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Sociology and the Behavioral Sciences. Towards a Unified Theoretical Framework of Knowledge

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Sociology and the Behavioral Sciences

Towards a Unified Theoretical Framework of Knowledge

by Mario Lucchini

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Introduction

The discipline of sociology is currently marked by internal fragmentation and conflicts with the other behavioral sciences. Social science scholars concur that any effort to found a general theory of human behavior is deemed to fail. Whereas the hard sciences – physics, chemistry, molecular biology – are united by a common explanatory model based on fundamental particles, the behavioral sciences – sociology, economics, anthropology, psychology, political science, etology, sociobiology, evolutionist biology, neuroscience, archaeology, palaeontology, etc. – fail to establish a unifying theoretical framework that might reduce the pulverisation of knowledge.

During the last decades, only rare and isolated scholarly voices have denounced the negative consequences of this theoretical and methodological polymorphism on the accumulation of knowledge within the behavioral sciences [Langton 1979; Gallino 1987; Sanderson 1987; van den Berghe 1990; Marsden 1998; Wilson 1998; Turner 2005; Mesoudi, Whiten and Laland 2006; Nielsen 2006; Parisi 2006; Gintis 2007; Pisati 2007]. This article attempts to establish whether sociology, and the behavioral sciences in general, can be adequately enclosed within a *common underlying theory* based on Darwinian evolutionism, on complexity theory, and on the developments in neuroscience. The aim is to sketch a unified theoretical framework that can then be applied within different disciplinary fields in order to tackle their distinct explanatory goals. The question I wish to address is whether theories and methods exist that are

able to bridge across the social and natural sciences, enabling the development of a naturalised epistemology.¹

Conceptual Oppositions within Sociology

During the nineteenth century, sociologists observed social phenomena through the lenses of rigid antinomies, such as understanding/explanation, agency/structure, individual/society, micro/macro, freedom/constraint. The hardening of these oppositions hindered the positive recognition, within sociology, of a unified ontology of social facts and the subsequent adoption of sound theoretical approaches inspired by Darwinian evolutionism, by the physics of complex and nonlinear systems and by modern neuroscience.

This pulverisation of sociological knowledge is likely to derive from a rash illusion on behalf of the discipline's founders. Weber [1922] and Durkheim [1895], in particular, rejected scientific naturalism in favour of an understanding of social phenomena as entities that have nothing in common with the physical processes that characterise the natural world. Expressly, the Durkheimian analysis of behavior is based upon structures or systemic forces that cannot be reduced to mental and biological characters. On the other hand, the Weberian approach is centred around the socially constructed meaning of action. Besides these two opposite factions, other thinkers such as Coleman [1990], Boudon [1984] and Hedström [2005] rely on a combination of these different approaches, suggesting that virtue lies between two opposing vices and advocating a structuralist individualism based on generative mechanisms. Such syntheses portray the acting subject as both product and producer of meanings and structures. He is the maker of his own destiny, but within the constraints and opportunities of the context in which he belongs. The question of micro/macro, agency/structure, quality/quantity is solved by considering the terms of these antinomies as the expression of different aspects of social life which are inextricably interrelated. In short, the social configures itself as a world that conceals multiple ontologies, that mutually imply and influence each other. Particularly relevant, in this sense, is the analytical realism developed by Bhaskar [1979] and Archer [1995], according to whom reality is a stratification of ontologically separate entities and activities, each of which has its own distinctive properties and autonomous causal mechanisms.

Over one and a half centuries since its foundation, sociology identifies the initiators of social action either in meanings that are socially constructed during inter-

¹ For further readings on naturalised epistemology see Quine [1969], Quine [1987], Bellone [2006; 2008].

action, or in systemic forces with the power to move unaware subjects, or again in a cybernetic combination of both. We too often forget that social actors are first and foremost made of flesh and blood [Gallino 1987], and that at the basis of meanings and structures are physical entities and biochemical processes inherited through millions of years of evolution.

Not only the theoretical and methodological pulverisation within sociology is not perceived as a source of embarrassment and of disciplinary immaturity, but it is even acclaimed as an expression of pluralism and democracy. As a result, anyone is welcome within sociology and all approaches and research experiences deserve to be valued as potential revealers of concealed meanings that would otherwise remain obscure. An author of the calibre of Giddens [1976; Giddens 1981] stubbornly argues that the theories and methods of the natural sciences are of no use within the field of social studies. In fact, their application to phenomena of a reflexive nature – which cannot, therefore, be objectified – would give way to distorted results. On the contrary, van den Berghe [1990] believes that the traditional opposition on behalf of the social sciences against the evolutionist perspective is greatly attributable to a mixture of anthropocentrism, ideological bias and ignorance.

Sociology has currently still not developed a general paradigm able to rid the field of weak thoughts, liquid arguments, fanciful deconstructions and methodological anarchism that drive the discipline towards the spheres of expressive arts, literary criticism and rhetoric. A careful observer will note that most sociological theories have the same explanatory power of common sense arguments or popular sayings and proverbs. The only difference lies in the fact that the former are embellished with specialist language that confers to the discipline a seemingly scientific nature.

It is worth recalling that the first efforts to establish a new science of society rooted in the laws of nature and mathematics date back to a long time ago and can be traced in the works of Condorcet, Comte and Spencer. Condorcet was the first scholar to apply mathematics to the study of political behavior and more general collective action. Under the influence of Condorcet, Comte understood sociology as the empirical investigation of the relations, similar to laws of nature, that bind men and institutions. Finally Spencer [1855; Spencer 1874] not only holds the merit of having considered evolution as a general property, applicable to the entire organic, inorganic and superorganic universe, but he also had the impudence to naturalise mental phenomena in terms of biological processes of formation or strengthening of synaptic connections between neurons.

The materialistic and evolutionistic presumptions that form the fundamental basis for the accomplishment of a convergence of paradigms and methods have been banned from sociology since the beginning of the last century. On the one hand,

Durkheim considered social phenomena as objects, or as unique entities that cannot be associated with those of biological or psychological nature. On the other hand, influenced by Dilthey's historicism, Weber traced an insurmountable gap between the "sciences of the spirit" and the natural sciences, arguing that the former should not only deal with physical objects, but they should also investigate their underlying motivations.

Few contemporary sociologists have lamented the lack of a naturalised epistemology as defined in the work of Quine [1969], and even fewer have suggested concrete ways forward to accomplish a theoretical unity within sociology and the behavioral sciences. Particularly worthy of mention, in this respect, is EGO, the social actor model elaborated by Luciano Gallino in the 1980s and rooted in Darwinian evolutionism, in the principles of self-organisation of human beings, and in the developments in neurophysiology and artificial intelligence of the time. Restoring "flesh and blood" to the subject of action, EGO represents a worthy attempt of developing an analytical framework for the unification of the behavioral sciences, able to recompose the breaches between nature and culture, organism and environment, individual and society [Gallino 1987; Gallino 1992].

