The Journal of Mind and Behavior
Summer, 1984, Volume 5, Number 3
Pages 245-260
ISSN 0271-0137

The Classification of Psychology among the Sciences from Francis Bacon to Boniface Kedrov

Claude M.J. Braun

University of Quebec at Montreal

and

Jacinthe M.C. Baribeau

Concordia University, Montreal

The central purpose of this essay is to synthesize the history of the various attempts made to develop systems of classification of the sciences—with special emphasis upon the problem of the classification of psychology among the sciences. The general principles which have guided the major contributors in the field since its origin, are outlined. An analysis of the status and position of psychology within the major systems of classification follows. A critical summary of Piaget's circular system of classification of the sciences and of Kedrov's triangular system of classification of the sciences are presented. Piaget's and Kedrov's conceptions of the importance of psychology within the system of the sciences are also analyzed.

The classification of the sciences has often been a preoccupation of historians and philosophers of science, mathematicians, and natural scientists. Rarely however has the problem been attended to by behavioral scientists. A notable exception of course is Jean Piaget (1929, 1949-51, 1966a, 1966b, 1970, 1971), whose work in this area unfortunately remains largely untranslated and little known to English speaking readers. Similarly, Boniface Kedrov's scholarly *Classification des Sciences* (1977-1980, 1082 pages) is little known to English speaking scholars. It has recently been translated from Russian to French. As far as we know, it is the most exhaustive review of what has been written on the problem of the classification of the sciences from Chinese, Indian and Greek antiquity to present times. It also includes an important original classification.

The first part of this paper presents a historical overview of the major systems of classification of the sciences from the 17th century to the present.

Request for reprints should be sent to Claude M.J. Braun, Ph.D., Department of Psychology, University of Quebec at Montreal, Case postale 8888, Succursale A, Montreal, Quebec, Canada H3C 3P8.

The next section is a relatively exhaustive, and therefore more schematic, review of the *position* and *status* that have been attributed to psychology in the various systems of classification of the sciences since the 18th century. The third section is a summary of Piaget's circular system of classification of the sciences with special emphasis on the classification of psychology among the sciences. The fourth section summarizes Kedrov's criticisms of Piaget's model, presents Kedrov's triangular schema of the organization of the sciences, and closes with a critical discussion of Kedrov's understanding of psychology in the system of sciences.

Principles of the Classification of the Sciences: A Retrospective

Francis Bacon, in his *De Dignitate et Augmentis Scientarium* (1620/1905), was the first modern author to propose a comprehensive classification of the sciences on the basis of a single coherent principle. In his case the principle consisted of dividing up the sciences into groups according to the type of intellectual faculty which is required to practice each science. Bacon's classification can be summarized as follows:

History (sciences based on memory)	Poetry (sciences based on imagination)	Philosophy (sciences based on reason)

It is obvious from this diagram that Bacon viewed the system of sciences of his day as one might view an immense psyche. This *subjective principle* of classification has made its way in philosophy of science to this day. Though he did not distinguish psychology as an individual science, Bacon prepared the ground for British psychologism in the theory of knowledge, empiricism in philosophy of science, and associationism in psychology.

Descartes, in his *Principles of Philosophy* (1644/1955), combined two new principles which allowed him to make an important contribution to the classification of the sciences. He classified the sciences according to the properties of their objects of study (an objective principle); then he arranged them logically from those with more general objects of study to those with more particular objects of study:

Logic/Mathematics/Physics/Medicine/Mechanics/Ethics
(natural science) (applied science) (social science)

Descartes' interest in the time dimension of the system of science was purely limited to the order according to which the various sciences ought to be studied. His main concern, of course, was pedagogical and methodological rather than historical.

In a rather unsystematic way, Saint-Simon, in *Lettres d'un Habitant de Genève à ses Contemporains* (1802/1925), *Mémoire sur la Science de l'Homme* (1816/1966), and *Travail sur la Gravitation Universelle* (1813/1966) formulated the idea of a classification of the sciences : the subjective properties of the sciences would be entirely determined by their objective properties; the way by which we think about scientific objects would correspond to the nature of these same objects. Along with this original idea, he adopted a logical principle of classification from the general to the particular. He was also a pioneer historian of the sciences and introduced into his classification scheme ideas of the interconnection, the interpenetration, and even the progression of the various sciences. He distinguished three phases in the development of knowledge: polytheism, monotheism, and physicism (see Saint-Simon, 1964).

