

Emergence in Psychology: Lessons from the History of Non-Reductionist Science

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Key Words

Cognitive science · Emergence · History · Reductionism · Socioculturalism

Abstract

Theories of emergence have had a longstanding influence on psychological thought. Emergentism rejects both reductionism and holism; emergentists are scientific materialists, and yet argue that reductionist explanation may not always be scientifically feasible. I begin by summarizing the history of emergence in psychology and sociology, from the mid-19th century through the mid-20th century. I then demonstrate several parallels between this history and contemporary psychology, focusing on two recent psychological movements: socioculturalism and connectionist cognitive science. Placed in historical context, both socioculturalism and connectionism are seen to be revivals of 19th and early 20th century emergentism. I then draw on this history to identify several unresolved issues facing socioculturalists and connectionists, and to suggest several promising paths for future theory.

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1. Introduction

Emergentism is a form of materialism which holds that some complex natural phenomena cannot be studied using reductionist methods. My first goal in this paper is to identify the historical roots of two emergentist paradigms in contemporary psychology: sociocultural psychology and cognitive science. My second goal is to draw on this history to explore several unresolved issues facing these contemporary paradigms. Sociocultural psychologists are sociological emergentists; they hold that group behavior is consti-

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tuted by individual action, yet they maintain that its study cannot be reduced to individualist psychology. Consequently, socioculturalism has historical roots in both psychological and sociological emergentism. Cognitive scientists are psychological emergentists; unlike behaviorists, cognitivists model mental phenomena without reducing them to lower-level components. More recently, several contemporary cognitive paradigms have drawn explicitly on emergentist insights; these paradigms include connectionism, situated robotics, and developmental systems theory.

In section two, I describe the 19th century origin of emergentism. In sections three and four, I review the ensuing history of emergentism in psychology and then sociology. My summary is designed to emphasize the similarities of these positions; a brief article is too short to do justice to the many subtle distinctions. In section five, I identify emergentist elements in contemporary cognitive science and in socioculturalism, and I draw historical links with these earlier schools. In section six, I note unresolved issues that emergentism has encountered throughout its history, and I suggest several implications for contemporary psychology.

2. Atomism, Holism, and Emergentism

Since the origin of scientific psychology in the 19th century, the field has included both reductionist atomists and anti-reductionist holists. The structuralist psychology associated with Wundt and Titchener was reductionist, in attempting to identify the component sensations of conscious experience. Behaviorism, although rejecting the methodology of introspection, was equally reductionist. In his seminal 1913 paper, Watson wrote that after psychology accepts behaviorism, psychology can then be unified with the physical sciences: 'The findings of psychology ... lend themselves to explanation in physico-chemical terms' [1913, p. 177]. Gestaltism, in contrast, was a form of psychological holism; it was foundationally based on the claim that humans perceived irreducible wholes, or *gestalts*. Consequently, its attacks on behaviorism and introspectionism targeted their reductionist assumptions: 'The processes of learning, of reproduction, of striving, of emotional attitude, of thinking, acting, and so forth ... do not consist of independent elements, but are determined in a situation as a whole' [Köhler, 1929, p. 193].

Since the 19th century, most physical and biological scientists have been reductionist atomists, believing that the only scientific way to understand a complex system is to first analyze it into its component parts; then, to discover the rules and laws that describe these components; and finally, to analyze interactions among the parts. In the 20th century, reductionist methods were increasingly successful in the physical sciences, identifying *bridging laws* between levels of analysis that were formerly thought to be incommensurable. Canonical examples include the reduction of thermodynamics to statistical mechanics, and the reduction of the regularities of the periodic table to the laws of quantum mechanics [Nagel, 1961]. These successes led to a form of reductionism known as *physicalism* – the belief that all science ultimately reduces to the laws of physics – that was closely associated with logical positivism.

The opposite of atomism is *holism*: the position that there are some complex systemic phenomena that must be studied in their own terms, that mechanistic, reductionist methods are not applicable to such systems, and that no part can be understood except in its relation to the entire system.¹ For example, at the turn of the 20th century,

psychological holists such as William James were opposed to *epiphenomenalism* – the belief that the mind could not have any causal power apart from the biological brain. These psychologists argued that the mind was a higher-level entity that had causal power over its lower-level components, and that this causal power was not reducible to the causation of the components.

Holists have always faced the difficult task of ontologically grounding their anti-reductionism. If the holist accepts the ontological position of materialism – only physical matter exists – then on what grounds can an anti-reductionist argument be made? After all, the higher-level phenomenon is nothing but its component matter. From the late 19th century through the 1920s, many holists rejected materialism and held to dualist ontologies such as *vitalism* or *organicism*. Vitalism holds that living organisms contain a ‘vital’ force or substance, in addition to physical matter. If this were true, reduction to physical matter would be impossible, and science would have to remain dualistic. In social philosophy, many vitalists were also *organicists*, drawing analogies between society and complex biological organisms. As science became more firmly detached from metaphysics, non-materialist holisms, including vitalism, dualism, spiritualism, and idealism, became increasingly difficult for serious scientists to maintain, although metaphysical philosophers continued to make such arguments through the 1920s. Today, dualist ontologies such as vitalism are rejected as unscientific by the mainstream of all scientific disciplines.

Emergentism is a form of nonreductionism that accepts the ontological position of materialism. With regard to the complex natural phenomena under study, emergentism accepts that nothing exists except the component parts and their interactions, and thus avoids the ontological problems of holism. However, the emergentist also rejects atomism, and argues that reductionism, physicalism, mechanism, and epiphenomenalism are not necessary consequences of materialism. Some complex natural phenomena cannot be studied with reductionist methods; these phenomena are complex systems in which more complex and differentiated ‘higher level’ structures emerge from the organization and interaction of simpler, ‘lower level’ component parts.²

Because emergentists are materialists, they hold that higher-level properties *supervene* on the system of lower-level components [Davidson, 1970; Fodor, 1974; Kim, 1993]. Supervenience refers to a relation between two levels of analysis, and states that if two events are identical with respect to their descriptions at the lower level, then they cannot differ at the higher level. If a collection of lower-level components with a given set of relations causes higher-level property *E* to emerge at time *t*, then on every other occasion when that same collection of components in that same set of relations occurs, *E* will again emerge. Note that this implies that an entity cannot change at a higher level without also changing at the lower levels. Although emergentists accept supervenience,

¹ This is the sense of holism used in sociology and in the philosophy of the social sciences [Gellner, 1956/1968; Phillips, 1976]. Holists can be more or less receptive to incorporating some analyses of parts, although they all assign analytic primacy to the arrangement of the parts in a complex system. The term ‘holism’ is sometimes used in an even broader sense, to indicate a belief that components must be studied not only in isolation but also to see how their behavior changes when in relations with other parts in complex systems. But even reductionists accept this truism: ‘If this is emergence, then this is a sort of emergence that the most reductionist and mechanist physicalist will never have dreamed of denying’ [Smart, 1981, p. 111; also see Phillips, 1976, p. 35].

² Emergentists make a wide range of philosophical arguments for this latter claim; the arguments are quite complex, and are found primarily in philosophy of mind and philosophy of biology [see Sawyer, 2000b]. The consensus among these scholars is that reductionism is not the only valid scientific method, and that for many natural phenomena, it will not be successful.

many of them also hold that higher level structures can have causal powers over the lower level components [Davidson, 1993; Fodor, 1989; Horgan, 1989].

The observation that some complex systems manifest emergent higher level properties that are not attributable to the components is not in itself incompatible with reductionism. The pressure of a volume of gas is an emergent property – no component molecule can be assigned the property ‘pressure’ – yet, the pressure can be reduced to statements about molecular movement and interaction, using the laws of statistical mechanics. Such examples have led some scientists to argue that ‘emergence’ only reflects the incomplete state of science and is not a fact about the natural world. For example, reductionists in sociology, known as *methodological individualists*, hold that although we may identify laws about social groups that we cannot at present reduce to laws about individuals, these are only incomplete and interim explanations; as our scientific knowledge advances, we will ultimately be able to effect the reduction to laws about individuals (see section 4). These issues remain unresolved, and I discuss the implications for contemporary psychologists in section 6.