The question I wish to attempt to answer is whether it is possible to study social and cognitive phenomena in positive terms, i.e., as natural phenomena that are the outcome of Darwinian evolutionism, therefore clearing the way from theories and methods that separate facts of the spirit from material facts, and that escape the laws of physics. We shall see how Darwinian evolutionism, the physics of complex systems and computational neuroscience are able to offer new perspectives through which to examine, and amend when necessary, the intuitions of the classics of sociological thought.

In order to empower and give greater credit to sociological imagination, it is necessary not only to collect solid microdata bases generated by experimental designs and probability sampling, but also to borrow new theories from the natural sciences. The price to pay is the setting aside of all those metaphysic entities – sense, meaning, intentional acts, beliefs, aspirations and other Cartesian sprites – that fill sociological narratives and that have never been questioned by generations of thinkers, who believed them to be the ultimate initiators of action that could not be further decomposed. The convergence between social and natural science is made possible through a programme of naturalisation of cognitive and social facts, i.e., through the progressive substitution of the theoretical and conceptual framework of popular psychology with the more rigorous one of biology, chemistry and physics [Feigl 1934]. We shall therefore proceed by naturalising some of the common sense arguments that are put forward in the works of the classics, in the light of important acqui-

tions borrowed from evolutionary biology, the neurosciences and physics of adaptive systems.

There is no doubt that social facts configure themselves as complex processes and that, in order to control that complexity, researchers must therefore adopt conceptual simplifications at different organisational levels. This way of proceeding is greatly efficient when the laws of reduction from a particular level to an even more fundamental level are unknown. This must not induce us to believe, however, that to understand social phenomena one must resort to a Babel of incommensurable paradigms and methods. The different organisational levels that make up a phenomenon are analytical strategies for the simplification of reality, therefore there is no reason to believe that such levels are independent and cannot be reduced to components or more general processes. As Wilson [1998] and Weinberg [1992] have taught us, the outcome of a healthy reduction is the recognition of the unique and unifying ontology within which the laws of biology, chemistry and physics converge.

Emergence of Structures and the Substance of System Processes

At the end of the Nineteenth century, Durkheim [1895] inaugurated the methodological holism approach, according to which social phenomena can be explained exclusively on the basis of “things” that are positioned at a relevant ontological level, more precisely at the social level. In other words, the properties and functioning mechanisms of a system cannot be explained by way of the properties and functioning mechanisms of its elementary components. One, therefore, ends up believing that social arrangements, patterned institutional and cultural features are the product of non-human entities such as mystical or mysterious forces, rather than of human endeavour. Sociological holism, however, has the merit of having highlighted a number of unthinking elements of social action – social rules, cultural symbols, moral values – that form structures able to mould actors’ consciences, driving them towards compliance with the system’s needs.

Those who believe that social phenomena unfold at an independent ontological level face the risk of spurious explanation, i.e., the error of identifying causal relations between events or system properties, whereas those relations should be located at the more elementary level of the acting individual [Boudon 1984; Elster 1989; Viale 2000]. Explanations that highlight hypostatized or extra-individual social realities draw us towards mysticism, hindering the possibility of achieving a disciplinary unification. The subjects of action are individuals made of flesh and blood, not mysterious forces able to mould individual consciences. There is no reason to believe, in

principle, that causal relations between properties at the macro or extra-individual level cannot be rooted in micro foundations made of relations between properties at the individual or intra-individual level.

To avoid throwing out the baby with the bath water, it is worth mentioning that, if adequately revisited, methodological holism can be effectively absorbed within more robust and convergent approaches such as the theory of complex systems [Holland 1975; Langton 1990; Kauffman 1993; Gell-Man 1994], network theory [Barabási 2002], memetics or the theory of cultural evolution [Dawkins 1976; Cavalli-Sforza and Feldman 1981; Dennett 1995].

During the 1970s, a number of scientists wishing to grasp the emergence of complex phenomena from the interaction between elementary constituents inaugurated a new theoretical approach that has been variously defined as theory of complex adaptive systems, of emergent behavior, of chaos, of phase transitions.² According to these theories, it is not possible to infer complex behaviors from the properties and behaviors of their constitutive elements and other two factors are, instead, responsible for their emergence: the number of components and their specific connection scheme. Resulting from the hybridisation of Darwinian evolutionism and cybernetics, the theory of complexity is a sort of a social physics, a transdisciplinary approach to the study of emerging phenomena that has found fertile grounds in particular in physics, chemistry, biology, and the neurosciences. It aims at describing the emergence of orderly structures from dynamic networks that express competitive and cooperative interactions between agents or elementary units – be they cells, ants, individuals, firms or communities. Theorists of complexity seek for general principles, simple and universal algorithms through which to generate computer simulations and test the empirical soundness of theories in virtual laboratories.

Barabási [2002] has recently suggested a New Science of Networks that searches for the fundamental laws governing the evolution of dynamic systems with a reticular configuration. This approach is concerned not only with the decomposition of nature into its elementary constituents, but also with the identification of the rules of assembly. Given certain circumstances, nature generates networks with links that are distributed following a mathematical expression known as power law, or scale-invariant law, rather than in a casual way along a bell curve. The networks that give way to dynamic adaptive systems present many nodes with few links and few nodes [known as hubs] with many links. Scale-invariant topologies give systems a strong structural stability. They not only certify the existence of self-organisation princi-

² The Santa Fe Institute, founded in 1984, is the global hub for studies on complex adaptive systems. Further information can be found on the Institute's website: <http://www.santafe.edu>.

ples, but also represent the brand of products manufactured by evolution [Barabási 2002].

When a dynamic adaptive system reaches a given critical point – i.e., the point in which a phase transition takes place and disorder gives way to order – the distribution of its elementary components can be described by a power law.³ A derivation of Zipf's law, power laws are applied to a wide variety of physical, chemical, biologic, cultural and behavioral phenomena.⁴ In its original form, Zipf's law claims that a certain amount of interest for a given unit is inversely proportional to the number of the unit's position within the list of all units, i.e., it is directly proportional to 1, 1/2, 1/3, 1/4, 1/5, etc. Mandelbrot suggested that Zipf's law should be generalised and thus added a first constant (k) to the list number and a second constant (n) to the exponent 1. The modified exponential law, therefore, takes the following form: $1/[1+k]^{1+n}$, $1/[2+k]^{1+n}$, $1/[3+k]^{1+n}$, $1/[4+k]^{1+n}$, ... It seems that in the real world the sales volume of the major commercial enterprises, the distribution of wealth, the population of metropolitan areas, the monetary value of exports in a given year, the number of citations in physics journals and numerous other phenomena are distributed in an inversely proportionate way to their position on the list.

