal and autonomic nervous system occur without our being aware of them; our attention would be drastically overloaded if we had to keep track of all these changes. It has long been known that under hypnosis, and in subliminal perception, events of which we are not aware influence subsequent behavior. A variety of more recent experiments show the presence of unconscious information processing. *Blindsight* occurs in patients with a lesion in area V1 of the visual cortex. They are unable to see an obstacle in their path, yet they will act as if they see it and will walk around it. In another type of experiment carried out by Benjamin Libet (1985), subjects were told to record the exact moment when they voluntarily initiated a finger movement. Electric impulses were detected in the brain (the so-called *readiness potential)* up to one-third of a second before the subject's decision, suggesting that brain processes occur before the subject is aware of them.

Daniel Dennett reports experiments on *metacontrast* in which the image of a disc is followed after a very short delay by the image of a ring. Subjects say they have seen only the ring, yet they report that there were two stimuli. Dennett offers three possible explanations: the first stimulus was overridden before it entered consciousness; it entered consciousness but memory of it was then obliterated; or information from the first stimulus was reinterpreted in the light of the second one (Dennett 1991, 141–44). The experiment provides one more example of information processing that occurs without our being aware of it.

b. The Evolution of Consciousness. Simple organisms have a minimal sensitivity and responsiveness to the environment. If a one-celled paramecium finds no food at one location it will use its coordinated oarlike hairs to move to another location. Perception of an elementary kind occurs when there is a selective response to information used to control actions. At somewhat higher levels, sentience includes a capacity for pain and pleasure, which were presumably selected in evolutionary history for their contribution to survival. When a neural system is present, pain serves as an alarm system and an energizing force in avoiding harm. But continued pain may hinder action; even invertebrates under stress release endorphins and other pain-suppressant chemicals similar to those released in humans in response to pain, so it is reasonable to assume that they have at least some experience of pain.

Donald Griffin (1992) has studied the mental abilities of insects and animals. He associates consciousness with complex and novel behavior in changing or unfamiliar circumstances. Bees can communicate the direction and distance of food sources and can distinguish between water, nectar, and a possible hive site; they do their waggle dance only when other bees are around, but they have limited ability to modify their behavior in new circumstances. Griffin argues that the versatile and goal-directed behavior of animals is evidence of thought, feeling, and conscious awareness. Animals imaginatively compare possible courses of action and anticipate their consequences. Comparison of mental representations of alternative actions allows for more rapid, diverse, and adaptive responses to a changing environment. But Griffin holds that self-awareness is present only in certain species of primates. When looking in a mirror, a great ape will touch a mark previously placed on its forehead. Terrence Deacon (1997) notes that primates have a limited capacity for symbolic communication. Teaching a few symbols to apes is a slow and arduous process requiring repeated rewards and punishments. Primates' ability to generalize and to follow logical rules (such as inclusion and exclusion) is impressive but far short of human capacities for language and abstract thought. Such evidence would lead us to speak of *degrees of consciousness* rather than an all-or-nothing attribute.

c. The Construction of the Self. There are numerous versions of the thesis that mental activity is modular. Jerry Fodor's *Modularity of Mind* (1983) argues that the mind is a collection of relatively independent special-purpose modules. Marvin Minsky's *Society of Mind* (1985), making use of computational models, claims that the human mind is an aggregate of many small mindless components. According to Arbib, "the you is constituted by the holistic net of schema interactions in your brain." The coherence of the schemata is achieved by their interaction and not by a central organizer (Arbib 1989). William Calvin (1989) compares mental activity to a choir that works together, coalescing into a harmonious chorus without a conductor. A higher-order model of the self and the narratives in which it is represented serves to coordinate diverse subsystems. Dennett (1991) argues that "multiple drafts" (alternative interpretive narratives) momentarily compete for attention below the level of consciousness, and we are aware only of the winning versions.

Michael Gazzaniga (1988), on the other hand, introduces a more centralized coordinating system. He finds that split-brain subjects will carry out an action with one brain hemisphere that uses information from a visual input to the other hemisphere of which they are not aware; they will then try to explain their action by some other reason, unrelated to the visual input. He postulates an Interpreter (in the left hemisphere, the main site of linguistic abilities) that monitors and integrates the unconscious activities and tries to make sense of them in relation to belief systems. Robert Ornstein's *Multimind* (1986) proposes many small modules with specialized skills but also a governing self that links and coordinates these units. A few brain researchers, including John Eccles (1989), have continued to defend a dualism of mind and body in which the unity of conscious experience is an inherent property of mind, but this position has few adherents among scientists today. There is thus considerable diversity among neuroscientists in their interpretations of modularity, but there is wide support for the idea that the unity of the self is not given but is achieved in the life of the individual (see Teske 1996).

4. THE SOCIAL SELF. Neuroscience provides many types of evidence concerning the social character of cognition in animals and humans.

a. Social Interaction. Leslie Brothers attached electrodes to the brain of a monkey watching videotapes of the face of another monkey. She found neurons selectively responsive to the other monkey's facial expression of emotions. She suggests that human infants are attentive to adult faces because they have been prewired by evolutionary history to respond to relevant facial signals. Human emotions are expressed and recognized as part of a socially constructed communicative system. Brothers insists that the mind is a social creation that cannot be understood by studying its neural basis alone. "I take the mind to be irreducibly transactional" (Brothers 1997, 146). The person is part of a social-moral order, not something to be found in the neural account. Human actions are explained by reasons and historical narratives, not by physical and chemical causes. Through narratives we create ourselves as persons in collaboration with others as we enact our place in a social world.

Human language is of course a social product, even if the capacity for language is genetically based. Selfhood is intersubjective and relational, dependent on history and culture. The social world is internalized in the formation of one's self-image, which in turn affects one's interaction with other people. The whole field of social psychology is devoted to the study of phenomena that cannot be understood by analysis of individuals alone.

b. Memory and Narrative Construction. The stories we tell about ourselves as agents and subjects of experience are part of our self-identity. Children learn mental predicates and self-referential language as their parents ascribe intentions, desires, and feelings to them. We have a continuing identity as subjects, but memory is always an active reconstruction rather than simply a retrieval of information. We seek coherence and plausibility in our stories; narratives are revised and related to future goals and plans. The tragedy of Alzheimer's disease is the loss of the long-term memory that is required for self-representation. Sacks (1985) describes the case of "the lost mariner" with a brain lesion and memory loss, for whom art and music aided the reconstitution of a new identity. The stories we tell about ourselves are also influenced by the stories in our culture, including those of our religious traditions.

c. Cultural Symbol Systems. Human beings form symbolic representations of the self and the world that are always partial and selective. We seek meaning and order by seeing our lives in a wider context that is ultimately cosmic in scope. We identify ourselves with purposes and goals that extend beyond our own lives, temporally and spatially. Religious traditions have provided many of the symbols through which individuals integrate conflicting desires and make sense of their lives in a more inclusive context. In story and ritual people participate in religious communities and share their historical memories and their experiences of personal transformation. These wider symbolic structures of order and meaning are indeed human creations, but I have argued that they are also responses to patterns in the world and in human experience, so they can be critically evaluated and revised (Barbour 1974).