Comte (*Cours de Philosophie Positive*, 1830-1837/1853), who had been Saint-Simon's junior assistant, not content to absorb his master's genial insights introduced several of his own. He was the first to recognize the extent to which there exists an asymmetry in the relations between the sciences; in Comte's classification, each science rests upon the preceding science much more than upon the following one. Comte believed that this asymmetry was due to the increasing complexity of the objects of each science. He was the first to introduce the principle of classification of the sciences by *increasing complexity and decreasing generality*. Furthermore, he abandoned trying to classify the "applied" sciences and was content to limit his system to the "theoretical" sciences. This allowed him to avoid a number of pitfalls which plagued other more ambitious and perhaps more talented philosophers of science, such as Ampère. Comte's classification is as follows:

Mathematics/Astronomy/Physics/Chemistry/Physiology/Sociology

Comte viewed only human society as a properly "historical" process, not nature itself. For him the history of human society consists of regular successions, of a flat progression, not connected with revolutionary class struggle and excluding qualitative leaps. One must therefore agree with Kedrov's judgment that Comte did not differ much from his predecessors who placed more emphasis on the *logical principle*, the principle of coordination, than on a truly historical perspective. In Comte's classification, as in Spencer's, and despite the universal evolutionism of the latter's *Classification of the Sciences* (1864/1861-1902), the sciences are disposed linearly and contiguously to show how they share each other's properties and not in the order of their historical progression. Though Spencer (1854/1861-1902) introduced the principle of classification from the *abstract to the concrete*, the result was nearly the same as Comte's coordination principle.

Schelling (*Ideas for a Philosophy of Nature*, 1797/1946) and Hegel (*Philosophy of Nature*, 1817/1959) were the first to conceive of the sciences as a *developing*

system whose parts generate one another. Hegel's schema can be summarized as follows:

Science of Logic	Philosophy of Nature	Philosophy of Spirit
1. being	1. mechanism	1. subjective spririt
2. essence	2. chemism	2. objective spirit
3. concept	3. organicism	3. absolute spirit

The three most general units are organized into a dialectically united triad, but each unit is also divided into such a triad and so on, two more times—thereby yielding 81 divisions. Not surprisingly Hegel was unable to substantiate all the categories of this collossal encyclopedic classification.

Hegel's dialecticism, objective idealism, and organicism are major determining factors in his classification of the sciences. Hegel viewed world history as an *Absolute Idea* which metaphorically gives birth by a sort of "parthenogenesis" to an undeveloped, alienated, but germinal copy of itself. The growth of this "baby" is the evolution of the natural world. The self-consciousness of social activity in its highest form, philosophy, represents the "grown-up offspring" of the Absolute Idea at the point where the most universally concrete, developed concepts of the alienated world become transparent, i.e., reintegrate the Absolute Idea.

Several powerful new principles of classification implicit—or explicitly mystified—in Hegel's system were to be stripped of their idealistic garb by Engels (*Dialectics of Nature*, 1879/1940) and reformulated in the language of the positive sciences of the late 19th century. Taking for granted the material unity of the world, Engels proposed, for example, the principle of the *unity of the sciences*. The materialist idea of the immanent development of nature applied to the classification of the sciences produced the principle of development from the *inferior* to the *superior*, from *the simple to the complex*. Furthermore, the principle of *subordination* of the sciences, one to the other, took a form with Engels which (contrary to Hegel's conception of the pure deducibility of the successive alienations of the Absolute Idea) recognized the objectivity (or reality) of the passages and transmutations of material processes. Naturally, Engels applied the Heraclitean idea of universal motion to the exposition of the various sciences in his *Dialectics of Nature*. As a result, Engels was able, on the basis of his detailed familiarity with the positive state of each science of his day, to define the object of each science according to the specific type of motion observed within the material forms studied by each science. Finally, in harmony with the most revolutionary scientific discoveries of his century (e.g., transformation and conservation of energy, cellular biology, evolutionary biology, etc.), Engels elaborated the principle of *reciprocal interaction* of the objects of each science, and, consequently, of the various

scientific activities, concepts, and theories themselves. Engels's classification corresponds to the following diagram:

Mathematics--Astronomy--Mechanics--Physics--Chemistry--Geology--Biology--History

The principal weakness of Engels's classification is his adherence to the belief that there is a very tight correspondence between the *objective* progression of matter from the simple to the complex and the *historical* order of appearance of the sciences from the abstract to the concrete. As Kedrov points out, the formation of atomic physics and then of subatomic physics after Engels's death discredited his idea of an unbroken isomorphism between natural and scientific history. At the turn of the 20th century it was no longer possible to maintain that physics should be positioned in "historical" order before chemistry, since we realized that nuclear physics succeeded chemistry historically but that its object preceded chemistry's object cosmogenically. Kedrov does agree with Engels, however, that the world evolved in rigorous progression from the simple to the complex, and he quotes American astronomist Shapley (*Of Stars and Men*, 1959) in support of this contention. Shapley wrote that in its most ancient state, as inferable scientifically, the world consisted of nothing but disjointed microparticles (quanta, electrons, protons, neutrons, positrons, mesons, antineutrons, antiprotons), and that structures made their appearance in a rigorous progression of complexity, from atoms to molecules to molecular systems (crystals, colloidal matter), to organisms.

The Status and Position of Psychology among the Sciences

Positivism may be credited with the historical responsibility of having recognized the potential of psychology as a *fundamental* science. To our knowledge, the first classification of the sciences which gave psychology the status of a fundamental science was published in 1826 by a sympathizer of Comte, John Stuart Mill. However, this positivistic recognition of psychology as a fundamental science has always been marked by ambivalence. For example, one of the later classifications of the sciences to deny psychology the status of a fundamental science was Ostwald's (1904/1911) positivistic attribution of a status for psychology which once again was viewed as subordinate to biology.

This ambivalence can be found in other theoretical quarters as well. Several—though not the majority—of Soviet authors of the early 20th century under the influence of Pavlovian reflexology also subordinated psychology to biology. These include Somov, Poliouta, and Rogitsin (cited in Kedrov, 1977-1980). Clearly however, the view of psychology as a *fundamental* science has predominated over the years. A last instance as far as we have been able to ascertain, concerning the subordination of psychology to another science within a formal classification of science is to be found in an article published

in 1954 by Stroumilin, who included psychology as a branch of anthropology. The unacceptability of the anthropological categorization of psychology seems so obvious to us that no further discussion will be devoted to it.

At the turn of the 20th century, philosophy of science, world-wide, became dominated by positivism. Mach's empirio-criticism (1897/1959) suggested for example, a special rapprochment between physics and psychology. Mach's, Peirce's, Russell's and Wittgenstein's mentalistic psychological analyses of scientific activity resulted in a process of relative subjectivization of physics and mathematics. Classifications of the sciences by Mach's disciples or admirers were characterized by the same principles as those of Comte except that Comte's strong objectivism was replaced by marked subjectivism. Pearson's distinction proposed previously by Spencer, between "abstract" and "concrete" sciences, is an example of this. Comte's notion of the dependence of the social sciences upon the biological sciences and of the latter upon physics (combined with Machian subjectivism and epistemological atomism) resulted in more radically reductivistic positivist classification schemes, such as Pearson's proposal in his *Grammar of Science* (1892/1937) that economy, politics, morality, and law are branches of psychology, which is in turn a branch of biology! Despite positivism's constant tendency to reduce psychology to a branch or sub-science of biology, the marked sociological individualism of several positivists such as Pearson served to promote psychology to the status of "mother science" of all the humanities, and "daughter science" of the natural sciences. Mach himself had high hopes for the young discipline though (and in part because) he saw it as a branch of biology. Logical positivists, including Carnap, Neurath, and Brunswik, admitted the logical possibility of a distinct psychological science which they called "behavioristics." *The Encyclopedia of Unified Science* included in its first volume a chapter respectfully devoted to the science of psychology. Even Wittgenstein's remarks on the limitations of experimental psychology were not intended as a blanket indictment of the science of psychology. In 1926, the logical positivist Oppenheim gave psychology the status of a fundamental science, and to our knowledge very few explicit classification schemes have since reneged from this attribution.

After this brief review of the major principles which have inspired the most important classificatory schemes, it is now possible to take a more detailed look at where psychology has been situated and what has been its status in the various classificatory systems proposed since Bacon. In order to summarize this large body of data effectively, we have schematized it in Table 1. It appears that the term "psychology" was introduced no earlier than the 16th century by Rudolph Goclenius and that it was rarely used until the 18th century (see Mueller, 1976). The idea of a natural science of the mind (or soul) also dates no further back than the 16th century, but received little attention until the 19th century with the founding of Sechenov's and Wundt's psychological

laboratories. The term psychology itself makes its first appearance in the classifications of the sciences with the encyclopedists, as Table 1 illustrates.