It is therefore possible that, during millions of years of evolution and with breathtaking precision, nature has woven networks that take the form of invariance scale topologies. Barabási and his collaborators not only describe complex phenomena in terms of power laws, but they even infer the mechanisms responsible of the evolution of network structures. Power laws typify real world networks and originate from two basic processes: growth and preferential connection. As a network expands, the nodes that are first set up also stand a better chance of attracting and establishing connections. New nodes that later join the network, moreover, prefer connections with those presenting a higher number of links. This results in a more rapid growth of older nodes as a result of the fact that they are chosen more often than newer nodes. The speed of growth appears to be directly proportional to the number of already established links. Growth and preferential connection together naturally lead to power laws, i.e., to “the rich becoming even richer” and “it never rains but it pours,” as suggested also by proverbs and popular sayings. The introduction of the concept of fitness allows Barabási to render network expansion mechanisms even more com-

³ The first scholar to suggest a general theory of phase transitions within statistical physics was Kenneth Wilson. Power laws, that indicate the existence of strong self-organisation abilities, are applied in the same way to all scales at critical points or phase transitions in correspondence of which disorder gives way to order [Gell-Man 1994].

⁴ Zipf's law was outlined by the linguist George Kingsley Zipf in *Human Behavior and the Principle of Least-Effort: An Introduction to Human Ecology* [Zipf 1949].

plex, thus making them closer to reality. Fitness, intended in a general sense as any phenotypic ability (physical strength, beauty, intelligence, sympathy) or phenotypic extension (income, wealth, technological endowment), gives a true chance of victory also to newcomers.

The physics of emergence provides us with algorithms that, in principle, are easily applicable to any network related phenomenon. Many networks in the natural world – proteins within the cell, neurons within the nervous system, commercial enterprises within the national economy, individuals within society, words within a text – form hierarchies of nodes that can be ordered following a power law, i.e., they configure themselves as webs that are self-organising, with no need for the intervention of reticary spiders.

It should also be mentioned that the physics of complexity and of network topologies are not antireductionist approaches.⁵ According to Weinberg [1992] there are no new types of laws that govern the emergence of complex systems. As mentioned above, different levels of experience can be described using specific models and laws, particularly when the laws of reduction from a given level to a more fundamental one are unknown. It would nonetheless be strongly naive to believe we are facing multiple ontologies that can be explained by different types of laws.

Social laws describing collective behavior cannot constitute scientific knowledge if they cannot be translated into the more basic laws of biology, chemistry and physics. As opposed to philosophy, science is a systematic enterprise and it favours reductionist explanations. The latter are not a dangerous pathology of western thought, as suggested by some post-modernists, but they are the sole strategy available allowing scientists to understand complex systems. Scientists, in fact, not only separate reality into its basic components, but they also attempt to grasp the rules governing the integration of those components. In the words of Wilson [1998, 58]: “The love of complexity without reductionism makes art; the love of complexity with reductionism makes sciences.” The reductionist attitude is a precious methodological compass for the valid reconstruction of causality networks that cut across organisational levels. It prevents us, in fact, from wasting time in pointless Cartesian arguments that only drift us away from science towards the sphere of mysticism, art and rhetoric.

On the basis of what stated above, scientists who analyse human cognition and behavior would do best not to mock reductionism. Mature sciences do not consider analysis (reductionism) and synthesis (holism) as conflicting programmes inspired by incompatible opposing and paradigms. The only weakness of the theory of complexity is what Wilson defines an “insufficiency of facts” to be brought into cyberspace.

⁵ Gleick [1987], however, strongly argues that the physics of chaos is antireductionist.

This approach, which is based upon algorithms that can be computer simulated, sets off from postulates that are far too generic and should be strengthened with greater empirical information that can be derived from biology [Wilson 1998].

Beliefs, Aspirations, and Intentional Facts as Agency Initiators

Methodological individualism is an explanatory approach that considers social phenomena as intelligible facts that can be reduced to meaningful actions. Similarly to holism, such an approach was also conceived by sociologists towards the end of the Nineteenth century. Weber [1922] believed that humans have distinctive features that differentiate them from the “objects” of the natural world. Whereas in the natural sciences the scientist examines objects that can only be understood as external manifestations, in the social sciences the observer deals with facts that have an intentional nature. The sociologist therefore analyses not only the external behavior of subjects, but also the meaning and reasons that underlie that behavior. As a consequence, the methodological tools of the *Naturwissenschaften* cannot also be adequate for the *Kulturwissenschaften*.

Methodological individualism today takes the form of a torrent giving way to various streams. The followers of this approach basically believe that social phenomena can be reduced to mental facts. The latter, however, can be differently defined by referring to rationality principles (Becker), psychological dispositions (Homans, Kanheman and Tversky, Boudon) and socially constructed meanings with indexical nature (Schutz, Blumer, Garfinkel).

Hedström [2005], Golthorpe [2004] and other methodological individualism sociologists have recently outlined a programmatic manifesto for the development of sociology into a veritable social science – SSS: *Sociology as Social Science*. Hedström, in particular, is strongly committed to the promotion of an analytic sociology of social mechanisms through computer simulations relying on agent-based models. This approach draws on a series of former theoretical considerations advanced by Merton [1936], Schelling [1971], Boudon [1984], Elster [1989], and Coleman [1990]. Surprisingly, an analytical sociology that aspires to being an objective discipline is backed by a Cartesian ontology of social facts. The existence, out there, of a social world is taken for granted, as well as the assumption that this world manifests itself in empirically observable macro-regularities. Following the definition given by Hedström [2005], social mechanisms describe a constellation of entities and activities that are organised in order to regularly generate a given social outcome. It is assumed, moreover, that these macro-regularities are grounded in relational properties at the meso

level – the schemes of interaction between acting units – and in relational properties at the micro level – the causal networks of beliefs and aspirations that lurk in the minds of social actors.

Analytical sociologists believe that the interpretation of the initiators of action in terms of desires, beliefs and opportunities is the necessary way forward to eliminate the confusing (spurious) character of the properties that measure emerging macro effects [Kieser and Hechter 1991]. One is therefore relying on a theory of the mind – known as D-B-O theory (D-B-O being the acronym of Desires, Beliefs and Opportunities) – that is identical to the functionalist theory of the mind in cognitive psychology and that offers an alternative to the neurophysiologic mind-brain identity theory.

Those who define themselves as functionalist conceive mental events as independent and autonomous states from their physical substrate (neuronal and synaptic). Every mental event is identified on the basis of the causal role it plays within the cognitive economy. A given functional role cannot be supported by radically different physical states. This argument is known as multiple realisability thesis. An acting subject can be defined as rational simply by describing the web of causal relations between mental thoughts without taking into account what is going on in the neuronically ravines. As far as the functional roles of mental states, neurosciences do not have a say, as the subject falls within the exclusive domain of psychology. The relation between the mind and the brain is described through the computer metaphor, in which the mind is represented by the software and the brain by the hardware. This type of functionalism therefore reduces the mind to a syntactic device for the manipulation of symbols.