James Ashbrook and Carol Albright (1997) have proposed that models of ultimate reality can be found in neuroscience itself, particularly in Paul MacLean's (1990) idea of the tripartite brain. The upper brain stem, which we share with creatures as far back as the reptiles, controls the basic life support systems, such as breathing and reproduction. It offers an analogy to the image of God as the sustainer of the conditions for life. The limbic system, which we share with mammals, is the center of emotions that mobilize action and make richer forms of relationship possible, including empathy and care of the young. These qualities lead us to recognize emotion and social relationships as part of reality and to envision a nurturing and interacting God. The neocortex as it developed in primates and humans is the center of interpretation, organization, symbolic representation, and rationality. Damage to the frontal lobes affects the ability to prioritize, make plans, and pursue long-term goals. The left hemisphere is associated with verbal and logical analytical thought, and the right with visual, spatial, and holistic synthesizing thought. The activities of the neocortex would parallel the idea of a purposeful God who rationally orders and pursues goals. (We should note that critics of MacLean have argued that relationships between the three regions of the brain are more complex than he recognized; but analysis of three functions of the brain might still provide analogies for envisioning God.)

Ashbrook and Albright say that human beings seek meaning by viewing their lives in a cosmic and religious framework that is itself a human symbolic construct. But they go on to say that such symbol systems are not just useful fictions if they seek to interpret coherently the data of human experience. Moreover, the brain is itself part of the cosmos and a product of the cosmos, so its structures reflect the nature of the cosmos and whatever ordering and meaning-giving forces are expressed in its history.

To summarize this section, recent work in neuroscience is consistent with the biblical emphasis on embodiment, emotions, and the social self. It offers some parallels with ideas found in recent theology concerning the narrative self. The findings of neuroscience on distributed mental activities and multiple levels of processing can be cited in support of holistic and multilevel ontologies, as we shall see. Current theories concerning consciousness are more speculative, and they are subject to a variety of philosophical interpretations that will be examined later. The biblical view does indeed conflict with the determinist and materialist philosophical assumptions of many neuroscientists, but not, I suggest, with the data and theories of neuroscience itself.

III. Artificial Intelligence and Human Nature

We look now at recent work on computers and artificial intelligence (AI) and ask how it relates to neuroscience and our understanding of human nature.

1. SYMBOLIC AI AND THE COMPUTATIONAL BRAIN. AI research has a double goal: creating intelligent computers and understanding how the human brain functions. In an influential essay, Allan Newell and Herbert Simon ([1976] 1990) maintained that a world of discrete facts can be represented by a corresponding set of well-defined symbols. They claimed that the relationships among symbols are abstract, formal, and rule-governed; symbols can therefore be processed by differing physical systems (natural or artificial) with identical results. They asserted that the brain and the computer are two examples of devices that generate intelligent behavior by manipulating symbols. Symbolic AI tries to explain all cognition in terms of information, but it is not necessarily physicalist or reductionist because information is not reducible to the laws of physics.

Proponents of symbolic AI have made four assertions:

- *The Formalist Thesis.* Intelligence consists in the manipulation of abstract symbols according to formal rules.
- *The Turing Test.* A computer is intelligent if in performing tasks it exhibits behavior that we would call intelligent if it were performed by a human being.
- *Substrate Neutrality* (or *Multiple Realizability).* Software programs can be run on differing physical systems (neuron-based or transistor-based) with identical results.
- *The Computational Brain.* The human brain functions like a computer. In popular parlance, mind is to brain as software programs are to computer hardware.

Critics of formalism have said that human language and perception are context-dependent. Hubert and Stuart Dreyfus (1993) have portrayed the importance of common-sense understanding, background knowledge, and nonlinguistic experience in the interpretation of human language. Linguistic and perceptual understanding, they insist, are active processes, strongly influenced by our expectations, purposes, and interests. They also emphasize *the role of the body* in human learning. Much of our knowledge is acquired actively through interaction with our physical environment and other people. We learn to ride bicycles not by studying physics or by acquiring a set of rules but by practice. We use the skills of "knowing how" rather than the propositions of "knowing that." Such tacit knowledge cannot be fully formalized. In a child's development, growth in perception is linked to action and bodily movement. These authors see in the formalist thesis the legacy of a rationalism that goes back to Plato: the assumption that knowledge consists of formal rational relationships that exist independently of the body and the material world. They claim that formalism is a new kind of dualism in which software and hardware, like mind and body, can be analyzed independently.

Terry Winograd, whose programs for robots that could manipulate blocks were hailed as early successes in AI, subsequently repudiated formalism and stressed the importance of individual and social life in human understanding. He now accepts Heidegger's view that our access to the world is primarily through practical involvement rather than detached analysis. According to Heidegger, understanding is aimed not at abstract representation but at the achievement of our goals and interests. Our speech is communication for particular purposes, a form of action. Winograd also draws from Wittgenstein, who insists that there is no private language or individual representation of the world but only communication in contexts of social interaction. Language reflects our social practices, cultural assumptions, and "forms of life" in an interpersonal world. Winograd has redirected his own research and is working on the design and use of computers to facilitate human communication and social interaction rather than to simulate individual human behavior in isolated domains (Winograd and Flores, 1986).

2. LEARNING, ROBOTICS, AND EMBODIMENT. In most AI systems, discrete symbols that represent the world are processed serially. The development of *parallel distributed processing* (PDP), however, allowed many separate units to carry out operations simultaneously and to interact with each other without centralized control (Rumelhart and McClelland 1986). In task-oriented PDP networks, the system can be programmed to modify itself in successive runs, so it learns by trial and error. One such network can be trained by an instructor to pronounce a text, converting various combinations of letters into a recognizable sound output from a voice synthesizer. The information is stored throughout the network, not by a one-to-one correspondence between separate data items and separate memory locations. Patterns develop in the whole without prior specification of the parts. If the learning procedure is repeated, the network will not end up with an identical circuit configuration (Franklin 1995, chap. 12).

A further step is taken by Rodney Brooks and others in the design of robots that are *embodied, situated agents.* They are embodied in the sense that they can interact with the world through perception (using visual, auditory, and tactile sensors) and through action, and they are situated in particular environments. They have a minimum of central control; their architecture is decentralized in relatively independent units that interface directly with features of the environment in the generation of actions. New modules are added as incremental layers without disrupting existing modules (Brooks and Steels 1995; Clark 1997). Such robots learn by doing, not by manipulating abstract symbols. Their mechanical bodies are of course very different from our biological bodies; what they learn from their actions will differ from what we learn from ours.