In this paper I show that, in contrast to the almost total dominance of reductionism in the physical sciences, psychology has been influenced by emergentism from its late-19th-century origins through the present. Early versions of emergentism first arose in the mid to late 19th century, and include the theories of French sociologists Auguste Comte [1842/1854] and Émile Durkheim [1895/1964], American psychologist William James [1890], English philosopher G.H. Lewes [1875], and several German social organicists. For psychologists such as Wundt and the later Gestaltists, emergentism provided grounds for a non-reductionist science of psychology. I review this history as a way of providing insights into the philosophical foundations of contemporary cognitive psychology and connectionism. For sociologists like Durkheim and Parsons, emergentism was a way of creating a science of social phenomena that is not derivative from psychology; I review this history to provide insights into the foundations of contemporary sociocultural psychology.

3. Psychological Emergence

In psychology, emergentist arguments can be grouped into four schools: British emergentism of the 1920s; Gestalt psychology of the 1920s and 1930s; American pragmatism from the 1890s through the 1930s; and contemporary philosophy of mind and cognitive science, in the 1970s through 1990s.

British Emergentism

The British emergentists were a group of philosophers who elaborated a theory of emergence in the 1920s, focusing primarily on biological evolution [see Ablowitz, 1939; Blitz, 1992; McLaughlin, 1992]. By the late 1920s, emergence was a full-fledged intellectual fad. British emergentists cite Mill as the source of the emergence concept. In his *Logic* [1843] Book III, Chapter 6, ‘Of the composition of causes,’ Mill elaborated the implications of the science of chemistry, and proposed two types of causation: mechanical causation, which was additive, and *heteropathic* causation, or emergent causation, which was not additive and not mechanical (vol. 2, p. 427).

However, Mill did not use the term 'emergent'; this term was coined by his friend and colleague, philosopher George Henry Lewes [1875]. Like Mill, Lewes distinguished between mechanical and chemical effects, referring to them as *resultants* and *emergents*, respectively. The classic example of emergence invoked by both Mill and Lewes was the combination of hydrogen and oxygen, resulting in water. Water does not have any of the properties of either hydrogen or oxygen; its properties are *emergent* effects of the combination:

Although each effect is the resultant of its components, the product of its factors, we cannot always trace the steps of the process, so as to see in the product the mode of operation of each factor. In this latter case, I propose to call the effect an emergent. It arises out of the combined agencies, but in a form which does not display the agents in action. [1875, vol. 2, p. 412]

If all effects were resultants, Lewes noted, the power of scientific rationality would be absolute, and mathematics could explain all phenomena. But Lewes claimed that 'effects are mostly emergents' [p. 414]. Thus, science must proceed by experiment and observation, rather than rational reasoning, since emergent effects are unpredictable before the event.

Mill's distinction between mechanical and heteropathic causation and Lewes's concept of the emergent were elaborated by several English-language philosophers during World War I, including C. Lloyd Morgan [1923], Samuel Alexander [1920], and Edward Spaulding [1918]. Morgan, who was responsible for reintroducing Lewes's term 'emergence', claimed that in *emergent evolution*, 'one cannot predict ... the emergent expression of some new kind of relatedness among pre-existent events' [1923, p. 6]. Although emergent phenomena follow the laws of nature, they will not always submit to scientific study; 'such novelty is for us unpredictable owing to our partial knowledge of the plan of emergence up to date, and our necessary ignorance of what the further development of that plan will be' [p. 282].

During this period, several emergentists were also vitalists, proposing that complex systems contained some non-material substance, such as Driesch's *entelechies* and Bergson's *élan vital*. In particular, Bergson's book *Creative evolution* [1907/1911] was widely studied by British philosophers, particularly by those who most strongly advocated emergentism in the 1920s. This book was a critique of what Bergson called 'radical mechanism' and 'radical finalism'; both positions exaggerated the predictability of natural phenomena. Bergson argued that both evolution and mental processes were unpredictable for similar reasons: because they 'endure' in time. He appealed to a vitalist, non-material force, the *élan vital*, to account for novelty in evolution. For some British emergentists [such as Alexander, 1920] such lingering vitalist influences contributed to a tendency to be dissatisfied with a strict materialist ontology, and this vestigial vitalism led many scientists of the day to dismiss emergentism entirely. Bergson proposed a process metaphysics that became an element of the emergentist theories of the pragmatists Mead and Dewey: 'Everything is obscure in the idea of creation if we think of *things* which are created and a *thing* which creates ... There are no things, there are only actions' [p. 248]. Bergson referred to the human tendency to fixate on stable forms as the 'cinematographical illusion', a metaphor for the false belief that reality is a succession of fixed structures [pp. 305–307].

Morgan's work was influential because it explicitly rejected vitalism and yet seemed to provide a non-reductionist version of materialism. It resulted in a dramatic burst of activity, including conference symposia and special issues of journals [see Love-

joy, 1927; Pepper, 1926; Russell, Morris, and MacKenzie, 1926]. These British emergentists argued that life and mind – what philosophers today call ‘consciousness’ and ‘intentional states’ – were emergent, and were supervenient on material reality. Through the 1930s, the nonreductive materialism of the British emergentists had a wide-ranging impact in psychology and the social sciences, and these scholars were explicitly acknowledged as influences by theorists as diverse as Wolfgang Köhler, George Herbert Mead, and Talcott Parsons. These same theorists acknowledged their debt to Alfred North Whitehead [1926], whose theories were also heavily emergentist. Philosophers of science continued to elaborate on the writings of the British emergentists through the 1950s and 1960 [e.g. Hempel, 1965, pp. 258–264; Mandelbaum, 1951; Meehl & Sellars, 1957]. Although emergentism continued to influence psychologists and sociologists, in the 1930s it was rejected by physical scientists, due to developments in quantum mechanics and other sciences that reinforced the physicalist belief that all science would ultimately reduce to physics [McLaughlin, 1992, p. 89].

Gestalt Psychology

Emergentism in psychology has its roots in 19th-century *organicism*: the theory that the organism is different from the sum of its parts, and that it depends on the structural arrangement of the parts. Social organicism – the notion that society formed an integrated unity similar in some sense to that of living organisms – can be traced to Classical social philosophy, but the publication of Darwin’s account of evolution gave new energy to social organicist theories [see Giddens, 1970, p. 172]. In the 19th century, organicism was prominent in German social philosophy; influential advocates included Schäffle and Lilienfeld. Like the works of Bergson and other vitalist biologists and philosophers of the 19th century, these organicist social theories retained elements of vitalism; they were not strictly materialist in ontology, and therefore they did not meet the definition of ‘emergentism’ I am using here. However, these theories were widely read, and influenced German psychologists including Wundt and the early Gestaltists. Both Wundt and the Gestaltists drew on the insights of organicism to develop a non-vitalist, materialist form of non-reductionist psychology.

The psychologist Wundt included emergence as one of his fundamental principles, the ‘principle of creative resultants’, writing that ‘[The principle of creative resultants] attempts to state the fact that in all psychical combinations the product is not a mere sum of the separate elements that compose such combinations, but that it represents a new creation. But at the same time ... this product is formed by the elements, so that further components are not necessary for its creation’ [1912, p. 164]. Note in particular that this principle is opposed to associationism, which is additive and thus a mechanical principle.³

Drawing on organicist precedents, the Gestalt psychologists opposed the reductionist claim of physiological psychology that the brain took simple sensations, and by a

³ Wundt had already formulated the principle of creative resultants in his 1874 *Grundzüge der physiologischen Psychologie* (*Principles of physiological psychology*, 1874/1904), although these passages appeared in the final chapter of the second volume, which has never been translated into English [for a translated passage, see Wheeler, 1928, pp. 60–61]. Wundt is often considered to be a structuralist psychologist, and his method was essentially reductionist; however, his writings were contradictory – at times he wrote as if he held to associationism, yet at other times, he emphasized creative synthesis [see Boring, 1929, pp. 336, 607–609].

process of association, identified and evaluated them. Gestalt anti-reductionism was opposed to structuralist psychology – represented by E.B. Titchener – which claimed that mental experiences could be analyzed into elementary units such as sensations, feelings, and thoughts. The Gestaltists drew on emergentism to philosophically ground their anti-reductionism. Köhler explicitly noted that his Gestalt psychology was emergentist [1929, p. ix], and frequently appealed to emergence, arguing that higher-level structures emerge from ‘dynamical self-distribution’ [1929, p. 140] and presenting Gestalt theory as an analysis of how ‘a process dynamically distributes and regulates itself’ [1929, p. 193]. However, the Gestaltists were more holist than emergentist; their emphasis was on the study of irreducible wholes, and they did not explore how those wholes emerged from lower-level components and their interactions.