Table 1

The Status and Position of Psychology among the Sciences.
A Retrospective of the Various Classifications from
the Encyclopedists to Present Times

Authors	Classifications		
Diderot (1752/1938, 1751-72/1967) and d'Alembert (1754-56, 1808)	HISTORY	PHILOSOPHY 1. sciences of god 2. sciences of man (. . . psychology, logic, linguistics, morality, ethics . . .) 3. sciences of nature	POETRY
Ampère (1834)	MATHEMATICAL SCIENCES 1. arithmology 2. geometry	PHILOSOPHICAL SCIENCES 1. psychology 2. ontology	
Comte (1830-1837/1853)	CHEMISTRY →	BIOLOGY . . . psychology . . . →	SOCIOLOGY
Mill (1826/1875)	BIOLOGY →	PSYCHOLOGY →	SOCIOLOGY or HISTORY
Note: Successors of Mill who maintained this part of his classification include Spencer (1864/ 1861-1902), Grot (1884; cited in Kedrov, 1977-1980), Wundt (1880-1883), Giddings (1895/1924), Tchijov (1896; cited in Kedrov, 1977-1980), Goblot (1898), Naville (1920), Gouchtchin (1924; cited in Kedrov, 1977-1980), and many others.			
St-Hilaire (1854-1862)	Did not mention psychology in his classification of sciences. He was to be followed in this respect by Engels (1879/1940) and Ward (1894).		
Cournot (1851/1912, 1851/1956, 1872/1934)	PHYSICS → chemistry	BIOLOGY → 1. plant biology 2. animal biology 3. human biology 4. psychology	SCIENCES OF THE MIND 1. logic . . .
Bain (1870)	CHEMISTRY →	BIOLOGY →	PSYCHOLOGY sociology . . .
Pearson (1892/1937)	PHYSICS →	BIOLOGY Psychology 1. economy 2. politics 3. morality 4. law	
Ostwald (1909/1976	MATHEMATICS →	ENERGETICS → astronomy physics chemistry	BIOLOGY physiology psychology sociology
Berg (1921)	ZOOPSYCHOLOGY →	PSYCHOLOGY →	LINGUISTICS

Note: The symbols utilized in this table are to be interpreted in the following manner: (a) arrows indicate relations of priority (indifferently in the logical, historical, or causal sense), (b) bars indicate contiguity of coexistential categories (principle of coordination), (c) capital lettering is used to indicate the fundamental sciences, whereas lowercase lettering is used to refer to the non-fundamental, secondary or derivative sciences (as judged by each author). This table does not present the complete classification scheme of each author, but only the position and status of *psychology* relative to its immediate neighbors.

Piaget's Circular Classification of the Sciences

Piaget (1929) was the first author to propose that the image best suited to conceptualize the organization of the sciences is a circle rather than a straight line. In his *Logique et Connaissance Scientifique* (1966a), he presented in detail his four-level circular model (see Figure 1). In order to understand this model, it is important to know that Piaget's innumerable studies in cognitive psychology had left him with the strong conviction that action structures are the primary factor of intellectual development. He then discovered that the cognitive structures of action observed in child development could also be observed in the scientific process in varying degrees from one science to another. This idea became the basis for his system of classification of the sciences, the four levels of which we will now explain:

(1) Piaget believed that of the sciences, the logico-mathematical group represents that level in which the activity of the scientist is the most important. According to Piaget, these tautological sciences have no object, only the constructions of an active subject—those of the mathematician's or logician's mind. Because of this, mathematicians and logicians are the least likely of scientists to develop a realist epistemology. (2) Next came the physical sciences whose technical-conceptual operations have become so elaborate as to remove them (though less completely than the logico-mathematical sciences) from directly touchable, audible, seeable reality. (3) Then came the biological sciences whose objects have remained relatively concrete and are therefore less dependent upon the activity of the scientist. The scientific practice of biologists, according to Piaget, forces them to lean toward realist positions in epistemology. Biology however, as it advances in its study of higher organisms, finds itself near the starting point of the circle of sciences: namely the active subject. (4) The psychological and sociological sciences are the last and closing group in Piaget's circle because they are a prolongation of biology into the field of cognition—they provide a new foundation upon which rest the logico-mathematical group. More explicitly, the biological sciences, according to Piaget, begin to reintroduce the active subject as an *object of study*; but it is the psychological-sociological group which takes on this task most directly. Thus, the circle of sciences forms a loop which closes upon itself to the extent that the subject-object dialectic is realized. This "aufhebung" finds its most perfect realization in a psychology which was viewed by Piaget as the cement which unifies the ensemble of the scientific epistemological structure. Piaget went much further than this however. In addition to the four levels just mentioned, he distinguished four *aspects* of each unit of classification:

(A) The aspect of each of the four science groups which has been under consideration up to now has been what Piaget called the *material* aspect of each group. When considering this aspect, Piaget refers to the objects of each

science group, such as numbers and functions for the logical mathematical group, bodies, energies, and organs for the physical and biological sciences, actions and mental operations for the psycho-sociological group. Piaget distinguished three further aspects of each group, namely the conceptual aspect, the internal epistemology and the "derived epistemology" of each science. (B) The conceptual aspect of each science consists of the *theories* which refer to the objects mentioned above but which are distinct objects in themselves. (C) *The internal epistemology* of a science consists of its own critical reflexion upon its conceptualizations. This exercise was considered by Piaget to be a natural and inevitable process within each science of laying out the conditions of correct and incorrect conceptualization. (D) The "derived" *epistemology* was defined by Piaget as the positing within a science of general epistemological problems such as the subject-object relation, the nature of representation, etc. This epistemological effort of science is characterized by the fact that it draws on the material, conceptual, and internal epistemological objects of the other sciences. In particular, it is psychology which has as its material object the elements of these derived epistemologies. To this extent, according to Piaget, psychology serves as a general foundation for the other sciences, an end point as well as a starting point. This double function of psychology in the system of sciences gives psychology tremendous theoretical importance in Piaget's system, as the following quotation illustrates.

> We will eventually find out whether the equations of protoplasm are a product of our minds . . . or whether our minds are a product of protoplasm . . . . But only psychologists will really understand why. (Piaget, 1970, p. 147)

Figure 1 illustrates that Piaget admitted that the circle of sciences closes upon itself only for aspects A and D, and not for aspects B and C. He did however consider for each of the four aspects that psychology is the starting point, or the most fundamental science, epistemologically speaking. This did not necessarily entail that psychology is the closing member of the circle of sciences. Scientific theories and metatheories (aspects B and C) in the Piagetian sense, cannot be conceived to proceed back and forth within the subject-object dipole as do objects and general epistemologies (aspects A and D).

Another important dimension of Piaget's circle of sciences concerns the meaning of the arrows which indicate varying types of relations between the different aspects of the sciences. In particular, Piaget very explicitly distinguished causal relations from implicative relations, the former belonging to the natural world and the latter to the psychic world. Piaget's parallelism is demonstrated clearly in his contention that "States of consciousness are not causally determined (they have no spatial structure, substance, mass, force, energy)" (1966a, p. 1181).

In addition, Piaget distinguished six types of relations between the sciences: complete causal reduction, reintegrative causal reduction, reduction from

cause to implication, isomorphy between cause and implication, reintegrative implicative reduction, and complete (or axiomatic) implicative reduction. For our purposes it will suffice to note that these relations (or arrows in Figure 1) are also organized by Piaget in a closed circle in the order presented above. Rather than opt for determinism or indeterminsim, Piaget once again took the constructivist route, never allowing the active subject to step out of his theoretical framework.

Finally, to do justice to the sophistication and detail of Piaget's epistemological thinking, it must be noted that many non-circular connections, internal and external to each aspect of the sciences, are discussed in his *Logique et Découverte Scientifique.*