Anne Foerst (1998), who has degrees in both theology and computer science, works at MIT with the group designing the humanoid robot, Cog. She describes four of its characteristics:

- *Embodiment.* The group holds that human intelligence cannot be separated from bodily action or reduced to computational abilities. Cog has a "head" and "hands" that can move and interact with its environment.
- *Distributed Functions.* Small independent processing units activate local motor controls. Modular units with loose connections between them, rather than large centralized programs, allow greater flexibility in coordination and facilitate the acquisition of new abilities without interfering with existing abilities.
- *Developmental Learning.* Like a newborn child, Cog learns visual-tactile (eye-hand) coordination from practice in grasping objects. Many of its capacities are developmentally acquired rather than preprogrammed.
- *Social Interaction.* Cog practices the equivalent of eye contact and is programmed to take into account some of the effects of its actions on people. These social features are at an elementary stage but are a goal of ongoing research.

Foerst acknowledges that most of her colleagues think that *consciousness* is illusory, and they adopt a functionalist view of both human and robot capacities. Foerst herself says that there are "two stories" about human beings; computation provides models for only one of these stories. In our own lives we justifiably rely on our intuitive self-understanding. She calls for dialogue and mutual respect between theologians and computer scientists and recognition of the biases and limits of each discipline.

3. SOCIALIZATION AND EMOTION IN COMPUTERS. Recent work in robotics answers some of the objections raised against the symbolic AI program, but other questions remain in the comparison of artificial and human intelligence. The process of socialization in humans occurs over a span of many years. In computers, information processing is very rapid, but interaction with the environment takes considerable time. Robots might be socialized partly by being fed vast quantities of information, but if the critics of formalism are correct, participation in human culture and forms of life would require active interaction over a longer period of time. Dreyfus maintains that only computer systems nearly identical to the human brain and endowed with human motives, cultural goals, and bodily form could fully model human intelligence. That may be too strong a claim, but it points to the importance of culture as well as body in human understanding and in any attempt to duplicate such understanding in machines.

The ability or inability of android artifacts to experience emotions has been a recurrent theme in science fiction, from Karel Capek's R.U.R in 1923 to Commander Data in *Star Trek.* Most AI researchers claim only to simulate cognitive processes, and they hold that cognition is quite independent of emotions. Roger Schank writes: "It would seem that questions such as 'Can a computer feel love?' are not of much consequence. Certainly we do not understand less about human knowledge if the answer is one way or the other. And more importantly, the ability to feel love does not affect its ability to understand" (Schank 1979, 222). Other authors hold that we can analyze the function of an emotion in evolutionary history and then try to construct an AI program that fulfills the same function. For example, the main behavioral function of fear is avoidance of danger, which could be programmed directly. Aaron Sloman has developed a computational theory of emotions (understood as dispositions to behave in certain ways). He says that computers could not experience feelings but could represent the cognitive components of emotions—for example, the external causes of anger and its relation to one's beliefs and ensuing actions (Sloman 1990; Oatley 1992).

Rosalind Piccard's research is directed toward building computers with the ability to *recognize and express emotions*. Her goal is to facilitate communication between computers and humans. For example, a computer instruction program could slow down or offer further explication when it perceived expressions of frustration or anger in the user's face or heartbeat. A computer voice synthesizer might deliver a message with an intonation conveying an appropriate emotional tone. Piccard cites Damasio's work on the positive role of emotions in human cognition and suggests that emotional abilities would also contribute to computer intelligence. But she remains agnostic as to whether future computers might actually experience emotions. If they did, she says, their experience would differ greatly from ours, which is linked to physiological and biochemical processes unlike anything in computers. Some emotions, such as shame and guilt, reflect distinctive experiences of selfhood. Piccard says that we do not know enough about human consciousness to speculate on whether it could be duplicated rather than imitated in a computer. "Our feelings arise in a living and complex biological organism and this biology may be uniquely able to generate feelings as we know them. Biological processes may be simulated in a computer and we may construct computational mechanisms that function like human feelings, but this is not the same as duplicating them" (Piccard 1997, 136).

4. CONSCIOUSNESS IN COMPUTERS? There are still enormous differences between computers and brains. A brain has 1,000 trillion neurons each connected to as many as 10,000 neighbors; the number of possible patterns in interconnecting them is greater than the number of atoms in the universe. Signals between neurons are not digital but are encoded in

continuously variable properties such as electrical potentials or neuron firing frequencies. Serial computers retrieve fixed information from local addresses; human memory is accessed through partial descriptive clues and is reconstructed in a more dynamic way. Gerald Edelman (1992) argues that parallel distributed processing in computer networks offers analogies to neural networks but that neurons and brains have many properties unlike those of computer chips. During embryonic development, for example, nerve cells connect to particular types of cells, but there is no exact prewiring such as computers require.

Human beings are hierarchically organized, with many levels between the atom and the self; computers can indeed be built with hierarchical architecture, but the levels are less diverse and lack the degree of integration found at higher levels in organisms. Most computers are designed to be reliable by following precise algorithmic rules. To be sure, the final states of distributed networks in computers that learn from experience are unpredictable, but their potential for creative novelty seems rather limited. New knowledge from neuroscience will undoubtedly affect future computer design, but we should not underestimate the differences or the difficulties.

Is it conceivable that a future computer or robot could be *conscious?* A human infant develops by participation in a social and linguistic community. Events in the human mind are dependent on cultural contexts that extend far beyond the individual. The prospects for the socialization of robots are rather uncertain. But once we recognize that there are gradations of consciousness at different stages of an infant's development from a fertilized egg, and differing forms of consciousness in diverse animal species, we will not have to assume that consciousness in computers, if it is possible, will be like adult human consciousness. I suspect that it will turn out that conscious awareness requires forms of organized complexity or properties of neural cells and networks that have no parallels in silicon-based systems. I do not think we can exclude the possibility of conscious computers on metaphysical grounds, but there may be empirical grounds for the impossibility of computer consciousness. Because we know so little about the physical basis of human consciousness or the directions of future research in computer science, I am willing to leave this question open.

The mathematician and theologian John Puddefoot emphasizes the gap between computers and humans today. "To be regarded as something approaching the human, a computer would need to grow, feel pain, experience and react to finitude, and generally enter into the same state of mixed joy and sorrow as a human being. In particular it would need to be finite, aware of its finitude, and condemned one day to die" (Puddefoot 1996, 92). On the other hand, he does not think we can set limits as to what might be possible in future computers. He speculates that with structures closer to those of living organisms, and with processes of evolutionary change within computers themselves, an artifact might conceivably produce its own forms of mind. Puddefoot adds that it was through evolutionary processes, after all, that God created human minds.