Kurt Lewin’s research on *group dynamics* was a particularly interesting elaboration of Gestalt psychology; it shifted emergence arguments from the individual to the group level of analysis. Lewin, working alongside Köhler and Wertheimer in Berlin, applied Gestalt holism to group phenomena, using Köhler’s term ‘dynamical whole’ to refer to the group. By analogy with a perceptual Gestalt, Lewin argued that a change in any component of the group changed the state of the other components. The research in Lewin’s school focused on the internal characteristics of groups – cohesiveness, internal communication processes, and group structure and position [Deutsch, 1954]. When Lewin first began to develop and publish his theories on group dynamics, most psychologists denied the existence or reality of groups. Rather, they held a reductionist atomist view of social phenomena: Only individuals were real, and to talk about properties of groups was considered to be nonscientific or mystical. Thus, one of Lewin’s major contributions was to help make the concept of ‘group’ acceptable to psychologists, and was thus foundational for late-20th-century social psychology.⁴

Pragmatism and Symbolic Interactionism

American pragmatism was formed at the same time as the above theoretical discussions were most prominent, and consequently emergentist elements were significant influences in the development of pragmatist thought. William James was often cited by both British emergentists and process metaphysicians, and also was widely read among French sociologists, including Durkheim. In rejecting associationism, materialist monism, and epiphenomenalism, James argued that ‘thoughts and feelings exist’ [1890, vol. 1, p. vi], and that ‘we ought to continue to talk in psychology as if consciousness had causal efficacy’ [1890, vol. 1, p. 138]. Chapter 6 of the 1890 work is a critique of psychological atomism – of the ‘mind-stuff theory’ that ‘our mental states are composite in structure, made up of smaller states conjoined’ (vol. 1, p. 145).

Mead and Dewey developed their theories under the influence of James, Whitehead, and the British emergentists, and each developed a distinct variant of emergentism. Dewey’s concept of ‘experience’ was a theory of agent-environment interaction; experience emerges from the active process of an intelligent agent engaging with an environment: ‘Experience is the result, the sign, and the reward of that interaction of

⁴ Of course, a belief in the existence of the group was common among French sociologists of Durkheim’s school (see section 4 below); yet according to Deutsch [1954], Lewin developed his conceptual framework without influence from sociology.

organism and environment which ... is a transformation of interaction into participation and communication' [1934, p. 22]. In focusing on interaction between a complex organism and its environment, Dewey's emergentism is subtly different from the version I emphasize here, in which higher level properties *within* a complex system are emergent from and yet irreducible to lower level components. In his focus on process and change, and his critique of static, structuralist theories, Dewey was influenced by the process metaphysics of Bergson and Whitehead.

Arthur Murphy's 'Introduction' to Mead's 1932 *The Philosophy of the Present* noted that "'process', 'development' and 'emergence' are catchwords of recent thought" [Mead, 1932, p. xi] and described Mead's work as an elaboration of both Alexander's theory of emergence and Whitehead's process metaphysics. Dewey's 'Prefatory Remarks' to the same book also noted of Mead that "Long before the words 'emergent evolution' were heard, [his problem was] that of the emergence of the new ... one can appreciate how much more fundamentally he took the doctrine of emergence than have most of those who have played with the idea" [Mead, 1932, p. xxxviii]. Like James, Mead opposed the epiphenomenalist materialism that attributed causal force only to the lowest level physical particles [e.g. 1932, p. 38]. In Mead's conception of emergence, both the lower level *and* the higher level entities have causal power; the emergent, higher levels of reality have causal influence on the lower, component levels [e.g. 1932, p. 69]. Mead's term for this principle was *sociality*. Sociality is a property of emergence processes, because such processes are emerging simultaneously within different systems, at different levels of analysis.

In addition to their theoretical work, Mead and Dewey were concerned with the empirical mechanics of emergent processes. The philosophical theory of process, emergence, and sociality led Mead to propose an empirical focus on *symbolic social process* [Mead, 1934]. This was the foundational inspiration for symbolic interactionism, an empirical branch of microsociology which focuses on *joint action* [Blumer, 1969] and is one of the roots of sociocultural psychology. Symbolic interactionists reject explanations that reduce joint activity to individual psychology, and argue that joint activity is the only appropriate level for social scientific study.

The Cognitive Revolution

Several authors have noted connections between the early stages of the cognitive revolution and Gestalt psychology [Murray, 1995; Simon, 1999]. From the emergentist perspective, the most important connection is that they both share anti-reductionist, anti-physicalist impulses. Behaviorism and associationism are consistent with reductionist atomism, in holding that the physical processes of the brain are causally complete, without reference to consciousness or mental states. If higher-level mental phenomena are merely epiphenomenal, with no causal powers, then why should scientific psychology attempt to study them?

The cognitive revolution represented a new approach to psychology, one which rejected the reductionist atomism of behaviorism, and proposed that mental phenomena could be scientifically studied without first reducing them. The first cognitive psychologists were heavily influenced by cybernetics and systems theory, which had identified feedback and homeostasis processes at the level of complex systems (the same influence was foundational for Talcott Parsons; see below). Philosophers responded with proposals

for new forms of materialism that were mentalist and thus nonreductionist. Perhaps the first was the neuroscientist R.W. Sperry, who drew on the British emergentists and as early as 1965 proposed theories of emergentism and *nonreductive mentalism* to ground the new cognitive science [see Sperry, 1980]. In the philosophy of mind, the cognitive revolution re-activated a dormant mind-brain debate, with *identity theorists* holding to the epiphenomenalist position (mental states cannot have any causal force) and *nonreductive materialists* holding that mental properties and events are not reducible to physical ones [Davidson, 1970; Fodor, 1974; Lowe, 1993], and may indeed have causal power over the physical brain [Campbell, 1974; Lowe, 1993; Andersen, Emmeche, Finnemann, & Christiansen, 2000]. At various points in this recent debate, the 1920s-era concepts of emergence and supervenience have been influential [Beckermann, Flohr, & Kim, 1992; Horgan, 1993; Humphreys, Rohrlich, Rosenberg, & Wimsatt, 1996; Kim, 1993].

Piaget's genetic psychology, another major influence on cognitivism, was also opposed to the reductionist atomism of behaviorism [see Taylor, 1985, p. 140]. Piaget was influenced by a strong line of holist thinking in French philosophy, having studied Durkheim and Lévy-Bruhl early in his career.⁵ Piaget's constructivism was quite similar to emergentism, in that schemas at one stage emerge from the interaction between activity and schemas at the prior stage. His empirical research focused on the detailed incremental mechanisms of this emergence. By providing bottom-up explanations of the emergence of mental schemas through time, Piaget was rejecting the claim of mental holists that higher-level phenomena can be analyzed and explained without reference to their components. However, once a schema had emerged in development, Piaget was a holist concerning that schema; the schema, as an irreducible whole, had a causal influence on behavior.

Piaget's theorization of mental schemas thus has an interesting relation to the sense of emergentism considered here. I have defined emergence as a synchronic relation between higher-level properties of a complex system and the properties of its components and their relations; in contemporary psychology, this corresponds to a relation between cognitive schemas and their underlying neuronal substrate. In contrast, Piaget focused on the diachronic relations between schemas and activity at one stage, and the resulting schemas at the next stage. The form of emergentism found in Piaget's constructivism was formative for cognitive psychology and its rejection of behaviorism, because it provided an account whereby cognitive schemas could be emergent from a past process of ontogenesis, and thus not reducible to present behavior.