Surprisingly, social scientists have not yet acknowledged the obvious paradox held in the assumption of psychological functionalism that all propulsive factors of behavior (and therefore of physical facts) are states of a non physical nature. In the realm of the natural sciences there is no room for causal schemes that relate spiritual and material constructs: causal mechanisms are simply described in terms of processes transferring matter and energy [Dowe 2001]. Functionalism is not interested in what happens “in the black box,” i.e. in the biological brain. Its only concern is to implement a valid entry-exit function. Modern neuroscience, however, teaches us that biological processes taking place inside us are important and cannot be reduced to a simple manipulation of a discrete set of symbols governed by a set of rules.

We too often forget that explanations grounded in an “intentional mechanics” cannot be considered strictly scientific as they are based on a simple process of interpretation. In Dennett’s words, the intentional attitude is a cognitive shortcut that an observer chooses to interpret, foresee and explain his own and the behavior of others [Dennett 1996]. Such an attitude requires to consider adaptive systems as bearers of beliefs and aspirations similar to those that the observer assumes to have. Truth is

that what we define as intentionality is simply an infinitely complex tangle of electric and physical-chemical processes through which our nervous system relates to its endogenous (the body) and exogenous (the external environment) background. Such a majestic complexity embodied in the biological brain cannot be verbalised by mere introspection.⁶

In describing the behavior of social actors we are unlikely to adopt a physical perspective, as it would be impossible to control the vast number of internal and external physical factors that move the acting subject. The *intentional attitude* represents the only currently viable strategy to communicate in everyday life and to conduct social research. This does not, however, exempt us from being aware of the fact that it is also a naïve and fallible perspective as it escapes the laws of physics. The implementation of Wilsonian consilience requires us to avoid considering aspirations, beliefs and other Cartesian elements as indescribable mental states that cause a given behavior. The logical constructs that an observer employs to foresee or rationalise social practices are, if anything, metaphors and they should not be confused with the true processes taking place in the biological brain in the form of prototypes of neuronal activation [Churchland 1995; Churchland 2002].

Analytical sociologists consider *agent-based simulations* a privileged route towards the development of a social science. The results currently achieved in this disciplinary field, however, are quite disappointing. Simulations, in fact, consist of simple virtual entities (agents) interacting according to local rules that are established “externally” by the project designer. These artificial worlds are rich in formal syntactic rules for the processing of symbolic representations and their analytical capacity does not go beyond the valid execution of an entry-exit function [Epstein 1999; Hedström 2005]. There is a lack of concern to verify the degree of isomorphism that exists between simulated and physical processes that give way to *generative complexity*. Simulations certainly represent a privileged means of verifying social behavior theories, yet to be consistent they should rely on instruments (robots) able to reproduce in a however simplified way the complex processes of neurons and bodies. The simulations conducted within the realms of connectionism and Artificial Life⁷ are, in this respect, of great interest. Reference is made here to the simulations of agent populations implemented in the form of robots that alter their state as a result of endogenous (originating from within their simulated bodies) and exogenous (orig-

⁶ For further insight into these concepts see the works of Edelman [1987; Edelman 2004], Churchland [1995], and Damasio [1994; Damasio 1999].

⁷ Artificial Life (AL), which in a strict sense means “life created by humans rather than by nature,” aims at reproducing living phenomena with artificial artefacts (biomorphic robots, virus, mobots) or at least at producing computer simulations of them (neural networks).

inating from the external environment) stimulations. Social complexity cannot be grasped by simply implementing agent populations that reason in a mechanic way. A deeper approach is needed that implements self-organising dynamic systems able to maintain a certain degree of isomorphism with the complexity of the human brain and body. It remains evident that the path ahead of us to pursue a scientific simulation model of human behavior remains long and full of difficulties [see Maes 1991; Parisi 2006].

Vector Coding and Parallel Calculation: Towards a Microphysics of the Emergence of Sense

Various popular science books and numerous articles in newspapers and magazines that have been published over the last 25 years deal with the issue of the biological basis of knowledge. Edelman, the Churchlands, Damasio, Freeman, Dawkins, Dennett, Cavalli-Sforza, Auger, Rizzolatti and Gallese, to cite just a few, have provided highly interesting naturalised explanations of mental phenomena that rest upon scientific grounds, without resorting to computing figures or mysterious extra-individual forces. The sociologist Luciano Gallino [1987, 112] reported already in the early 1980s human sciences' incapacity "of supplying a brain suited to the natural complexity of social actors, in order to relate the complications of behavior to the naturalness of the brain."

The point that it is worth highlighting is that theories do exist that represent an alternative to theories of action with micro-foundations in Cartesian sprites and that have the ability of ensuring the convergence of behavioral sciences within a unified theoretical framework. Connectionism, in particular, offers not only a conceptual window through which the mind can be naturalised, but also a "tool box" full of mathematical models inspired by the functioning of the biological brain (reference is to the vast range of neural networks, genetic algorithms, Associative Memories or Contents Addressable Memories). The strength of this approach lies in the fact that it does not avoid looking at what goes on in the brain's *black box*. Exploring inside it, to find out what it contains and how it works, is in fact one of the main aims of modern neuroscience.

Neuroscience scholars therefore wish for a zeroing of the mental level and the progressive substitution of the conceptual fund of popular psychology with the more rigorous one of biology, chemistry and physics. Connectionism fully adopts the philosophical approach known as mind-brain identity theory that was elaborated by Place [1956] in the 1950s to overcome the difficulties encountered by old behaviorism.

Connectionism, differently from behaviorism, allows the existence of internal cerebral states that cause behavior. Moreover, differently from psychological functionalism, it considers such states as having a physical consistency. It is worth underlining that the evolutionist sociologist Herbert Spencer is among the precursors of connectionism. In *The Principles of Psychology*, Spencer [1855] put forward a number of brave ideas about the physiological bases of human behavior, developing the notions of “neural hierarchies,” “connection networks,” and “plexus” that were to have a vast impact on the development of modern neurophysiology. According to Spencer, because knowledge of the world is coded within the web of the brain’s connections, psychology should ground itself in the anatomy and physiology of the nervous system.