Our view of computers and robots, like our view of animals, will influence *our own self-understanding*. In relation to both animals and robots, interpretations that abolish sharp lines between human and nonhuman forms seem at first to be a threat to human dignity. But human dignity is not threatened if we recognize that future robots would be more than information processors, and that they may share some of what we consider the higher human capacities. In the case of animals, the recognition of similarities with humans has led to calls for respect for animal rights and for the inclusion of other life forms in the sphere of moral consideration. In the case of robots a similar extension of moral status would be required. If they can suffer, as we believe animals suffer, we would have duties to minimize such suffering. Robots would also have moral responsibilities toward each other and toward humans. There are also important psychological issues concerning our fears of creatures different from us, whether aliens from space or human creations from the laboratory. Moreover, the dangers of human *hubris* and misuse of technological power (evident in myths from Prometheus and the Tower of Babel to Frankenstein) need exploration—but that would divert us from the topics of this paper.

IV. Information, Systems, Levels, and Emergence

In attempting to relate studies of neurons and studies of persons, I find four concepts helpful: communication of information, dynamic systems, hierarchical levels, and emergence as an alternative to reduction.

1. THE COMMUNICATION OF INFORMATION. The concept of information is applicable to biological, cultural, and computer systems and can illuminate some similarities and differences among those systems. Information is an ordered pattern that is one among many possible sequences or states of a system. The pattern can be a sequence of DNA bases, alphabetical letters, auditory sounds, binary digits, or any other combinable elements. Information is *communicated* when another system (a living cell, a reader, a listener, a computer, etc.) responds selectively—that is, when information is coded, transmitted, and decoded. The meaning of the message is dependent on a wider context of interpretation. It must be viewed dynamically and relationally rather than in purely static terms as if the message were contained in the pattern itself (J. Campbell 1982).

The information in DNA sequences in genes is significant precisely because of its context in a larger organic system. In the growth of an embryo, a system of time delays, spatial differentiation, and chemical feedback signals communicates the information needed so that the right proteins, cells, and organs are assembled at the right location and time. As Susan Oyama (1985) shows, complicated developmental pathways, with information flowing in both directions, connect genes with molecular activities and physiological structures. Molecules of the immune system recognize an invading virus, which is like a key that fits a lock to release a specific antibody. The communication between molecules is dependent on properties of both the sender and the receiver. A receptor is part of an embodied action system that implements a response to signals.

In sense perception, transducers in the eye and ear convert physical inputs into neural impulses. As in all the cases above, the communication of information in the brain is a holistic property of a whole system. In itself, the frequency of firing of a neuron tells us very little about the information that is being communicated. Information is effective only in a context of interpretation and response. Once again, information flows in two directions. Information is constructed from sense data by active and action-oriented processes (Maturana and Varela 1987; Varela, Thompson, and Rosch 1991).

Stored in the DNA is a wealth of historically acquired information, including programs for coping with the world. A bird or mammal uses specific visual or auditory clues to recognize and respond to a dangerous predator that it has not previously encountered. Individuals in some species are programmed to communicate warning signals to alert other members of the species. Higher primates are capable of symbolic communication of information, and human beings can use words to express abstract concepts. Human information can be transmitted between generations not only by genes and by parental example but also in speech, literature, art, music, and other cultural forms.

It is tempting to use the concept of information to defend the possibility of immortality. In *Star Trek* the astronauts in a spaceship are instantly transported to a nearby planet by the transmission of information about all their molecular components, which are reassembled in a new location ("Beam me up, Scotty"). One might imagine that God has complete information about us and recreates us in another realm, which would have some similarities to the biblical idea of resurrection. However, the proposal appears reductionistic in its assumption that higher levels of selfhood are explainable by (and can be reconstituted from) information at the molecular level. I suggest that God knows us at all levels, including the highest level of our selfhood and subjectivity, and not just at the molecular level. God's relation to us is more personal than an inventory of molecules.

2. DYNAMIC SYSTEMS. Some authors have suggested that the study of *complex systems* provides principles applicable to phenomena as varied as neural, behavioral, and mental activities. They start from the thesis of Ilya Prigogine and Stanley Kauffman that complex systems exhibit global properties not predictable from their components. For example, a pattern of

convection cells suddenly appears when a fluid is gradually heated from below; the cells all rotate in the same direction (left or right), but the direction is unpredictable. New forms of order appear when systems are near the border between order and chaos (Prigogine and Stengers 1984; Kauffman 1995). *Chaos theory* is the study of holistic temporal and geometric patterns without reduction to detailed causal mechanisms. In nonlinear thermodynamic systems far from equilibrium, an infinitesimally small uncertainty (arising from quantum indeterminacy or from perturbations from outside any given system) can be greatly amplified, leading to large-scale consequences (Kellert 1993).

Scott Kelso (1995) has used *dynamic systems theory* to compare the patterns found in neural, behavioral, and mental systems. Though the components at these various levels are very different, the trajectories mapped in the space of possible states show striking similarities. Nonlinear systems in metastable states make sudden transitions, often along bifurcating paths. Kelso studies situations in which an organism is coupled with its environment so that neither can be understood alone. He claims that underlying principles of self-organization operate at many levels and that global patterns of cooperative behavior can be most fruitfully analyzed by attention to collective variables.

As one example, Kelso cites experiments in which subjects were told to clap their hands between the beats of a metronome. As the frequency of the beats was increased, the subjects suddenly switched from syncopated to synchronized claps. Using sensitive magnetic field detectors, he found that patterns in small groups of neurons became less coherent and then switched to new phase relations at the critical frequency. As another example, he cites studies of recovery of functions after brain damage or loss of a limb or an eye; neural activities shifted to a nearby locus as the cortical map was reorganized, though the neurons themselves did not move. Distributed dynamic patterns, he claims, are more important than the physical structures themselves. As I see it, the results of such research are relatively modest so far, but they suggest the value of inquiry conducted on several levels at once. Systems analysis cannot replace microanalysis at the neural level, but it may provide principles for correlating events at multiple levels.

Alwyn Scott portrays *the emergence of consciousness* in a hierarchy of levels he calls "the stairway to the mind." He describes several examples of nonlinearity, including the diffusion equations for traveling waves in nerves, which cannot be derived from the equations of physics and chemistry. He calls his view "emergent dualism" or "hierarchial dualism."

> The idea that all can be reduced to the spare concepts of physics has been exposed as untenable because each level of the hierarchy is dynamically independent of its neighbors. Dynamic independence—in turn—arises from *nonlinearity,* which induces the *emergence* of new and qualitatively different atomistic entities at each level." (Scott 1995, 187)

3. A HIERARCHY OF LEVELS. Both neuroscience and computer networks support the idea that organized wholes exhibit systemic properties not evident in their parts. A *level* identifies a unit that is relatively integrated, stable, and self-regulating, even though it interacts with other units at the same level and at higher and lower levels. A living organism is a many-leveled hierarchy of systems and subsystems: particle, atom, molecule, macromolecule, organelle, cell, organ, organism, and ecosystem. The brain is hierarchically organized: molecule, neuron, neural network, and brain, which is in turn part of the body and its wider environment. Human beings participate in the social and cultural interactions studied by the social sciences and humanities. A particular discipline or field of inquiry focuses attention on a particular level and its relation to adjacent levels.