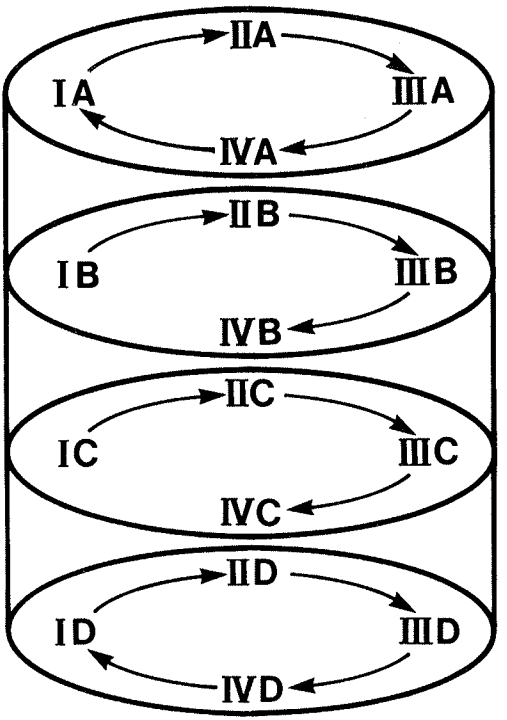

Figure 1: Piaget's classification of the sciences, drawn by us on the basis of Piaget's writings in *Logique et Découverte Scientifique. Sciences*: I. Logico-mathematical; II. Physical; III. Biological; IV. Socio-psychological. *Aspects*: A. Material; B. Conceptual; C. Internal epistemological; D. Derived epistemological.

Kedrov's Triangular Classification of the Sciences

In the second half of the 20th century the interest of philosophers of science in the problem of the classification of the sciences has declined. The last of the important theorists to seriously address the issue, Boniface Kedrov, was certainly influenced by Piaget's ideas, though circular classifications of the sciences had appeared in the Soviet Union as early as 1954 (see Stroumilin, 1954). Kedrov agrees that "circularity" in science classification models is useful in two respects. Firstly, he is aware that the view of the sciences as a linear progression has become untenable since the recent emergence of new fundamental sciences such as sub-atomic physics and molecular biology. Secondly, the growth of interdisciplinarity, or bidirectional feedback, can best be described in a model by means of loops or circles. On the other hand, Kedrov opposes himself to Piaget's extreme constructivism and demarcates himself from Piaget by adhering closely to Engels's line of reasoning in philosophy of science. Before presenting the details of Kedrov's model, we will examine the above mentioned points of opposition to, and demarcation from, Piaget's approach to the classification of science.

While admitting that the activity of the scientist should not be neglected, Kedrov disagrees with Piaget's assimilation of the formal sciences, and to a lesser extent of physics, with such activity. Kedrov argues that mathematics, logic, and physics are reflections of external objects that are real. He emphasizes that these sciences all have a content and obtain results. Their progress is not due to a progress in the cognitive apparatus of scientists. Rather, progress is due to the science's ability to reflect things with greater adequacy. The increase in the role of mathematics within physics, contrary to the Machian and Piagetian view, is not due to an increase in the role of subjective activity, but simply to our greater ability to quantify physical processes. It follows from these criticisms that Kedrov rejects Piaget's constructivistic principle of classification of the sciences.

Kedrov's reinstatement of Engels's definition of philosophy as the science of the most general laws of nature, society, and thought, is, of course, also directly at odds with Piaget's view not to recognize philosophy as a science (Piaget, 1966b). Engels's division of the world into three domains is faithfully reproduced by Kedrov in his classification scheme. This gives the scheme the appearance of a triangle. The reasons for selecting these three chunks, rather than, for example, the organic versus the inorganic, are unfortunately not given by the author in much detail. Engels had of course derived his tripartite concept of the universe from Hegel's *logic* in which the three terms are formulated as a unity of opposites.

Kedrov chose to orient his classification scheme according to the following three principles: (1) The sciences differ from each other in their degree of subordination one to the other. Every object is physical, not every object is

psychological. The meaning of this principle is close to the general category of materialism since it postulates the continuity (reducibility) of all forms of matter. (2) According to the principle of objectivity, the nature of the objects studied by each science is more important than the mental processes involved in the scientists' minds. (3) According to the developmental principle, the order of emergence of forms of matter corresponds to a process of increasing complexity.

Kedrov explicitly applied the objective and developmental principles by placing the sciences of simple objects at the top and of complex objects at the bottom of the triangle. The principle of subordination of the sciences of particular objects to those of general objects is thereby portrayed since complex objects are indeed more particular and simple objects more universal. The technical sciences are shown to be connected with the empirical sciences and not the formal sciences. Among the formal sciences, the mathematical sciences are shown to be connected most intimately with the physico-chemical group, whereas philosophy is shown to be connected more closely to the social and psychological sciences. Strangely, at least for Westerners, psychology is portrayed as being connected most intimately with philosophy and secondarily with the social and biological sciences. We wonder how many psychologists in the West or even the Soviet Union would agree with this. The reason for this unusual emplacement is again tracable to Engels. Engels believed that in addition to its general object of study, philosophy has a specific object which consists of "the specific laws of thought and logic." Kedrov adopted this view word for word (1962, 1977-80, p. 23). Engels was consistent in not mentioning psychology in his classification of the sciences—not so for Kedrov who defined psychology as "the psychic activity of man"! (Kedrov, 1956, p. 84; 1977-80, p. 492). It is no wonder then that philosophy and psychology should be so close to each other in Kedrov's scheme. A major difficulty which he does not sufficiently address is the problem of clearly determining the difference between the two. Is it necessary to mention that few psychologists would exclude animal behavior from the domain of psychology?