According to the connectionist logic, behavioral choices do not originate from a computer’s sprite – *the Ghost in the Machine* – but from the global configuration of about one hundred billion neurons and one hundred thousand billion synaptic connections, making the human brain the most complex dynamic adaptive system in the universe. There is no need to express knowledge through a logical and rational language: it is rather necessary to understand the ways in which knowledge develops from the union of neurons and synaptic connections within which the personality of each individual is nested. Throughout our existence the synaptic junctions of the brain constantly adapt in response to changes taking place in the corporal and extra-corporal environment in which it is placed [Churchland 1995]. Alongside genes, which determine the configuration of a number of rigid circuits, it is experience that constantly shapes the brain following Hebb’s famous law [Hebb 1949].⁸

The computation that takes place in our brain consists in signals travelling along vast synaptic weavings: intelligence equates to sensory-motor coordination, i.e. to the capacity of our brain to realise fine transformations of neural activation vectors. A living system is adaptive when it owns a nervous system with synaptic connection schemes through which it can partition neuronal activation spaces into categories and vector successions that are adequate for the satisfaction of its ultimate goals of survival, persistence and reproduction.

Connectionism has developed a number of mathematical models – known as neural networks – based on vector codification and the parallel calculation of information. These devices represent dynamic adaptive systems that imitate in a simplified way the functioning of the real nervous system. Their architecture is made up of a)

⁸ According to the latter, the connections exposed to a higher number of stimulations coming from experience are strengthened, whereas the others are weakened: “When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A’s efficiency, as one of the cells firing B, is increased” [Hebb 1949].

sensorial receptors, or *input units*, that receive the environmental stimulation; *b*) internal receptors, or *hidden units*, that re-elaborate the stimulation; and *c*) effectors, or *output units*, that represent the behavioral outcome. The synaptic junctions that link the various processing units incorporate the system's knowledge and they allow the information to flow between neuron layers. Knowledge, within these models, becomes a physical phenomenon that substantiates itself in the quantitative transformation of input vectors into vectors of internal representation, and of the latter into output vectors. Curiously, these contrivances learn from experience and therefore simulate a sort of ontogenetic development, however in an extremely simplified form [Rumelhart and McClelland 1986].

Since the biological brain presents assonic projections of *feedforward* and *feedback* type, it is possible to increase the complexity of traditional *feedforward* networks by adding paths that retroact from the output units on the units of previous layers. This expedient allows to safeguard the information contained in a "remembered present," i.e. the "focusing" or "parallel vision" of images.

Paul Churchland [1995] believes that with powerful recurrent networks it might be possible to obtain a neurocomputational reconstruction of conscience, considered by both scientists and philosophers as the ultimate enigma, an impregnable fortress. The social actor's conscience, awareness and identity can be described as a capacity of the brain to represent itself through self-connection paths that ensure constant access to cerebral and general bodily activity.⁹ By generating successions of activation vectors even without stimulations coming from the external environment, recurrent networks give way to what, in mathematical terms, are known as *limit cycle attractors*, i.e., regular successions of points in a neuro-perceptive space of multidimensional activation.¹⁰ Most periodic behaviors, anticipatory processes of prediction, imagination and planning that are so crucial in all human beings can be described as vector successions taking place within the neuro-perceptive space of the biological brain without being provoked by stimulations coming from the outside world [Churchland 1995]. These models appear to disclose new horizons for naturalised explanations of conscience.

Whereas cognitive models rely on an enunciative cinematic made up of local rules, connectionism chooses a truly causal cinematic, able to generate neural acti-

⁹ The individual's behavior unfolds over time: perception, categorisation, planning and action require continuous successions of sensory-motor vectors. In Paul Churchland's words, the perception of the unfolding of time is at the basis of processes of awareness and self-consciousness [Churchland 1995].

¹⁰ Curves are not always closed, so not all trajectories return to their point of departure. In such cases we have chaotic cycles that are likely to be at the origin of creative processes.

vation prototypical vectors that are transformed into other vectors passing through vast synaptic connection weavings. The functioning of a connectionist system can at last be truly described in terms of causal mechanisms, as within it a process for the transmission of physical quantities is simulated.

Weberian hermeneutics, as well as the analytic sociology of mechanisms, lead us to believe that the mind of social actors is a warehouse of *belief tokens*, i.e., a collection of abstract entities tied by way of causal connections and equipped with specific functionalities. A given *belief* therefore has a precise meaning, or even a causal role, within a given cognitive setting. Connectionist models, instead, do not contain formal syntactic rules for the processing of representations. Information has a sub-symbolic meaning, i.e., it is distributed and coded in the synaptic junctions linking the artificial neurons. All is required in these models is a population of processing elements that delimitates the multi-dimensional space of possible *activation patterns* and a learning algorithm that gradually alters the strength of synaptic junctions. Once the learning has taken place, the pattern of synaptic junctions will act as memory storage, as an *adaptive filter*, as a grill for the interpretation of the world.

Whereas functionalist approaches are top-down, setting off from skyhooks and considering values, beliefs and aspirations as the causal antecedents of behavior, modern connectionist neuroscience is bottom-up and sets off from Dennett's biochemical cranes, simulating the physical language of neurons and synaptic junctions. The mentalistic causality that pervades contemporary sociology is opposed by neuroscience's "natural" or "physiological" causality, that reduces mental processes to the functioning dynamics of brains and bodies in their entirety. Following this perspective, cognition cannot be conceived without sensory-motor activity, being in the world and directly experiencing it.

It is worth recalling that artificial neural networks, differently from our nervous system, are not embedded in a biological body, nor do they interact with a physical environment. As a result, their ontogenetic development is not regulated by the multiplicity of genetic, biological, cultural and social factors that characterise our real world. A branch of Artificial Life, known as morphologic robotics, aims in this respect at simulating not only the evolution of an adaptive agent within its life course, but also the social interaction with other adaptive agents as well as the evolution of species coded in genes. A deep understanding of mental matter cannot exclude taking into simultaneous consideration the advancements within the neurosciences, genetics and biological sciences in general [Edelman 1987; Parisi 2006].

Scholars wishing to found a sociology in accordance with Boudon's notion of social science should move beyond the traditional cognitivist formulation and follow the ambitious paths of Artificial Life [Langton 1990], of computational connection-

ism [Churchland 1995] and of the theory of complexity [Gell-Mann 1994]. Given that social scientists deal with human beings and not with abstract entities, they would do better to seriously take into account the issue of naturalisation of mental facts and, more generically, the existing parallelism between the evolution of life and the evolution of culture. The dualism that needs to be overcome is not the one between micro and macro sociology, nor the one between comprehension and explanation, but the one between social and natural sciences.

Towards a Unified Model of Bio-cultural Evolution

Contemporary social theory generally shows a mixture of reticence and disdain towards Darwinian evolutionism. There is no doubt that hazardous applications of Darwinian thought in the political field have contributed towards the production of some of the darkest pages of our history: Spencer's "strength for the survival of the fittest" as a means for racial purification and the progress of humanity is one sad example. It would be a serious mistake, however, to mistake the solidity of a theory for its political exploitation [Gould 1991].