4. Sociological Emergence

Emergentism has been perhaps even more influential in sociology than in psychology. Although this article focuses on psychology, I include a brief overview of this history here for two reasons. First, the emergence arguments of sociologists have occasionally

⁵ Piaget's autobiographical comments on his early holism and on the formative influence of the Durkheim-Tarde debate can be found in Piaget [1952, pp. 240–242]. Piaget noted that the nonreductionist task of genetic epistemology was analogous to Durkheim's emergentist project [1995, pp. 39–40] (see below). In spite of this general influence, on several occasions in his *Sociological Studies*, Piaget explicitly rejected Durkheim's sociological emergentism, arguing in contrast that any social totality must be conceived of as the set of all social interactions: "one can reduce all 'social facts' to interactions between individuals" [p. 97; also see pp. 45, 134–139].

filtered into psychological theory, and they apply by analogy to mental phenomena; second, because socioculturalism is implicitly based on emergence arguments at the social group level.

Émile Durkheim

Durkheim's foundational argument for sociology was heavily emergentist [Sawyer, 2000a]. In the preface to the second edition of *Rules*, Durkheim responded to reductionists' criticisms of the first edition by giving examples of emergence from other sciences:

Whenever certain elements combine and thereby produce, by the fact of their combination, new phenomena, it is plain that these new phenomena reside not in the original elements but in the totality formed by their union. The living cell contains nothing but mineral particles, as society contains nothing but individuals. Yet it is patently impossible for the phenomena characteristic of life to reside in the atoms of hydrogen, oxygen, carbon, and nitrogen ... Let us apply this principle to sociology. If, as we may say, this synthesis constituting every society yields new phenomena, differing from those which take place in individual consciousness, we must, indeed, admit that these facts reside exclusively in the very society itself which produces them, and not in its parts, i.e., its members ... These new phenomena cannot be reduced to their elements. [Durkheim, 1901/1964, pp. xlvii–xlvi]

In 'Individual and Collective Representations', Durkheim explicitly noted the analogy between emergence arguments as applied to collective phenomena, and emergence arguments as applied to psychological phenomena. Durkheim noted that '[Individual minds] are compounds' [1898/1953, p. 320], and that 'Not without reason has it been said that the self is itself a society' [1898/1953, p. 111, in a reference to William James, who was widely read in France due to his relationship with Durkheim's professor, Renouvier]. Durkheim noted that mental emergents are caused by neuronal activity, but are not merely epiphenomenal; they exert causal force on those neurons: 'They are caused, but they are in their turn causes' [p. 4]. Otherwise, 'Ideas have no power' [p. 10]. In situations of higher-level causation, reductionist analysis is inappropriate because the component elements are changed by their association [p. 11]. Durkheim argued that analogous threats of reductionism faced both sociology and psychology, and that if psychological phenomena exist, then so must social phenomena. Psychologists who attack sociologists for studying something that doesn't really exist apart from its components – the social group – are themselves subject to a similar reduction to biology, unless they make the same emergentist arguments.⁶

Talcott Parsons

The influential sociological theorist Talcott Parsons drew on emergence concepts in his first major work, *The Structure of Social Action* (1937). Parsons defined the discipline of sociology as the study of the emergent properties of 'social action systems' [p.

⁶ 'Each mental condition is, as regards the neural cells, in the same condition of relative independence as social phenomena are in relation to individual people ... Those, then, who accuse us of leaving social life in the air because we refuse to reduce it to the individual mind have not, perhaps, recognized all the consequences of their objection. If it were justified it would apply just as well to the relations between mind and brain' [Durkheim, 1898/1953, p. 28].

768], and drew on emergence to argue for the irreducibility of his chosen level of analysis: the *unit act* and *action systems*. He argued that reductionism was an inappropriate methodology for the scientific study of social action, because it ‘consists in the progressive elimination, as the breaking down into parts is carried farther, of the emergent properties of the more complex systems’. In contrast, Parsons argued that the science of social action must focus on a level of analysis that is not reducible to physical science: ‘Action systems have properties that are emergent only on a certain level of complexity in the relations of unit acts to each other’ [p. 739]. He defined three emergent levels of analysis, which are the objects of study of economics, politics, and sociology [p. 768]. In his later major work, *The Social System* (1951), Parsons drew on systems theory and cybernetics, and presented what became known as *structural-functional* sociology.⁷ Although Parsons rejected the reduction of sociology to psychology, as an emergentist he also rejected a sociological holism that denies the relevance of psychology. Scientists who study the ‘higher levels of emergence’ have to be familiar with the sciences of the lower levels as well: “The ‘mechanisms’ of the processes that a sociologist is interested in will always prove to involve crucially important elements on these ‘lower’ levels” [1937, p. 772].

Methodological Individualism

The opposition between sociological holism and reductionism has been central not only in sociology but also in economics. Reductionism in both disciplines is known as *methodological individualism*: the position that all social phenomena can and should be explained in terms of individuals and relations among individuals, and that there are no irreducible social properties. Like those physical scientists who observe that the properties of water only seemed to be emergent from hydrogen and oxygen until one had identified the quantum mechanical bridge laws, methodological individualists argue that emergent social properties only seem to be irreducible due to limitations of our current state of scientific knowledge. Thus, the existence of emergent social properties is not an argument against methodological individualism, just as the existence of water, with emergent properties irreducible to hydrogen and oxygen, does not demonstrate the falsity of physicalism.

Carl Menger, founder of the influential Austrian school of economics, insisted – in opposition to German social organicism and other forms of sociological holism – that even emergent social phenomena, including law, language, money, and markets, could be analyzed by reducing them to the analysis of individuals pursuing individual interests, using a reductionist atomist method that he called the *exact orientation* [1883/1963, pp. 151–159].⁸ F.A. von Hayek, in his three-part essay *Scientism and the Study of Society* [1942, 1943, 1944], elaborated Menger’s theories to develop an influential statement of methodological individualism. In this essay, Hayek argued that social phenom-

⁷ Cybernetics and systems theory also gave birth to Bertalanffy’s *general systems theory* [1968] and Miller’s *living systems theory* [1978], which also invoke emergence in making non-reductionist claims.

⁸ Menger was influenced by Mill, who was quite explicit in denying that the chemical method of heteropathic causation was necessary for the social sciences: ‘The Laws of the phenomena of society are, and can be, nothing but the actions and passions of human beings ... Men are not, when brought together, converted into another kind of substance, with different properties; as hydrogen and oxygen are different from water’ [1843, vol. 2, p. 469].

ena must be explained in terms of individuals. Like Menger, Hayek rejected sociological holism, and described higher-level social phenomena as emergent from, although reducible to, individual action:

The conscious action of many men produce undesigned results ... regularities which are not the result of anybody's design. If social phenomena showed no order except in so far as they were consciously designed, there would indeed be no room for theoretical sciences of society and there would be, as is often argued, only problems of psychology ... The reason of the difficulty which the natural scientist experiences in admitting the existence of such an order in social phenomena is that these orders cannot be stated in physical terms. [1942, p. 288]

His examples included the forest trails that form gradually as hundreds of people each seek the best path; the task of social science is to discover explanations for how such patterns emerge. The 'compositive theory of social phenomena' has as its goal a resolution of Menger's problem: how the independent actions of many people can produce higher-level social structures that are not intentionally designed [1944, p. 27]. Economists emphasize that what distinguishes their field from psychology is their concern with emergent phenomena in systems with large numbers of individuals; the canonical example is how the price of a good emerges from many exchanges among individuals in a free market.

In the 1950s, there was a wide-ranging debate among theorists about the merits of taking Hayek's methodologically individualist stance [O'Neill, 1973]. J.W.N. Watkins [1955, 1957/1973] formulated an even stronger version of methodological individualism. Whereas Hayek held that an understanding of social phenomena, using the compositive method, could never be complete due to the extreme complexity of the task and the limitations of the human mind [1944, pp. 30–31], Watkins was more optimistic: 'We shall not have arrived at rock-bottom explanations of such large-scale [social] phenomena until we have deduced an account of them from statements about the dispositions, beliefs, resources and inter-relations of individuals' [Watkins, 1957/1973, p. 168].

Methodological individualism has been widely attacked by sociologists [Blau, 1977], philosophers [Lukes, 1977], and even some economists [Arrow, 1994]. However, it remains influential, forming part of the theoretical foundation of individualistic psychology, and of major contemporary schools of sociology, including rational choice theory and exchange theory.