Bottom-up causation occurs when many subsystems influence a system. *Top-down causation* is the influence of a system on its subsystems. Higher-level events impose boundary conditions on chemical and physical processes at lower levels without violating lower-level laws (D. Campbell 1974). Microproperties are not referred to in the specification of the macrostate by its global or collective properties. Network properties may be realized through a great variety of particular connections. Correlation of behaviors at one level does not require detailed knowledge of all its components. Just as the rules of chess limit the possible moves but leave open an immense number of moves that are consistent with but not determined by those rules, the laws of chemistry limit the combinations of molecules that are found in DNA but do not determine the sequence of bases. The meaning of the message conveyed by DNA is not given by the laws of chemistry but by the operation of the whole system. Communication of signals in neurons requires some expenditure of energy, but what is communicated is not the energy but the *form* of the signal in relation to input and output processes occurring at higher levels than the signal itself.

One way in which activities at higher levels influence lower-level activities is through *the feedback of information*. PET scans show that when people shut their eyes and think of mental images, the lowest level of the visual processing system (closest to the retina) is activated from higher levels without any input from the retina (Harth 1993, 64–83). Learning programs in distributed processing networks result in patterns in the whole that have not been achieved by specifying the parts. The robot Cog is hierarchically organized with relatively autonomous distributed modules; information concerning the results of its activities is fed back so that it can learn by doing.

Holism is the claim that the whole influences the parts. The whole-part distinction is usually structural and spatial (e.g., a *larger* whole). *Top-down causality* is a very similar concept, but it draws attention to a hierarchy of many levels characterized by qualitative differences in organization and activity (e.g., a *higher* level). Levels are defined by functional and dynamic relationships and patterns in time, though of course they are inseparable from patterns in space.

John Polkinghorne has used the idea of *communication of information* as a model for conceiving of God's relation to the world. The opening verse of John's Gospel says, "In the beginning was the Word." The biblical concept of *logos* (Word) combines the Hebrew idea of God's active communication and the Greek idea of rational structure, suggesting parallels with the concept of information. Arthur Peacocke has extended the idea of whole-part relations and suggests that God is the most inclusive whole. He also holds that the idea of top-down causality may be appropriate if God is imagined as acting from a level higher than any level in the realm of nature. I have discussed these proposals elsewhere (Barbour 1999).

4. REDUCTION AND EMERGENCE. *Epistemological reduction* is the claim that theories at higher levels are derivable (in principle if not in practice) from theories at lower levels. Historically, higher-level theories have seldom been derived directly from previously existing low-level theories. Biological and psychological concepts, for example, are distinctive and cannot be defined in physical and chemical terms. But the theories of adjacent levels are not unconnected. The conceptual structures of theories at one level have typically been gradually altered in the light of theories at other levels. Moreover, interlevel theories may be proposed that are not derived from theories at either level alone. Lindley Darden and Nancy Maull discuss some historical examples and conclude that the unity of science is an important goal, but it is not achieved by theory reduction:

> An interfield theory, in explaining relations between two fields, does not eliminate a theory or field or domain. The fields retain their separate identities, even though new lines of research closely coordinate the fields. . . . It becomes natural to view the unity of science, not as a series of reductions between theories, but rather as the bridging of fields by interfield theories. (Darden and Maull 1997, 60–61)

Patricia Churchland and Terrence Sejnowski describe *levels of organization and processing* in the brain, emphasizing network and system properties. Research at one level provides constraints and inspiration for research at other levels, both higher and lower. They portray the "coevolution of theories" as theories are revised and modified to take into account those at higher and lower levels.

> The ultimate goal of a unified account does not require that it be a single model that spans all the levels of organization. Instead, the integration will probably consist of a chain of models linking adjacent levels. When one level is explained in terms of a lower level this does not mean that the higher-level theory is useless or that the higher-level phenomena no longer exist. On the contrary, explanations will coexist at all levels, as they do in chemistry and physics, genetics and embryology. (Churchland and Sejnowski 1988, 74)

These authors believe that the integration of cognitive psychology and neuroscience will be the result of interdisciplinary interaction and not the replacement of one discipline by the other.

Ontological reduction is the claim that events at higher levels are determined by events at lower levels. It is a claim about reality and not just about theories. If events at a higher level have no causal efficacy, they are viewed as less real, or perhaps even as epiphenomena. I would defend *ontological pluralism*, a multileveled view of reality in which differing (epistemological) levels of analysis are taken to refer to differing (ontological) levels of events and processes in the world, as claimed by critical realism (Barbour 1997, 117–18). I take *emergence* to be the claim that in evolutionary history and in the development of the individual organism there occur forms of order and levels of activity that are genuinely new and qualitatively different. A stronger version of emergence is the thesis that events at higher levels are not determined by events at lower levels and are themselves causally effective.

To sum up, the concepts of communication of information, dynamic systems, hierarchical levels, and emergence allow a more systematic elaboration of the view of the person as a multilevel unity—a view that is consistent with biblical theology, neuroscience, and AI research. But they leave unresolved the problematic status of consciousness.

V. Philosophical Interpretations of Consciousness

Let us turn then to some philosophical interpretations of consciousness and its relationship to neuroscience and AI.

1. ELIMINATIVE MATERIALISM. In *The Astonishing Hypothesis,* Francis Crick, codiscoverer of DNA, has combined the presentation of data from the neurosciences with an explicitly materialist philosophy. He sees only two philosophical alternatives, a supernatural body-soul dualism or a materialistic reductionism. He equates dualism with religion, of which he is highly critical, unaware that many contemporary theologians have rejected dualism. The volume opens with this statement:

> The Astonishing Hypothesis is that "you," your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules. As Lewis Carroll's Alice might have phrased it: "You're nothing but a pack of neurons." (Crick 1994, 3)

On the scientific side, Crick is critical of cognitive scientists for relying on computational models and neglecting neural research. His book is devoted mainly to research on visual processing and awareness. He proposes that consciousness is a product of the correlation of diverse neural systems through electrical oscillations of roughly forty cycles per second. He suggests that the activities of various brain regions are coordinated when these oscillations synchronize the local neuron firings. He does not totally dismiss the subjective character of consciousness, but he does not think that it can be studied by science. "What may prove difficult or impossible to establish is the details of the subjective nature of consciousness, since this may depend upon the exact symbolism employed by each conscious organism" (Crick 1994, 252).

Daniel Dennett holds that "consciousness is the last bastion of occult properties and immeasurable subjective states." Qualia (phenomena as experienced) are vague and ineffable. The self is *a linguistic fiction* generated by the brain to provide coherence retrospectively among its diverse narratives. Dennett holds that "multiple draft" scenarios of which we are not aware compete for dominance. The self is the "center of narrative gravity" of these scenarios. It is a useful fiction that we create to provide order in our lives. But the unity and the continuity of consciousness are illusions. There is no enduring Cartesian observer who unifies our diverse perceptions. Nor is there a continuous "stream of consciousness," as posited by William James or James Joyce. There are only unconscious processes unified intermittently by a representation of the self that the brain repeatedly recreates from memories of the past and new scenarios in the present (Dennett 1991).