We know from Darwinian theory that behind the web of multiple forms of life that inhabit our planet there lies a common ancestry. Even humans, as an integral part of nature, are nothing but a small branch originated from the geological tree of life that sprouted three and a half thousand million years ago and has grown many ramifications. Darwinian theory sheds light on the most powerful learning algorithm in the history of our planet. Few key passages are extremely revealing: variations in the characters that affect "fitness," the transmission of characters to offspring and the differential reproduction of characters that improve the adaptation of their bearers. Said differently, evolution is a process of descent with modifications: each generation tends to accumulate adaptations that bestow reproductive success. The creatures that inhabit the natural world are not the outcome of an intelligent project, but they more simply originate from mechanical iterative loops of replication, variation and selection [Pievani 2006]. Despite Darwin's ignorance of the causal processes at the basis of variation and inheritance, his algorithm of the *differential transmission and selective retention of traits* still offers an extraordinarily beautiful and simple description of the evolution of life forms. It should be pointed out that such a theory is not an axiomatic system, but a simple inductive generalisation that derives from thorough empirical observation [Langton 1979].

During the 1970s and early 1980s the development of sociobiology, evolutionary psychology, dual inheritance theory and memetics was accompanied by a revival in

the application of Darwinian thought to cultural and social processes. Sociobiologists and evolutionary psychologists primarily aim at explaining human behavior in terms of the maximisation of genetic fitness. Sociobiology certainly has the merit of having stretched the Darwinian concept of fitness, originally intended as an individual's predisposition to survive and reproduce himself. Animals, including man, nonetheless tend to maximise the *inclusive fitness* that, alongside the vital interests of the individual, also incorporates the interests of kinsmen as depositaries and potential transmitters of the same genes. Genes are therefore an extended entity that spreads far beyond the bodily boundaries of the individual: the organism is nothing else but an accidental set of genes that characterise the species, the vehicle through which DNA produces other DNA. The primary factors of interest within sociobiology are not individuals, nor their reproductive abilities, but genes and their generation-to-generation transmission [Hamilton 1964].

Closely related to sociobiology is evolutionary psychology, which aims at explaining given mental phenomena – such as language, the ability to infer others' emotions, the preference for healthier mates, reciprocity, fear of spiders and snakes – in terms of evolved psychological adaptations that are coded directly in our genes [Tooby and Cosmides 1992; Ridley 1996; Pinker 1997]. According to evolutionary psychology, genes do not simply give the instructions for the realisation of the brain's anatomy and physiology, but they directly shape the psychological predispositions that are at the basis of learning and decision-making processes.

Cavalli-Sforza and Feldman [1981] have critically assessed some sociobiological models applied to the social sphere, while still recognising the importance of their scientific contribution. Theories that reduce behavioral choices to epigenetic rules or instructions coded in genes, ignoring the role played by learning and imitation, may adequately explain the behavior of colonies of eusocial insects, but they leave a high non-explained margin when applied to the study of human cognition and behavior [Cavalli-Sforza 2004; Richerson and Boyd 2005]. Once recognised our shared ancestry with other living beings, it is necessary to focus on the hypertrophic ability of humans to communicate with words and signs, to learn by attempts and errors and to imitate their fellows. The evolution of cultural traits started with *Homo Sapiens*, who's brain was an extraordinary physical device able to host and transmit complex ideas. Sociobiology and evolutionary psychology appear to have little interest for the numerous behavioral differences that can be traced in human societies and that result from processes of social learning. Norms, cultural traditions, artefacts that compose eco-social niches within which individuals operate can reveal conspicuous differences with no corresponding genetic variations.

In the words of Cavalli-Sforza [2004, 86-94], culture is an extraordinarily rapid and efficient mechanism of adaptation to the environment, as opposed to genetic transmission that is conservative. Culture can be transmitted vertically – from father to son – or horizontally – between friends and acquaintances. Vertical transmission tends to be slow and conservative, as opposed to horizontal transmission that tends, instead, to be rapid and somewhat similar to the diffusion of contagious diseases. It should also be noted that many cultural traits prove an extraordinary solidity throughout centuries and millennia that can be easily mistaken for expressions of a genetic inheritance.

Having recognised the importance of culture in human events, it would be greatly naïve to consider genetic heterogeneity as a black box of no interest within sociology. The extraordinary developments achieved in the last decades in the field of molecular genetics have made it possible to open up the genetic black box. We now know that the inclination to develop certain pathologies is strongly influenced by genes. As Guang Guo [2008, 160] maintains: “[I]f individuals do differ in genetic propensities for human diseases, it would be logical to predict that individuals also differ in genetic propensities for other human traits and behaviors.” Therefore, if sociologists do not control for differential genetic propensities for cognitive development, educational achievement, status attainment, health and other phenomena within their interests, they risk obtaining biased estimates of the social gradients.

Approaches considering that behavior and cognition are determined by genes, such as sociobiology and evolutionist psychology, are contrasted by other approaches that focus on the coevolution of *genes and culture*, that offer precious opportunities for interdisciplinary confrontation and are rich in positive accomplishments. The models suggested by Cavalli-Sforza and Feldman [1981], Richerson and Boyd [2005], Gallino [1987], and Dawkins [1976] dilate inclusive fitness into a complex fitness, able to take into due account gene-culture coevolution processes. In the last few years a burgeoning literature exploring gene-culture coevolution reveals a concrete way forward to accomplish a unified science of behavioral sciences [Aunger 2000; Aunger 2002; Blackmore 1999; Dennett 1995; Mesoudi, Whiten and Laland 2006; Pagel and Mace 2004; Plotkin 1993; Plotkin 2000; Runciman 1998a; Runciman 1998b]. Although still in an early stage of development, a new evolutionary framework is emerging that is able to analyse complementary aspects of social behaviors and that will be greatly useful within sociology, political science, economics, cultural anthropology, archaeology and psychology.

Gene-culture coevolution theory (or Dual Inheritance Theory) explains how heterogeneity in human behavior is a product of the interaction between genetic and cultural evolution [Durham 1990; Durham 1991]. Each individual can be described

as a “phenogenotype:” as genetic selection processes can influence the development and diffusion of cultural traits, so can cultural evolution processes interfere with biological inheritance. Any theory wishing to deal with biocultural evolution must first define what culture is, how it is incorporated in the brain and how it is transmitted to other brains. A naturalised definition of cultural processes, however, is a problematic task. Delius [1991] defines contemporary culture as the most powerful symbiont and parasite that man simultaneously allows to survive and hosts. Boyd and Richerson [1985; Boyd and Richerson 1995] consider it a favourable adaptation to a variable environment.

Scholars dealing with cultural evolution can be distinguished into two categories. The first gathers those who profess a broad definition of culture, inclusive of ideas, verbalisations, behaviors, artefacts and the instructions for their realisation.¹¹ The second category is formed by those scholars who exclude behaviors and externally visible phenotypic extensions from the definition of culture. Those who fall within this last group simply take into account those elements that are produced internally by the mind-brain, i.e. ideas, thoughts, attitudes and cognitive dispositions.¹² This last definition considers replicable and transmittable cultural traits as packages of information that are embodied in biological brains by imitation, through teaching and other forms of social communication [Dawkins 1982; Delius 1991; Dennett 1991; Aunger 2000].