5. Emergence in Contemporary Psychology

I have briefly summarized the history of emergentism, first in psychology, and second, in sociology. But emergence is of more than purely historical interest to contemporary psychology; emergence is a central concept in two recent psychological movements, socioculturalism and connectionist cognitive science. In this section, I identify some parallels between historical versions of emergence and contemporary uses of the concept in sociocultural psychology and in connectionist cognitive science. My goal is to provide new perspectives on contemporary issues by reference to this history.

Socioculturalism is a revival of a range of 19th and early 20th century intellectual trends that each contributed to emergentism in the 1920s and 1930s: German social organicism, Bergson and Whitehead's process metaphysics, and the psychological holism of the Gestaltists, particularly the social version of Lewin's school. The school of sociocultural psychology emerged in the 1980s and 1990s to study socially and culturally situated action. Within socioculturalism, I include cultural psychologists, Vygotskian-influenced educational theorists, and those studying situated action and cognition [Bruner, 1990; Cole, 1996; Forman, Minick, & Stone, 1993; Lave & Wenger, 1991; Rogoff, 1990; Stigler, Shweder, & Herdt, 1990; Suchman, 1987; Valsiner, 1998; Wertsch, 1998]. Socioculturalists have attempted to extend psychology by taking into account how meaningful activity is generated in social contexts. In doing so, they reject reduction of these phenomena to individual-level explanations, by appealing to an *event* or *situated action* level of analysis.

Intelligent behavior is seen to emerge from the socially situated interactions of individuals, rather than to be a product that resides in the head. Rogoff, for example, argued that knowledge itself is not reducible to individual cognitive representations: 'the assumption of abilities or skills as stable possessions of individuals ... we argue should be dropped in the sociocultural approach.' Instead, the focus is on 'the process and individuals' participation in and contributions to the ongoing activity' [Rogoff, Radziszewska, and Masiello, 1995, p. 144]. Several theorists have used organicist language to describe situated social action: 'By analogy, the organs in an organism work together with an inherent interdependence' and any feature 'would lose all meaning if it were actually separated from the whole' [Rogoff, 1992, p. 317].

Socioculturalism has been heavily influenced by the American discovery and elaboration of Vygotsky's writings in the 1960s and 1970s. Since Vygotsky's works were composed primarily between 1924 and 1934, it is not surprising that he was influenced by the multiple strands of emergence theory that were prominent during that time, including the British emergentists, the German Gestaltists, and the process metaphysics of Bergson and Whitehead. Like the Gestaltists, Vygotsky rejected the reductionist atomism of both behaviorism and introspectionism [Vygotsky, 1971, p. 18; also see Cole & Scribner, 1978, p. 5, and Wertsch, 1985, p. 4]. Although he was heavily influenced by the Gestaltists, Vygotsky argued that they did not explain the origins of complex mental phenomena. Vygotsky drew on several stands of 19th century *sociological holism* in proposing that irreducible psychological wholes originated in collective life; his belief in the social origins of higher psychological processes was influenced by the Durkheimian school of French sociology [see Cole & Scribner, 1978, p. 6]; he closely read Lévy-Bruhl [Vygotsky, 1971, p. 9], who made extensive use of the research and theory of Durkheim's school, particularly the concept of 'collective representation' [e.g. Lévy-Bruhl, 1910/1925].⁹ Vygotsky's sociological holism led him to focus on social units of analysis that were irreducible, functionally integrated wholes. Since 'all higher mental functions are internalized social relationships', Vygotsky expanded on Gestaltist theory by examining both psychological and social wholes, and how they were related in development: 'how individual response emerges from the forms of collective life' [Vygotsky, 1981, p. 164].

⁹ Lawrence and Valsiner [1993] also noted the influences of Janet (who was in the same university class with Durkheim at the *École Normal Supérieure*) and Baldwin.

With respect to complex social phenomena, Vygotsky was a sociological holist, because he did not attempt to explain social phenomena themselves in terms of how they emerged from individuals and interactions. Like holism more generally, sociological holism holds that macrosocial phenomena have primacy over individuals in explaining behavior, and cannot be redefined in terms of individual behavior. In sociological holism, minimal attention is given to the individual's influence on society; the structures of society are primary and are responsible for shaping the individual. Sociological holists are not emergentists because they are not concerned with the micro-to-macro processes through which individuals collectively create macrosocial structures [cf. Archer, 1995]; rather, their concern is with the macro-to-micro influences of society on individuals.

Although influenced by Vygotsky's sociological holism, American socioculturalists are rarely sociological holists, because they often seek to explain sociological phenomena as emergent from individual mental states and behaviors. In developing an emergence theory, socioculturalists have drawn heavily on the emergentism of the American pragmatist philosophers, and their focus on situated action continues the symbolic interactionist tradition of focusing on joint actions as the basic units of analysis. The sociocultural approach focuses on processes rather than products, and as such, is implicitly concerned with the durational mechanisms of the emergence of social-level phenomena from individual actions and interactions. (Note the distant, although suggestive, parallels with the process metaphysics of Bergson and Whitehead).

In turning to sociological emergentism, socioculturalism finds itself in the midst of a longstanding issue in sociological theory; above, we saw the historical roots of sociological emergentism in both Durkheim and Parsons, and these issues remain central to contemporary sociology's debate between individualism and collectivism. This debate has an ontological and a methodological dimension. *Ontological individualists* are analogous to materialists in physical science; they hold that only individuals exist. An ontological individualist holds that the group is not a real entity but merely a term used to refer to a collection of individuals. Social structure does not really exist, but is merely a convenient shorthand for summarizing individual behavior in the aggregate.

Sociological realists, in contrast, hold that the group is just as real as the individual, and that both are abstract, analytic units rather than concrete entities. Thus they reject both ontological and methodological individualism in favor of sociological holism: the position that the group can be analyzed and explained solely in terms of sociological processes and variables, without reference to facts about or behaviors of individuals. The social group operates according to its own principles, and these principles have no necessary relationship to facts or descriptions of individuals. Realists also note that sociological properties seem to have some causal influence over individuals; yet an ontologically individualist position entails that these higher-level properties be epiphenomenal. Contemporary realists include Keat and Urry [1975], Bhaskar [1979], and Archer [1995]; several realists have explicitly invoked emergence arguments [Archer, 1995; Bhaskar, 1979].

Anti-realist sociological theories include Giddens's structuration theory [1984], the methodological individualism of rational choice theory [Coleman, 1990], and the interactional reductionism of Collins [1981]. These critics claim that sociological realists propose a dualist ontology, one that 'hypostatizes' or 'reifies' sociological concepts. Anti-realists reject holism and argue that because groups are not real, explanations in terms of groups will be incorrect, misleading, or at best, approximations to the individu-

al-level explanation. However, a sociologist can accept *ontological* individualism and nonetheless reject *methodological* individualism; much of the contemporary debate rests on this distinction. Ontological individualism is the position that only individuals exist; but even if only individuals exist, there may be grounds for rejecting a methodology which explains all social phenomena in terms of individuals [Brodbeck, 1958/1968; Goldstein, 1958/1973; Sawyer, 2000b].

By taking an implicitly emergentist stance, socioculturalism is at the center of this active and unresolved theoretical debate. The historical debates concerning sociological emergence are directly relevant to foundational issues in contemporary social science. Familiarity with this debate could be beneficial for the development of sociocultural theory, by providing additional clarity to the ontological and methodological foundations of socioculturalism.

Contemporary Cognitive Science

In section 4, I noted the emergentist influences on the cognitive revolution. Several contemporary schools of cognitive science have drawn even more explicitly on emergentist foundations. These include situated robotics, connectionism, and dynamic systems theory.

The socioculturalist focus on situated cognition is paralleled by a contemporary paradigm in cognitive science, *situated robotics*, which expanded in popularity roughly contemporaneously with socioculturalism, in the late 1980s and early 1990s. Situated robotics researchers argue that intelligent behavior emerges from the interaction of an agent with a rich, complex environment [Agre and Rosenschein, 1995; Clark, 1997; Suchman, 1987]. By focusing on agent-environment interaction, situated robotics was a shift from 'Classic AI', which attempted to model the intelligence of the agent by developing internal mental representations of higher-level cognitive processes, including semantic networks, short-term memory, attention processes, language perception and comprehension.