Dennett describes *the intentional stance* as the strategy of acting as if other people had intentions. The ascription of intentions is predictively useful, but we do not have to assume that intentional states are ever actually present. Dennett claims that he is an instrumentalist or functionalist who judges concepts only by their usefulness in describing behavior, without asking about their status in reality. But he seems to accept a metaphysics of materialism when he asserts that neuroscience will be able fully to explain intentional action. He says that he is not a "greedy reductionist" who expects to explain all higher levels directly in terms of the lowest level, but that he is a "good reductionist," expecting to explain any level in terms of the next lower one (Dennett 1995, 81–83).

2. THE IRREDUCIBILITY OF CONSCIOUSNESS. In replying to eliminative materialism, several philosophers have maintained that consciousness and subjectivity are irreducible and inaccessible to science. Thomas Nagel (1986) holds that consciousness cannot be understood from the objective standpoint required by science (which he calls "the view from nowhere"). Conscious and intentional states presuppose a particular viewpoint. Scientific theories cannot explain phenomenal feelings or give an objective account of subjectivity. But science is not the only route to understanding, and in our practical life we inevitably attribute mental states to other people, and even to other species, though it is difficult to imagine what they are like. He cites evidence of the conscious inner life of animals but says that the experiential perspective can be understood only from within or by subjective imagination.

Nagel does not defend a mind-body dualism but rather a *dual-aspect theory.* There is one set of events in the brain, of which mental concepts describe the subjective aspects and physical concepts describe the objective aspects. There is one substance with two sets of properties. Psychophysical laws connect the first- and third-person accounts, which are both valid. Personal identity is unified and linked to memory and intention as represented in first-person accounts. Nagel holds that mental aspects are present only in relatively advanced organisms.

Colin McGinn (1992) holds that consciousness is beyond our comprehension because of the limitations of human knowledge. Evolution has endowed every species with limited powers of understanding developed for practical purposes. The senses are useful for representation of the spatial world in which we live, but consciousness is not spatial. The brain can be studied as a spatial object, and its parts have spatial coordinates and predicates such as size and shape. But the predicates of mental events are temporal rather than spatial. Knowledge of the correlations of phenomenal experience with physical data concerning the brain would not help us grasp the subjective character of consciousness, which cannot be described in the conceptual terms applicable to matter in space.

McGinn believes that neural and mental events are correlated, but we cannot say how. Consciousness is a causally emergent feature of certain kinds of organized systems, but we cannot specify the necessary and sufficient conditions for consciousness to appear. Consciousness will remain an insoluble mystery, an intractable obscurity, because of our limited powers of comprehension. Both Nagel and McGinn seem to me correct in their critiques of reductionism, but I believe they underestimate the contribution of neuroscience to the study of patterns in mental events, even if science cannot capture the subjective feeling of such events.

3. TWO-ASPECT THEORIES. Owen Flanagan (1992) defends a *nonreductive naturalism* that draws from three sources: phenomenal first-person accounts, cognitive psychology, and neuroscience. He believes that the accounts can be correlated though they have differing explanatory purposes. He takes seriously our conscious experience, our awareness of sensations, perceptions, emotions, beliefs, thoughts, and expectations. Flanagan describes neural correlates of visual experience, such as the neurons that respond to edges, shapes, colors, and motions, or the brain activities that are associated with the emotions of fear and anger. But high-level concepts of the self are not expressible in neural terms. Human actions, for example, must be identified by the intentions that constitute them.

Flanagan acknowledges that the self is *constructed.* It is not given to us as a single entity or a transcendental ego. The newborn gradually builds an integrated self with the help of parents and other people. With maturation and socialization a distinct identity is formed, cast largely in narrative form in the stories we tell ourselves. The self is formed in active engagement with the environment and other persons. Our self-representations organize our memories of past events and our plans and aspirations for the future. Models of the self do not use concepts applicable to neurons, and they reflect our aims and values, which affect the choice of alternative patterns of action and human relationships.

In replying to Dennett, Flanagan agrees that the self is constructed, but he insists that it is not simply a useful fiction. Patterns of thought are real features of mental activity. The narrative self has *causal efficacy* as a complex and ever-changing self-representation. It causes people to say and do things and hence has an ontological and not merely a linguistic status. Dennett had presented only two alternatives: either the self is a separate enduring autonomous entity or else it is an illusion, a fiction that serves only instrumental functions. Flanagan offers a third alternative, the self as a many-leveled reality that is constructed rather than given, in which activities at each level have some autonomy and yet are related to each other. This goes beyond Nagel's dual-aspect theory in arguing that there are causal relations between levels rather than two perspectives on a single set of events. Flanagan does not share McGinn's pessimism about the contribution of neuroscience to our understanding of consciousness.

David Chalmers holds that *consciousness is irreducible* but argues that all other biological and psychological facts are determined by physical facts and are in principle explainable by physical theories. He holds that the cognitive sciences can provide reductive explanations for mental states considered as causes of behavior. Psychologists can even study awareness when it is viewed as access to information that is used to control behavior. They can give detailed functional accounts of memory, learning, and information processing, but they cannot say why these processes are accompanied by conscious experience, which is not defined by its causal roles. Phenomenal subjective experience is known firsthand in sensory perception, pain, emotions, mental images, and conscious thought.

Chalmers rejects materialism and functionalism and defends a *two-aspect theory,* which he also calls property dualism or a form of panpsychism. He proposes that *information states* are the fundamental constituents of reality, which are always realized both phenomenally and physically. "We might say that the internal aspects of these states are phenomenal and the external aspects are physical. Or as a slogan: Experience is information from the inside; physics is information from the outside" (Chalmers 1996, 305). A dog has access to extensive perceptual information, so we can assume it has rich visual sense experiences. A fly has rather limited perceptual discrimination and also a lower level of experience with fewer phenomenal distinctions. Simple information states would be realized in simple physical structures and simple phenomenal experiences. "It is likely that a very restricted group of subjects of experience would have the psychological structure required to truly qualify as *agents* or *persons*" (Chalmers 1996, 300).

Lynne Baker (1995) holds that neuroscience may provide the necessary and sufficient conditions for conscious events of a given modality, but not the conditions for *particular reports of mental events*. We cannot expect neuroscience to explain the specific content of consciousness. No study of neuronal activity could confirm or disconfirm the report "I realized that I believed Hal was trying to embarrass me." A person's belief that taxes are too high may be explained or predicted from other beliefs or events that psychologists and sociologists can study, but data at the level of neurons will not be illuminating. Beliefs are states of persons that help to explain their actions, not the interactions between neurons. Baker says that patterns of explanation at various levels indicate the reality of events at each level; she calls herself a *metaphysical pluralist*, not a dualist or a two-aspect monist.