Despite such problems, Kedrov's emplacement of psychology at equal distances from the biological and social sciences makes sense by any criterion or principle of classification (refer to Figure 2). Piaget's emplacement of psychology between biology and mathematics makes sense only with reference to the constructivistic principle.

In conclusion, we are led to wonder whether there is not a particular reason why it is the metatheorists of Marxist persuasion who have manifested the most persistent interest in the problem of the classification of the sciences. Piaget certainly came very close to the Marxist world view. He frequently expressed an identity of views with Marxism. In *Épistemologie et Sciences de l'Homme* he referred to Marxism 26 times, always in positive terms, and

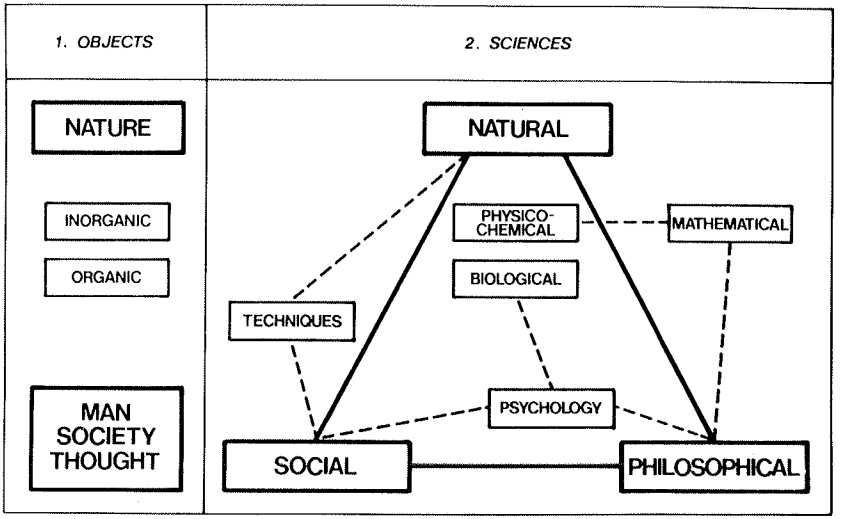

Figure 2: Kedrov's classification of the sciences, redrawn and translated by us from *Classification des Sciences* (Vol. 2, p. 491).

frequently eulogistically. In his book *Structuralism* he devoted an entire chapter to Marxism as an important instance of his own structuralist approach. In *Logique et Découverte Scientifique*, Piaget invited Lucien Goldman, a Marxist, to contribute the chapter on sociology. Kedrov, it goes without saying, considers himself a Marxist-Leninist.

With the loss of momentum of classical positivism, the failure of logical positivism to impose a unified meta-language of science, and the recent rise of anarchistic metatheories of science, we are witnessing an abandonment of faith in the possibility of formulating coherent and all-embracing philosophies of science. Marxism, critical as it has always been of premature attempts to put the puzzle together, nevertheless remains one of the most optimistic and steadfast general approaches to the metatheoretical problems which never cease to challenge us.

References

d'Alembert, J. (1754-1756). *Recherche sur différents points importants du système du monde* (Vols. 1-3) [Investigations of different important aspects of the world system]. Paris: David.

d'Alembert, J. (1808). *Oeuvres philosophiques, historiques et littéraires de d'Alembert* (Vols. 1-10) [Philosophical, historical and literary works of d'Alembert]. Paris: Bastien.

Ampère, A.M. (1834). *Essai sur la philosophie des sciences ou exposition analytique d'une classification naturelle de toutes les connaissances humaines* [Essay on philosophy of science or analytic exposition of a natural classification of human knowledge]. Paris: Mallet-Bachelier.

Bacon, F. (1905). *Novum Organum*. London: Routledge and Sons. (Original work published 1620).

Bacon, F. (1954). *Of the advancement and proficiency of learning (De augmentis scientarium).* London: J.M. Dent and Sons. (Original work published 1623).

Bain, A. (1870). *Logic, deductive and inductive.* New York: Longmans and Company.