Situated robotics emphasized that intelligent agents are situated in an environment. Agents typically have incomplete knowledge of the environment; thus, agents must be able to respond to unexpected events and interactions, modifying their plans opportunistically. This resulted in a shift in designers' approaches to planning and representation, because rather than maintaining explicit representations of the world, and preparing detailed plans of action, the behavior of situated agents is seen to emerge from agent-environment interaction, rather than to be strictly a result of internal representations. These ideas have occasionally influenced socioculturalism, for example through the work of Suchman [1987] and Hayes-Roth [1992]; also note the distant parallels with Dewey's concept of experience.

In its rejection of the representational approach of classic AI, situated robotics was preceded and enabled by another emergentist paradigm in computational modeling, *connectionism*. Connectionist systems do not explicitly represent or model higher-level mental processes. Instead, in connectionist simulations intelligent behavior emerges from the interactions of many rather simple units. Connectionist concepts date back to the neural nets of the 1940s [McCulloch & Pitts, 1943], yet the birth of contemporary connectionism is typically dated to the 1986 publication of *Parallel distributed processing* [Rumelhart & McClelland, 1986]. Many connectionists draw an analogy with the

neuronal structure of the brain, noting that individual neurons are not themselves intelligent, yet intelligent behavior emerges from the interactions of many neurons. Connectionists argue that the human brain is a complex system, and as such displays emergent behavior that cannot be predicted from a full and complete description of the component units of the system [Bechtel & Richardson, 1993]. Because this complexity prevents prediction in advance (as the British emergentists first argued), simulations must be run to determine how the system will behave at the macro level. Connectionists attempt to directly simulate the microprocesses whereby intelligent macrobehavior emerges from the complex interactions of many neurons. In addition to connectionism, work on distributed cognition has influenced sociocultural theory [e.g. Hutchins, 1995].

Connectionist and situated-robotics concepts of emergence developed in parallel with *developmental systems theory*, a synthesis of developmental biology and developmental psychology [Griffiths and Gray, 1994; Oyama, 1985]. Developmental systems theory argues that genes do not have primacy in explanations of ontogenetic development; rather, gene-environment interaction should be the focus, and researchers should focus on the process of construction of phenotypes, rather than the transmission of genotypes. Developmental systems theory holds that 'development is a process of emergence', and that the goal of developmental study is to identify 'the conditions under which emergent form arises and the ways in which emergence can be constrained' [Elman et al., 1996, p. 359]. Several themes deriving from developmental systems theory – including self-organization, complexity, and emergence – have begun to filter into developmental psychology, and are sometimes referred to as the *dynamic systems approach* [e.g., Lewis, 2000; Thelen and Smith, 1994].

Connectionism studies what Clark [1997] called *direct emergence*: the macro properties of a system emerge from interactions among its components. Sociological emergence is a form of direct emergence, because macrosocial properties of the group emerge from the group's component individuals and their interactions. Situated robotics studies *indirect emergence*, where the action of the system emerges from interaction with an external environment. A robotic agent executing a plan within a complex environment represents indirect emergence. Indirect emergence is analogous to the socioculturalist's focus on situated cognition, and echoes Dewey's conception of *experience* as an individual-environment system. Direct emergence is also used implicitly by socioculturalists, to ground their claim that properties of the group are emergent from, and irreducible to, participants' actions and interactions. Thus, socioculturalists combine interests in both types of emergence.

The above historical overview reveals broad theoretical parallels. Contemporary descriptions of complex dynamical systems have earlier echoes in the texts of the 19th century organicists, the Gestaltists, and the British emergentists. To argue for the non-reducibility of human cognition and consciousness, many contemporary philosophers of mind defend cognitivism by drawing explicitly on emergence.

6. Unresolved Issues

In the above historical review, I demonstrated that the concept of emergence has had a longstanding influence on psychological thought, and that its influence continues to the present day, in connectionism, philosophy of mind, and sociocultural psychology. Throughout the long history of emergence theory, anti-reductionist arguments have not

been convincingly proven or widely accepted. In the following sections, I discuss some unresolved issues in an attempt to indicate a path to a more robust emergence theory.

The Ontological Issue: Does the Higher Level Really Exist?

A materialist must accept that the universe consists of nothing but physical matter and interactions among elementary particles. A metaphysics which holds that something exists other than matter is known as *vitalism* or *dualism*. Vitalism is a 19th century position that rejected materialism, holding that life involved a non-material 'vital force' that existed independently of physical matter. British emergentists like Morgan explicitly rejected vitalism. Nonetheless, reductionist atomists often confused them with vitalists. After all, the reductionist reasoned, living beings contained nothing but physical matter; therefore, all science should be reducible to physics.

In a similar way, individualists argue that the methodology of sociocultural psychology is based on an invalid ontology because, after all, a social group contains nothing but individuals. Most socioculturalists implicitly accept that the social is just as real as the individual, and thus seem to hold to a dualist ontology. In a parallel fashion, contemporary sociological realists are criticized for proposing a dualist ontology, a world in which both individuals and social entities are autonomous realms of reality.

Socioculturalists can respond to such criticism by being more explicit about their ontological commitments, and being careful to distinguish ontological claims (the social is real) from methodological claims (the social cannot be meaningfully explained in terms of individuals). To hold to the ontological claim – sociological realism – I contend that the socioculturalist must defend this dualist ontology. And if a socioculturalist accepts ontological individualism yet intends to argue for methodological collectivism, he or she must develop an argument for why reductionism is not possible, even though groups consist of nothing more than individuals. Emergentism can potentially provide such an argument.

One possibility for socioculturalists is to turn to sociological theory, where these same issues have been central to a century of theoretical discussion. The 1980s and 1990s have seen a great deal of theoretical work in sociology on what is known as the *micro-macro link*, the relation between individual situated action and macrosocial structure [Alexander & Giesen, 1987]. Sociological realists from Durkheim onward have been accused of proposing a dualist ontology, a world in which both individuals and groups are distinct realms of reality, each autonomous and each exerting causal influence on the other. Their responses, particularly those of contemporary realists and emergentists, can be instructive for socioculturalists. For example, the debate between Giddens's structuration theory [1984] and the analytic dualism of Archer's emergentism [1995] is directly relevant to the ontological and methodological stance being developed by sociocultural theorists. As Archer [1995] noted, both structuration and emergentism reject the exclusive focus on either individual or society typical of traditional sociological theories, and attempt to develop theories that can incorporate both in close and constant interaction. Structuration theory holds that it is not possible to analytically separate individual action and macrosocial structure; the two cannot be meaningfully distinguished, because both individual and society are constituted through the same situated practice. Some socioculturalists hold to quite similar positions, rejecting a stratified conception of reality and holding that individual and group 'mutually consti-

tute' each other [Matusov, 1998]. In this context, it is interesting to note that structuration theorists have explicitly rejected emergence as a theory of the individual-collective relation [e.g. Giddens, 1984, pp. 169–174]. In contrast, Archer [1995] proposed an emergentist theory that retains an *analytic dualism* between individual action and social structure, and is heavily critical of structuration theory. Socioculturalists could draw on such debates to clarify and elaborate these theoretical issues.¹⁰

Non-reductionist scientists can also draw on the contemporary philosophy of mind. In rejecting the extreme reductionism of physicalism and logical positivism, philosophers of science accept that one can hold to materialism – nothing exists except for physical matter – and nonetheless reject two implications of physicalism: theoretical reductionism (higher level theories can be translated into theories of the lower levels) and methodological reductionism (the best way for science to proceed is to focus on analysis of the lower levels) [see Ayala, 1974]. Psychologists who hope to reject reductionism must make explicit their arguments on this point. Philosophers of mind have made significant progress in this area; in fact, the current dominant view is not the reductionist identity theory, but is rather nonreductive materialism.