Of the three views in this section—eliminative materialism, the irreducibility of consciousness, two-aspect theories—it seems to me that the third is most consistent with human experience and with current theories in neuroscience. Process philosophy might be considered a form of two-aspect theory, but I suggest that it can better be described as dipolar monism.

VI. Process Philosophy

The process philosophy of Alfred North Whitehead and thinkers influenced by him presents a coherent metaphysical framework within which many of the themes explored in previous sections can be brought together.

1. DIPOLAR MONISM AND ORGANIZATIONAL PLURALISM. Whitehead elaborated a set of philosophical concepts that emphasize becoming rather than being, change rather than persistence, creative novelty rather than mechanical repetition, and events and processes rather than substances. Whereas substances remain the same in different contexts, events are constituted by their relationships and their contexts in space and time. Whitehead and his followers hold that the basic components of reality are not one kind of enduring substance (matter) or two kinds of enduring substance (mind and matter), but *one kind of event with two phases.* In the objective phase a unitary event is receptive from the past; in the subjective phase it is creative toward the future. Every event is a subject for itself and becomes an object for other subjects (Whitehead [1929] 1978).

This philosophy is a form of monism, because it insists on the common character of all unified events. *Dipolar* indicates an ontological claim, not merely an epistemological distinction, as some advocates of two-aspect monism propose. *Organizational pluralism* is the recognition that events can be organized in processes in diverse ways, as emphasized by Charles

Hartshorne (1967), who reformulated and extended Whitehead's ideas. All integrated entities at any level have an inner reality and an outer reality, but these take very different forms at different levels. Both the interiority and the organizational complexity of psychophysical systems have evolved historically.

Looking at diverse types of system, Whitehead attributes *experience* in progressively more attenuated forms to persons, animals, lower organisms, and cells (and even, in principle, to atoms, though at that level it is effectively negligible), but not to stones or plants or other unintegrated aggregates. David Griffin (1977) proposes that this should be called *panexperientialism* rather than *panpsychism,* because for Whitehead mind and consciousness are found only at higher levels. Only in advanced life-forms are data from brain cells integrated in the high-level stream of experience we call mind. Experience at different levels varies greatly; consciousness and mind were radically new emergents in cosmic history.

An atom repeats the same pattern, with essentially no opportunity for novelty except for the indeterminacy of quantum events. Inanimate objects such as stones have no higher level of integration; the indeterminacy of the individual atoms of an inanimate object averages out in the statistics of large numbers. A cell, by contrast, has considerable integration at a new level. It can act as a unit with at least a rudimentary kind of responsiveness. There is an opportunity for novelty, though it is minimal. If the cell is in a plant, little overall organization or integration is present; there is some coordination among plant cells, but plants have no higher level of experience. But invertebrates have an elementary sentience as centers of perception and action. The development of a nervous system made possible a higher level of unification of experience. New forms of memory, learning, anticipation, and purposiveness appeared in vertebrates.

In human beings, the self is the highest level in which all of the lower levels are integrated. Humans hold conscious aims and consider distant goals. Symbolic language, rational deliberation, creative imagination, and social interaction go beyond anything previously possible in evolutionary history. Humans enjoy a far greater intensity and richness of experience than occurred previously. The human psyche is the dominant occasion that integrates and harmonizes the diverse streams of experience it inherits. Its continuity is achieved as the route of inheritance of a temporally ordered society of momentary events.

Process thinkers thus agree with dualists that interaction takes place between the mind and the cells of the brain, but they reject the dualists' claim that this is an interaction between two totally dissimilar entities. Between the mind and a brain cell there are enormous differences in characteristics, but not the absolute dissimilarity that would make interaction difficult to imagine. The process view has much in common with two-language theories or a parallelism that takes mental and neural phenomena to be two aspects of the same events. But unlike many two-aspect theories, it defends interaction, downward causality, and the constraints that higher-level events exert on events at lower levels. At higher levels there are new events and entities and not just new relationships among lower-level events and entities (David Griffin 1998).

2. EMBODIMENT, EMOTIONS, LEVELS, AND CONSCIOUSNESS. The themes in the neurosciences that were mentioned earlier are prominent in process philosophy.

a. Embodiment. Every unified event is portrayed as a synthesis of past bodily events. There are no events that have a subjective phase without a prior objective phase. This can be called an ecological, relational, or contextual philosophy because it holds that every basic unit is constituted by its relationships. Moreover, we experience the causal efficacy of our own bodies. The senses, such as sight, always have a bodily reference rather than simply transmitting information about the world. The body is the vehicle of relationality with other persons. Process thought defends the idea of the social self, which is a product of the interaction of embodied persons and not of disembodied minds.

b. Emotions. Process thought recognizes the importance of nonsensory experience and the perception of feeling in our own bodies. Consciousness and cognitive thought occur against a background of feeling. Whitehead writes: "The basis of experience is emotional. . . . The basic fact is the rise of an affective tone originating from things whose relevance is given" (Whitehead 1933, 226). The technical Whiteheadian term *prehension* includes the communication of both conceptual and affective elements. The influence of one event on another is similar to the communication of information—including selective response by an interpretive system—but it includes an emotional component absent from most analyses of communication.

c. Consciousness. Whitehead says that consciousness first appeared in animals with a central nervous system as a radically new emergent. In human beings, most mental activity is unconscious. Consciousness occurs only in the last phase of the most complex occasions of experience, as a derivative by-product of nonconscious experience. Self-identity consists in the continuity of processes most of which are below the threshold of awareness. Whitehead says that consciousness is "a late derivative phase of complex integration which primarily illuminates the higher phases in which it arises and only dimly illuminates the primitive elements in our experience" (Whitehead [1929] 1978, 162). It involves the unification of prehensions from the past and from the body with a new element: the contrast of past and future, the entertainment of possibilities, the comparison of alternatives.

d. A Hierarchy of Levels. Among process thinkers, Charles Hartshorne has developed most fully the idea of a series of levels intermediate between the atom and the self. He dwells on the differences between cells and mere aggregates such as stones (Hartshorne 1953, chap. 1; 1962, chap. 7). His holistic outlook directs attention to system properties that are not evident in the parts alone. Process philosophy has always insisted on contextuality and relationality. But it recognizes that various levels may be integrated according to very different principles of organization, so their characteristics may be very different. In a complex organism, downward causation from higher to lower levels can occur because, according to process philosophy, every entity is what it is by virtue of its relationships. The atoms in a cell behave differently from the atoms in a stone. The cells in a brain behave differently from the cells in a plant. Every entity is influenced by its participation in a larger whole. Emergence arises in the modification of lower-level constituents in a new context. But causal interaction between levels is not total determination; there is some self-determination by integrated entities at all levels.

e. The Construction of the Self. Whitehead was influenced by William James, who held that there is no enduring self but only the stream of experience. Thought goes on without a thinker, or even a succession of thinkers aware of the same past. Continuity of identity, James said, is guaranteed only by the persistence of memory. He held that we each use a constantly revised model of the self to impose order on the flux of experience. Whitehead also holds that the self is a momentary construction, but he asserts that it is a unified complex process. The unity of self is a unity of functioning, not the unity of a Cartesian thinker. We have seen that this view that selfhood is constructed is consistent with recent neuroscience.