Cavalli-Sforza [Cavalli-Sforza and Bodmer 1971] was the first to consider ideas as material objects and more precisely as “seeds” incorporated in the neuronal circuits of the cortex and able to reproduce themselves in other brains. After Cavalli-Sforza, other scholars – Dawkins [1976], Dennett [1995], Brodie [1996], Blackmore [1999], Hull [2000], and Aunger [2000; 2002] – have contributed to the development of a biocultural theory of evolution based on Darwinian grounds, which is currently known as memetics.

Dual inheritance theories have not yet reached a “new synthesis”, as in genetics, able to explain “large-scale macroevolutionary patterns of change in terms of small-scale microevolutionary changes in cultural traits frequencies within populations” [Mesoudi, Whiten and Laland 2006, p. 336]. We currently still do not know precisely whether a cultural DNA does exist, what its nature or biochemical process is and

¹¹ The main reference is to the work of Susan Blackmore [1999], who includes ideas, behaviors and artifacts in the concept of cultural unity.

¹² In *The Electric Meme*, Aunger [2002] prefers a limited definition of cultural units. The latter are physical entities able to self-replicate themselves and that cannot occupy substrata other than the one of the synaptic tissue. For this reason they must be distinct from the relative phenotypic expressions, i.e., from artifacts and behaviors.

what the mechanisms are for the onset, reproduction and transmission of memetic information. Future developments in the neurosciences will be able to shed light on the physical processes responsible for cultural inheritance. For the time being, we can only advance a few hypotheses on the “matter of mind” by borrowing the models that we cited earlier developed within neurophysiology, connectionism and Artificial Life.

Reference to an evolutionist perspective applied to cultural facts can gain strength and develop into an explanatory science if it grounds itself in a neurophysiological theory capable of revealing the molecular and cellular bases of learning, memory and transmission of cultural traits. The adoption of a materialistic philosophic perspective makes it plausible to believe that ideas are physical structures or processes that are embodied in neuronal circuits [Cavalli-Sforza 2004; Delius 1991]. Some ideas determined by genes in the course of embryonic development give way to rigid neuronal circuits, whereas others acquired during the course of life become innervated in more flexible circuits.

In *The Selfish Gene*, Dawkins [1976] suggested the term *meme* to indicate the cultural evolution unit able of self-reproduction and transformation, while still acknowledging Cavalli-Sforza’s original intuition of the existence of a cultural DNA.¹³ The term *meme* derives from the Greek *mimema*, which indicates an “imitation unit.” At first, Dawkins proposed a broad definition of meme, inclusive of any idea, thought, religious belief, theory, gesture, practice, fashion, clothing, habit, song, dance, and technology that can be passed from one person to another by means of imitation. Later, in *The Extended Phenotype*, Dawkins [1982] circumscribed the concept of meme to information particles that are contained in the mind and that influence behavior by creating copies of themselves in the minds of others. One of memetic’s main assumptions is that memes spread from brain to brain through social contagion, as viruses in an epidemic. Imitation, which is a genetically acquired ability, is the specific means of meme transmission. The reproductive success of a meme depends on its phenotype, i.e., on the project it exhibits to the world [Dawkins 1999]. In sum, both genes and memes represent embodied information and both are visible to natural selection by way of phenotypic expressions and/or extensions.

Cultural replicators can organise themselves in extended system units – memplexes – able “to take shape as well as to take the floor.” Popular sayings, songs, fashions, the instructions to make artefacts, ways of cooking, of dressing, of furnishing the home, but also moral obligations, philosophical doctrines, the prescriptions contained in universal religions and scientific paradigms are the expression of memes

¹³ Cavalli-Sforza [2004, 73] indicates that whereas the term *meme* highlights the imitation aspects of cultural transmission, the term *seed* evokes the reproductive capacity of ideas.

or, more precisely, of groups of memes that interact to reinforce each other. Another common assumption of memetics is that memes are stored in brains and can reproduce themselves in other brains only when they reveal themselves to the world under the form of behavior or artefacts (interactors) through imitation and social learning [Mesoudi, Whiten, and Laland 2006].

It is important to highlight that whereas memes can be stored only in biological brains, memetic expressions can be preserved and spread also in physical means other than the brain, such as books, computers, discs, artefacts, institutional assets, legislations, etc. It is therefore essential to distinguish between the meme, which can presumably be reduced to synaptic processes of strengthening and weakening, and the phenotypic expressions or extensions (interactors or instigators), which reveal themselves outside the brain in discourses, behaviors, artefacts or the instructions to make them. Memes can be conceptualised as neural activity-electrochemical states or self-replicating classes of memories that are sustained by a large number of neurons and synaptic weavings [Aunger 2002]. Because the biological brain elaborates information in a parallel and distributed way, a memetic representation cannot be reduced to the activity of a single neuron (the grandmother cell); if anything, it ends up implying a large number of elementary processing units.¹⁴

Finding inspiration in the pioneer works of Christine Skarda and Walter Freeman [1987] on rabbits' memories of smells, Nunn [2007] refers to the mathematical concept of "attractor space" to define the multidimensional space of memetic expression. Memes express themselves in biological brains as attractors do in neural network dynamics. Every mental phenomenon, including conscience, can be described as an expression of attractor dynamics. The brain not being a computer, nor a photocopier, it stores cultural particles in synaptic connection schemes that are constantly reshaped by experience throughout the life course. As memes can only be transmitted to other brains by way of the information contained in behaviors or artefacts, it derives that replicators and interactors (or instigators) are in a relationship of constant co-evolution.

Many of the criticisms raised against memetics underline the impossibility of identifying cultural replication units in a clear and precise manner [Bloch 2000]. The same criticism, however, can also be raised as regards modern genetics [Laland and Brown 2002]. Recent progress in genetics has shown that the Mendelian concept of gene as an indivisible unit of transmission, recombination and mutation is inadequate. Even genes appear to be "open" entities with fuzzy boundaries. It appears,

¹⁴ The grandmother cell was indicated by Jerome Lettvin around 1969 as a hypothetical neuron that represents a specific concept or object [in his example the grandmother's image].

in fact, that the relationship between genes and phenotypes cannot be considered of a deterministic nature. A single gene can lead to the emergence of more than one phenotypic propriety and a single phenotypic propriety can originate from the expression of more than one gene.