Connectionist work, although drawing on emergence concepts, is at present a fundamentally reductionist theory, because it models only the lower-level units and their interactions; the higher-level patterns that emerge are fully explained by the lower-level representation of the system, and they do not have any causal power. Any apparent causation of the emergent pattern can be fully explained in terms of local interactions between pairs of units. The above history suggests that connectionist theory could fruitfully proceed by relaxing its firmly reductionist assumptions [as argued by Elman et al., 1996, e.g. p. 359]. Connectionists could, for example, explicitly represent emergent macro patterns as computational objects. This would involve a partial return to the earlier paradigm of symbolic AI, which was a form of nonreductionist cognitive science that argued that psychology could be a science of the mental, not necessarily reducible to neurons and their interactions. At present, connectionists are quite averse to any form of symbolic AI, which they pejoratively refer to as 'GOFAI' (good old-fashioned AI); it may take some time before connectionism is ready to move towards an emergentist synthesis with symbolic AI. I predict that such a synthesis will eventually occur, and will retain the emergentist insights of connectionism, while extending them to incorporate elements of nonreductionism.

The Holism Issue: Is the Higher Level Independent of the Lower Level?

Holism, in my usage, is the position that the science of the lower level is largely irrelevant to the higher level science, that the higher level has explanatory primacy, and that the behavior of the components can only be explained in terms of their relations within the entire system. For example, sociological holism holds that social phenomena can be analyzed and studied without consideration of the science of individuals, and that many aspects of individual behavior are best explained by reference to macrosocial phenomena. Hayek attacked sociological holism and argued that it could not be connected to individual action, except in a deterministic, top-down fashion. In fact, as I

¹⁰ For example, see the Rogoff-Valsiner debate in *Human Development*, which hinges on exactly such issues [Valsiner, 1991; Rogoff, 1992].

noted in the previous section, holism has largely been rejected in contemporary sociological theory in favor of accounts that incorporate both a theory of the individual, and a theory of the dialectic relations between individuals and social phenomena.

Sociocultural psychology can draw on such theoretical work and its criticisms of methodological individualism. The methodological individualist criticizes sociocultural psychology, arguing that individuals have explanatory primacy and that social phenomena do not exist and thus cannot have any causal power over individuals. By drawing on arguments of sociological emergentists, sociocultural psychologists can better ground their methodological stance. To develop a robust response to methodological individualism, these sociological theories have had to develop sophisticated positions vis-à-vis individualism [cf. Alexander & Giesen, 1987; Archer, 1995; Sawyer, 2000b]. Contemporary rejections of reductionism in sociology – including both Giddens's structuration theory, Archer's emergentist theory, and micro-macro theory in general – have not been holist, because they have accepted the necessity of a theory of the individual, and the necessity of a theory of the relations between individuals and higher-level social phenomena.

Emergentism is a form of non-reductionism which is not holist; in emergentism, higher level emergents are supervenient on lower level components, and can, in principle, be systematically analyzed in terms of their connections to the lower levels. Because emergentism accepts supervenience, the science of the higher level has to be compatible with that of the lower level; thus to some extent emergentist theory is compatible with a limited form of reductionism because reductionist explanation can contribute a piece of the overall solution, even if not the complete scientific explanation.

Within an emergentist framework, the question with regard to any complex systemic phenomenon is the relative degree to which lower-level and higher-level explanation should be combined to develop a complete scientific explanation of the phenomenon. Certain aspects of system behavior can be explained by undertaking traditional reductionist analysis; some properties of the component elements will play a role in the types of macro phenomena that emerge. For example, contemporary economists accept a form of emergence, and yet pursue a methodology that explains emergent social phenomena by reduction to individuals; using this individualist methodology, they have developed reductionist explanations of some collective phenomena, such as commodity prices. Of course, there are well-known and significant concerns about the scope of social and human phenomena that such a methodology can explain. In response, nonreductionist emergentists hold that not all emergent phenomena will be explainable or predictable in terms of the lower level, although they generally accept that there is some role for the study of micro-to-macro processes of emergence.

Thus, nonreductive psychology needs to elaborate, in more explicit detail, how its theories connect to sciences of the lower levels, and yet are not reducible to them. Connectionism has avoided the holism issue, because it is a variant of emergentism that is quite close to reductionism: all explanations are framed in terms of the lower level of analysis, the units and their interactions. Yet in exchange for this, the status of higher-level emergents, and of mental causation, remains problematic. Socioculturalism does not yet have a unified theory that systematically relates social phenomena with individual mental states, largely because the relation between the micro and macro levels remains hotly debated. Socioculturalists are divided on how to resolve this theoretical point, with each researcher proposing a different micro-macro theory; contrast the positions of Jaan Valsiner, Barbara Rogoff, and Jim Wertsch. Sociocultural theory could

benefit by drawing on the recent decades of theoretical work on sociological emergence and on the micro-macro link.

The Issue of Higher-Level Causation

Scientists of the higher levels typically wish to attribute causal force to the phenomena that they study. Psychologists propose causal laws relating mental states, and they assume that mental events can result in neuronal activity that then results in external behavior. We explain the fact that an individual moved his hand away from the fire by saying that his feeling of pain caused his hand to move. Likewise, sociologists propose causal laws relating social states, and they assume that social structures have causal power over individual behavior. Socioculturalists imply that the social can causally influence the individual. Such scientists can appeal to emergence theory as a way of accounting for this higher-level causation which is nonetheless compatible with materialism or individualism, respectively.

Some emergentists take a position on downward causation that is compatible with reductionism: they deny that it exists, and focus only on 'upwards' emergence. This is the conventional position in economics, which accepts the existence of emergent social properties yet explains them using methodological individualism. As such, social properties do not have an autonomous existence and cannot have causal power over individuals. Likewise, connectionists focus on bottom-up emergence, but without providing any account of the apparent downward causation of the mind over the brain.

An opposing extreme is for the emergentist to hold that the emergent higher level is real [Archer, 1995; Bhaskar, 1979]. If what emerges is ontologically autonomous, then its causation is not problematic, but this leads to the problems associated with realism – how to explain the emergence of something from a lower level that is ontologically autonomous from its emergence base? To maintain the realist stance requires a rather sophisticated philosophical argument, and realism remains hotly debated in both sociological theory and the philosophy of mind.

An emergentist path between these two extremes could attempt to account for downward causation within a monistic ontology. This is the path that mental realists have taken in the philosophy of mind; they hold that mental properties are real and not reducible to physical properties, even though they are ontological materialists. The unresolved issue then becomes, if the higher level is not ontologically autonomous, then how can it have causal power? The status of mental causation is controversial in contemporary philosophy of mind [e.g. Andersen et al., 2000; Heil & Mele, 1993], and the status of social causation is foundational for sociology: it was the downfall of Durkheimian sociological realism, resulting in Parsons' [1937] and later American critiques. If emergentists reject a dualist ontology, and at the same time argue that higher-level phenomena have causal force, the argument must root that causal force in their emergence from lower-level components.

Thus, an emergence theory that is both non-realist and non-reductionist requires simultaneous consideration of two directions of causation: emergence of the higher-level phenomenon from the lower level, and downward causation from the higher level to the lower level. The caveat for psychology is that neuroscience must be considered; the caveat for both sociology and sociocultural psychology is that individual psychology must be considered.

The Methodological Issue: How to Study Multiple Levels of Analysis?

Drawing on emergence arguments, both connectionism and socioculturalism emphasize that it is not possible to analytically reduce the higher level to the lower level; however, both draw different methodological conclusions. Their different methodologies reflect their different stances on the above issues.

Connectionists assume that the higher level phenomena are not real, and they deny that the higher level is independent of the lower level. They also deny the possibility of mental causation; the higher-level emergent patterns are epiphenomenal. However, unlike a reductionist atomist, connectionists observe that the prediction of the system behavior from a complete knowledge of lower level components is impossible. Connectionists thus reject the conventional approach of analytic reduction – the belief that one has fully described a system once one fully understands the components and their interactions. Instead, due to the extreme complexity of cognitive systems, connectionists emphasize the need for simulation. This is sometimes called a *compositive* method, in contrast to the analytic method of reductionism. In fact, the compositive method used by connectionists has been applied to sociological emergence, in social simulations using multi-agent systems techniques; designers of these simulations explicitly claim that they have modeled sociological emergence [e.g., Epstein & Axtell, 1996]. Few socioculturalists would be satisfied with this compositive approach to sociological emergence, because it denies that the social level is real, and it denies that the social level has any causal power.