However, I believe that Whitehead himself overemphasized the momentary and episodic character of the self. I have suggested that without accepting substantive categories we can modify Whitehead's ideas to allow for more continuity in the inheritance of the constructed self, which would provide for stability of character and persistence of personal identity (Barbour 1997, 290). Joseph Bracken agrees with my criticism of Whitehead and believes it can be remedied by emphasizing Whitehead's thesis that a temporal society maintains continuity among its momentary constituents ("actual occasions"). Bracken suggests: "A much simpler way to preserve continuity among the discontinuity of successive actual occasions within human consciousness is to give greater importance to the Whiteheadian notion of a society as that which is created and sustained by a succession of actual occasions with a common element of form" (Bracken 1998, 407). Bracken proposes that a society that endures over time can be understood as a "structured field of activity" for successive generations of events. "When applied to the Whiteheadian notion of the human self as a personally ordered society of conscious actual occasions, this means that the self is an ongoing structured field of activity for successive actual occasions as momentary subjects of experience" (Bracken 1998, 407). Such revisionist or neo-Whiteheadian proposals can remedy some of the problems in Whitehead's writings while supporting his fundamental vision of reality (Kirkpatrick 1971; Sponheim 1979, 90–98).

3. THE STATUS OF SUBJECTIVITY. My own view is very similar to the emergent monism of Philip Clayton (forthcoming) and Arthur Peacocke (forthcoming). We share a commitment to explanatory pluralism and the diversity of levels of explanation, including the distinction between reasons for human actions and causes of physical effects. We share a commitment to organizational pluralism in a hierarchy of many levels rather than a mind-matter dualism. We join in advocating contextualism in which every entity is constituted by its relationships. Emergent monists also have a strong sense of the temporality and historical character of reality, and it would not be inconsistent for them to accept the Whiteheadian emphasis on momentary events and dynamic processes and the process critique of enduring substances. We agree that consciousness and mind are emergent new properties found only at high levels of complexity, and that these potentialities were built into the lower-level components from the beginning.

However, process thinkers diverge from emergent monism by holding that at least a rudimentary form of subjectivity is present actually, and not just as a potentiality, in integrated entities at all levels. What are the reasons for such attribution?

a. The Generality of Metaphysical Categories. In Whitehead's view, a basic metaphysical category must be universally applicable to all entities. The diversity among the characteristics of entities must be accounted for by the diversity of the modes in which these basic categories are exemplified and by differences in their relative importance. The subjective aspect of cells may for all practical purposes be ignored, but it is postulated for the sake of metaphysical consistency and inclusiveness. Mechanical interactions can be viewed as very low-grade organismic events (because organisms always have mechanical features), whereas no extrapolation of mechanical concepts can yield the concepts needed to describe subjective experience. New phenomena and new properties can emerge historically, but not new basic categories. Wings and feathers may evolve from other objective physical structures, but subjectivity cannot be described in physical terms. The subjective character of events is also important in process theology, because it provides one of the routes of God's influence on the world. The Whiteheadian analysis of causality allows for formal and final as well as efficient causes in all events (see Barbour 1997, 289–93; 1999).

b. Evolutionary and Ontological Continuity. There are no sharp lines between a cell and a human being in evolutionary history. Today, a single fertilized cell gradually develops into a human being with the capacity for thought. Process thinking is opposed to all forms of dualism: living and nonliving, human and nonhuman, mind and matter. Human experience is part of the order of nature. Mental events are a product of the evolutionary process and hence an important clue to the nature of reality. We cannot get consciousness from matter, either in evolutionary history or in embryological development, unless there are some intermediate stages or levels in between, and unless mind and matter share at least some characteristics in common.

c. Immediate Access to Human Experience. I know myself as an experiencing subject. Human experience, as an extreme case of an event in nature, is taken to exhibit the generic features of all events. We should then consider an organism as a center of experience, even though that interiority is not directly accessible to scientific investigation. In order to give a unified account of the world, Whitehead employs categories that in very attenuated forms can be said to characterize lower-level events, but that at the same time have at least some analogy to our awareness as experiencing subjects. Such a procedure might be defended on the ground that if we want to use a single set of categories, we should treat lower levels as simpler cases of complex experience, rather than trying to interpret our experience by concepts derived from the inanimate world or resorting to some form of dualism. It is of course difficult to imagine forms of feeling very different from our own, and we must avoid the anthropomorphism of assuming too great a similarity. Organizational pluralism allows for differences among levels and for the emergence of radically new phenomena, on which emergent monism rightly focuses attention.

4. IMMORTALITY WITHOUT AN IMMORTAL SOUL. The process view of immortality, like its view of sin, redemption, and the Incarnation, is relational—that is, it is a relationship of persons to God and other beings, not a property of individuals in themselves. To articulate it adequately would require a longer discussion of the process view of God than we can undertake here. In process thought, God's attributes include distinctive forms of embodiment, emotion, consciousness, and social interaction. God is present in all time and space and knows all that can be known. God is eternal and unchanging in character and purpose but temporal in being affected by interaction with the world.

Process thinkers have defended two forms of immortality. *Objective immortality* is our effect on God and our participation in God's eternal life. Our lives are meaningful because they are preserved everlastingly in God's experience, in which evil is transmuted and the good is saved and woven into the harmony of the larger whole. God's goal is not the completed achievement of a static final realm but rather a continuing advance toward richer and more harmonious relationships (see Cobb and Griffin 1976, chap. 7).

Other process writers defend *subjective immortality,* in which the human self continues as a center of experience in a radically different environment, amid continuing change rather than changeless eternity, with the potential for continued communion with God. John Cobb (1972) speculates that we might picture a future life as neither absorption in God nor the survival of separate individuals but as a new kind of community transcending individuality. Marjorie Suchocki suggests that subjective and objective immortality can be combined, because God experiences each moment of our lives not merely externally as a completed event but also from within in its subjectivity. In that case our subjective immediacy would be preserved in God as it never is in our interaction with other persons in the world (Suchocki 1988, chap. 5).

In summary, process philosophy is supportive of the biblical view—which I suggested was consistent with the evidence from the neurosciences—that a human being is a multilevel unity, an embodied social self, a responsible agent with capacities for reason and emotion. The dipolar monism and organizational pluralism proposed by process philosophy avoids the shortcomings of both dualism and materialism by postulating events and processes rather than enduring substances or entities. But neither science nor philosophy—even when supplemented by data from the humanities and social sciences—can capture the full range of human experience or articulate the possibilities for the transformation of human life to which our religious traditions testify.

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