According to Dawkins [1976; Dawkins 1982] there is no necessary connection between the meme's reproductive capacity and the biological fitness of the keeper and transmitting vehicle. Memetic evolution is able to unfold independently from the effects it may exercise on the genetic pool. In the long run however, as suggested by Dennett [1995], if we continued to incorporate memes that systematically damage our body we would become extinct. An interesting debate has developed around this issue. Cavalli-Sforza and Feldman [1981] believe that there generally is a certain parallelism between cultural and natural selection, although frequently negative cultural traits – that play against the adaptation and survival of organisms – can spread with a certain degree of success. The harmonic coupling of genes and culture would be justified by the fact that cultural traits are incorporated in neuronal structures that, in the last instance, evolve under the control of natural selection.

Boyd and Richerson [1985] believe, instead, that the genetic adaptability that follows certain systems of cultural transmission does not automatically prove that the interiorisation and diffusion process of cultural units is somehow conditioned by genes. Certainly memetic activity would not have arisen had it not been detrimental of genetic fitness; certain memes, nonetheless, spread not because their phenotypic expressions are right, good or genetically adaptive, but simply because they are good replicators. All memes do, as autonomous and selfish replicators, is compete against one another to take shape and to take the floor, in order to spread the information to other brains and other physical means.

We have mentioned that the main difficulties encountered by memetics can be reconducted to the lack of clear “principles” about the ways in which memes and their phenotypic expressions should be recognised. Said differently, we need to understand how to identify minimal sequences of characters – words, sounds, images, artefacts, smells, tastes – that make up the expression of a self-replicating cultural entity. According to Dennett [1995] we could focus on the most basic cultural expressions that ensure a reliable and successful replication: the first four notes of Beethoven's *Fifth Symphony*, for instance, hide a meme that is reproduced regardless of the rest of the symphony. Moreover, for memes to preserve themselves and spread their phenotypic expressions must trigger parcels of information in the biological brain that are sufficiently complex to be copied and recognised autonomously.

Another question that has to be untangled is whether cultural inheritance can be described as a Lamarckian or a Darwinian process. The lack of neurophysiological evidence does not allow us to establish precisely if there exists a barrier between replicator and interactor and, in case it does not exist, through which modes the replicator receives the phenotypic variation.

The recent discovery of mirror-neurons is of great interest and it should shed light on the mechanisms involved in cultural transmission. Experiments conducted by Gallese [2003] and Rizzolatti and Sinigaglia [2008] reveal that monkeys and human beings are equipped with neurons that are activated not only during the execution of actions, but also whenever they are observing someone else executing those same actions. The observation of an action requires its *embodied simulation*. As a result, empathic comprehension can be described as a material process of activation of the motor system taking place in the brain of the observer. On the basis of what has been said, it appears that there is solid empirical evidence to consider the mirror system as the basic neurophysiological mechanism governing processes of empathy, imitation, learning and social contagion.

The suppositions reviewed up to here allow to conceptualise mental phenomena as natural processes without evoking skyhooks, but simply setting off from Dennettian “cranes,” or structures that consent the construction of entities of greater complexity while being themselves founded in the grounds of biochemical matter [Dennett 1995]. It is a great pity that the majority of social scientists producing theories about action and social actors suffer from an immunological rejection of gene-culture evolution approaches, thus barring the opportunity of achieving a naturalised epistemology of social facts.

Universal Darwinism is a further development of memetics that has recently been advanced by Dawkins and Dennett. Their approach expands the selectionist paradigm to any unit able of generating copies of itself. The natural selection of genes and the cultural selection of memes would not be the only forces driving evolution on this planet. The assumption at the basis of universal Darwinism is that any universal design resulting from a selective process can be described with the Darwinian algorithm [Dennett 1995]. Darwin’s dangerous idea of *descent with modification by means of natural selection* would therefore be neutral with respect to the substrata. It represents a universal acid able to corrode our every entranced representation of any design that can be encountered in the universe.

While we wait for the development of neuroimaging techniques in order to reach a deeper understanding of the neural and molecular basis of culturally acquired information, we can still study culture by focusing on interactors, i.e., on all that makes up the phenotypic expression and the extension of memes. Richerson and

Boyd [2005], in this respect, call for the inauguration of a new quantitative ethnography era, able to revolutionise our knowledge of the heterogeneity of human behavior. A quality social science can be achieved by rigorously estimating the behavioral variations that take place in the life courses of a longitudinal sample of subjects. The necessary information could be derived from retrospective microdata bases collected by way of rigorous sampling surveys. Cultural change can be studied applying the same mathematical models, experimental methods and simulation tools that are used in evolutionist biology and population genetics [Mesoudi, Whiten, and Laland 2007]. An important example of good research practice on gene-culture coevolution is Cavalli-Sforza and other skilful scholars' mighty reconstruction of the genealogic tree of human populations that overlaps with the classification of the main linguistic families. This analysis constitutes a veritable atlas of the paths along which genetic traits and languages have spread throughout the world. The genetic distance between two populations acts not only as a marker of the geographic distance between places of origin, but also as a counter of the time elapsed since their separation.

To conclude, I wish to recall the efforts of Langton [1979], van den Berghe [1990], Burns and Dietz [1992], Marsden [1998], Runciman [1998a; Runciman 1998b], Freese, Li, and Wade [2003], Turner [2005] and Nielsen [2006] to newly found sociology on Darwinian grounds. From their writings, it emerges that, just as in the case of the biological world, the social world can be described as the differential transmission and selective retention over time of units that are rules, institutions, practices and social structures. The social units that appear most adaptive are selected differentially over others and tend to increase their diffusion within the population.

A last acknowledgment goes to the sociologist Luciano Gallino [1987], who as already mentioned, dared to suggest a bridge theory between biology, culture and society at the beginning of the 1980s. Unfortunately Gallino's efforts to unify the wealth of knowledge accumulated in recent years within the behavioral sciences have not yet been recognised, particularly by those who continue to develop theories on the social actor forgetting that the *subject of action is a man made of "flesh and blood", moved by an inescapable impulse to live for life, in physical and cultural form and through the highest possible number of biological and cultural allies.*

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Sociology and the Behavioral Sciences

Towards a Unified Theoretical Framework of Knowledge

Abstract: Sociology is currently marked by internal fragmentation and conflicts with the other behavioral sciences. Whereas the hard sciences are united by a common explanatory model based on fundamental particles, the behavioral sciences fail to establish a unifying theoretical framework that might reduce the pulverisation of knowledge. This article attempts to establish whether sociology, and the behavioral sciences in general, can be adequately enclosed within a *common underlying theory* based on Darwinian evolutionism, on complexity theory and on the developments in neuroscience. The aim is to sketch a unified theoretical framework that can then be applied within different disciplinary fields in order to tackle their distinct explanatory goals. The question I wish to address is whether theories and methods exist that are able to bridge across the social and natural sciences, enabling the development of a naturalised epistemology.

Keywords: Darwinism, complexity, neuroscience, gene-culture coevolution, memetics.

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