Like connectionists, socioculturalists note the difficulty of analytic reduction of complex social phenomena. But compared to connectionists, socioculturalists maintain a wider range of positions on the above issues. Many socioculturalists reject holism in their focus on the interrelations among the social and individual levels of analysis. Many socioculturalists believe that the social level is just as real as the individual level, and most socioculturalists accept the possibility of social causation. Although socioculturalists often do not make their ontological stance explicit, their method – in assuming that group-level properties can be studied, can influence individuals, and yet cannot be reduced to individuals – implies an acceptance of sociological realism.

The Definitional Task: Which Systems Manifest Emergence?

The history of science suggests that no scientist can assume a priori that a given higher-level phenomenon is emergent and thus non-reducible. For example, the favorite example of the British emergentists – that chemical combinations had emergent properties that could not be reduced to the laws of physics – had to be abandoned with the advance of quantum mechanics. Reductionism has a long history of success in the physical sciences; this success has contributed to the widespread acceptance of methodologically individualistic methods in the social sciences, including economics, most of psychology, and even prominent trends in sociological theory, including rational choice theory and exchange theory. Nonreductionist scientists of the higher level require a foundational theoretical argument for why their systems must be treated as emergent, and an empirical account that demonstrates the methodological value of the emergence approach. This is the *definitional task*: to identify characteristics that distinguish those systems that require emergentist explanation from those systems that will submit to

reductionist atomist analysis and explanation. These characteristics are likely to be subtle; sociological emergentists and methodological individualists in economics have noted the same general phenomena, yet have drawn opposing conclusions about the potential for reducibility.

Because emergentism is a form of materialism, and holds that higher level phenomena are supervenient on lower level component systems, reductionist methods always have the potential to offer a part of the complete scientific solution. To deny that the science of the lower level can contribute to the understanding of the higher level is the form of holism that I discussed earlier; yet, we have seen that emergentists, including socioculturalists and connectionists, often reject holism. Once holism is rejected, the emergentist must define the scope of the science of the higher level, and identify which higher-level phenomena cannot be usefully reduced to lower level explanation. In the philosophy of mind, these arguments include multiple realizability [Fodor, 1974] and complexity [Bechtel and Richardson, 1993]. Philosophers making these arguments claim that the issue of whether a reductionist or holist approach is appropriate for any given higher-level property or phenomenon is an empirical issue which can only be resolved via scientific inquiry. In sociological theory, no equivalent consensus has emerged [see Archer, 1995; Sawyer, 2000b].

Both connectionists and socioculturalists have not confronted the definitional task; thus, the bounds of these paradigms are not yet clear. Connectionists, for example, have never argued convincingly that the phenomena they simulate will not submit to higher-level description (in the language of GOFAI). Such a theoretical argument is not considered to be necessary, since their focus is on the pragmatic concerns of engineering: What is the most efficient way to simulate the desired behavior? If a connectionist simulation is more efficient than a direct representation of the higher-level emergents, the behavior is said to be 'emergent', even if a reductionist explanation is in principle possible. This is a pragmatic definition of emergence: Emergent behavior is higher level systemic behavior that cannot be predicted from knowledge of properties of the lower level components, except via simulation. Yet under this definition, the meaning of 'emergent' will always be changing, as better analytic methods are developed to derive global properties from local ones.

Although connectionist systems are commonly said to manifest emergence, only a few researchers have attempted to define the properties of emergent systems, or to define different classes of emergence [Baas, 1994; Cariani, 1991; Crutchfield, 1994; Darley, 1994; Sawyer, 1999]. Although such definitional concerns have not been primary for connectionists, a few theorists have proposed two contributing variables: the number of units in the simulation, and the complexity of the communication among the units [e.g. Darley, 1994; Sawyer, 1999].

Socioculturalists likewise have not presented an argument for the emergence and consequent irreducibility of social systems, nor have they distinguished social systems that will submit to methodological individualism from those that might require an emergentist approach, along the lines of micro-macro sociological theory. Instead, socioculturalists often assume that *all* social action is irreducible. Emergentist theories in sociology and philosophy suggest that this assumption cannot be made a priori, but requires a foundational and empirical argument. Promising theoretical paths are suggested by contemporary sociological theory, which typically proposes a hybrid between extreme micro and extreme macro approaches. For example, the relative influences of individual and structural factors have been explored by *network exchange theorists*,

sociologists that attempt to reconcile the methodological individualism of *exchange theory*, which holds that macrosocial phenomena are best explained in terms of individual's responses in pairwise exchange relations, and the holism of *network theory*, which holds that individuals' actions derive from their position in a complex social network [Cook & Whitmeyer, 1992]. Several such studies have reached a high level of theoretical sophistication, for example showing both that network structure has causal effects on individuals, and also that when different individuals occupy the same network positions, those downward causal effects can qualitatively change. Thus, an effect that seems to inhere in structure alone is actually part of a complex dialectic of emergence and downward causation [Sawyer, 2001].

In part, socioculturalists have not addressed the definitional task because they are split between an objectivist branch, and a subjectivist, interpretivist branch. For those psychologists and philosophers that hold to Dilthey-derived subjectivist dualisms – for example, Charles Taylor and Kenneth Gergen – the definitional task is a non-issue: subjectivity, meaning, and consciousness are fundamentally unique natural phenomena that are irreducible to material phenomena. (Subjectivism has also been an influential sociological response to micro-macro issues, playing a prominent role in the hybrid theories of both Giddens and Bourdieu.) For subjectivists, there will always be two sciences, a natural science and a human science; such claims are metaphysical variants of dualism.

Objectivist socioculturalists share with the subjectivists the claim that whereas reductionism works fine for many types of natural phenomena, psychological or sociocultural phenomena are somehow different. But those socioculturalists that are materialist and objectivist – thus holding that sociocultural analysis is a part of the natural sciences – have to explain why reductionism is not an appropriate methodology for the phenomenon in question.

7. Conclusion

The mainstream of contemporary psychology seems to hold to a view of science which is atomist and reductionist; many psychologists believe that psychology will ultimately be unified with biology. Some of the most rapid growth in psychology today has been in the most extremely reductionist paradigms: cognitive neuroscience, behavioral genetics, and evolutionary psychology.

Because a great deal of psychology is implicitly reductionist, emergence has remained largely unexplored by mainstream psychologists. Those who wish to establish a non-reductionist science of psychology must make explicit the relations between their science and the sciences of the lower level. This task is more critical for sociocultural psychology than for cognitive science, because cognitive scientists can rely on the philosophy of mind to elaborate these foundational arguments. In the same way that recent philosophy of mind has developed a sophisticated and detailed theorization of the relationship between mind and brain, socioculturalists must make explicit the relations between their (collective) objects of study and individual psychology. Sociological theories of emergence can offer some help, but because they are focused on sociological concerns, these theories do not address key psychological issues.

In his 1937 work, Parsons documented the phenomenon of *theoretical convergence* – his claim that four different theorists working in different disciplines and in different

countries, without significant influence on one another, developed essentially the same 'voluntaristic theory of action' and rejected utilitarian and positivistic theories of action. He claimed that this convergence itself provided an argument for the validity of the theory [1937, pp. 722–726]. The brief historical overview that I've presented here can be viewed in a similar light; because emergentism has been advocated by theorists in many disciplines, it represents a form of theoretical convergence. Emergentism is compatible with materialism and yet holds that reductionist methodology does not necessarily work for psychological (or social) phenomena. We don't yet know whether reductionism will ultimately be successful at explaining all complex natural systems, including the human mind and complex societies. Yet, emergentism provides a materialist, scientifically plausible account of why reductionist explanation may not be possible for certain classes of complex systems. The lesson for psychology, for its lower-level science – neurobiology – and for its higher-level science – sociology – is that empirical studies of the relations between levels of analysis should be an active area of research. Such studies are central to both Rogoff's 'three planes of analysis' framework [1995] and Wertsch's 'irreconcilable tension' between mediational means and situated action [1998]. Given the current state of empirical knowledge, neither sociology, psychology, or neurobiology can safely assume a priori that its level of analysis will explain the others, or that it will not ultimately be explained by the others. A scientific attitude of skepticism requires one to admit that reductionism may, or may not, be applicable to the mental or the sociocultural levels of analysis, pending further empirical study.

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