Berg, S. (1921). Nauka, eyo soderdzanie, zncechenie i eyo, klassifikazia [Science, its content, its meaning and its classification]. *Izvestia Institut Geografii, 2,* 110-125.

Comte, A. (1853). *Cours, the positive philosophy of Auguste Comte,* Vols. 1-2 (H. Martineau, trans.). London: Chapman Publishers. (Original work published 1830-1837).

Cournot, A.A. (1912). *De l'enchainement des idées fondamentales dans les sciences et dans l'histoire* [On the chain of fundamental ideas in the sciences and in history]. Paris: Hachette. (Original work published 1851).

Cournot, A.A. (1934). *Considérations sur la marche des idées* [Considerations on the march of ideas]. Paris: Boivin. (Original work published 1872).

Cournot, A.A. (1956). *An essay on the foundations of our knowledge* (M.H. Moore, trans). New York: Liberal Arts Press. (Original work published 1851).

Descartes, R. (1955). *The philosophical works of René Descartes,* Vols. 1-2 (E.S. Haldane and G.T.R. Ross, trans.). New York: Cambridge University Press. (Orignial work published 1644).

Diderot, D. (1938). Interpretation of nature. In J. Stewart and J. Kemp (Eds. and Trans.), *Selected writings of Denis Diderot.* New York: Lawrence and Wishart. (Original work published 1752).

Diderot, D. (1967). *The encyclopedia: Selections* (S.J. Gendzier, Ed. and Trans.). New York: Harper and Row. (Original work published 1644).

Engels, F. (1940). *Dialectics of nature* (C. Dutt, trans.). New York: Lawrence and Wishart. (Original work published 1879).

Giddings, F.H. (1924). *Principles of sociology.* London: MacMillan. (Original work published 1895).

Goblot, E. (1898). *Essai sur la classification des sciences* [Essay on the classification of the sciences]. Paris: Alcan.

Hegel, G.W.F. (1959). Philosophy of nature. In G.E. Mueller (Ed. and Trans.), *Encyclopedia of Philosophy.* New York: Philosophical Library. (Original work published 1817).

Kedrov, B. (1956). La classification des sciences [The classification of the sciences]. *Recherches Soviétiques, I,* 83-112.

Kedrov, B. (1962). La conception dialectique marxiste des contradictions [The Marxist dialectical conception of contradiction]. *Recherches Internationales à la Lumière du Marxisme, 33,* 197-205.

Kedrov, B. (1977-1980). *La classification des sciences,* Vols. 1-2 [The classification of the sciences] (J. Lemagnen, trans.). Moscow: Editions du Progrés.

Mach, E. (1959). *The analysis of sensations* (S. Waterlou, trans.). New York: Dover Publications Inc. (Original work published 1897).

Mill, J.S. (1875). *Ratiocinative and inductive system of logic* (Vols. 1-2). London: Longmans and Company. (Original work published 1826).

Mueller, F.L. (1976). *Histoire de la psychologie* (Vol. 1) [History of psychology]. Paris: Presses Universitaires de France.

Naville, A. (1920). *Classification des sciences* [Classification of the sciences]. Paris: Alcan.

Neurath, O., Carnap, R., and Morris, C. (1970-1971). *Foundations of the unity of science, toward an international encyclopedia of unified science* (Vols. 1-2). Chicago: University of Chicago Press. (Original work published 1938-39).

Ostwald, W. (1911). *Esquisse d'une philosophie des sciences* [An essay in philosophy of science] (E. Philippi, trans.). Paris: Alcan. (Original work published 1904).

Ostwald, W. (1976). *Klassifizierung der Wissenschaften* [Classification of the sciences]. Leipzig: Akademische Verlagsgesellschaft. (Original work published 1909).

Pearson, K. (1937). *The grammar of science.* London: J.M. Dent and Sons. (Original work published 1892).

Piaget, J. (1929). *Les deux directions de la pensée scientifique* [The two directions of scientific thought]. Geneva: Archives des Science Physiques et Naturelles.

Piaget, J. (1949-1951). *Introduction à l'épistemologie génétique* (Vols. 1-3) [Introduction to genetic epistemology]. Paris: Presses Universitaires des France.

Piaget, J. (1966a). *Logique et connaissance scientifique* [Logic and scientific knowledge]. Paris: Gallimard.
Piaget, J. (1966b). *Sagesse et illusions de la philosophie* [Wisdom and illusions of philosophy]. Paris: Presses Universitaires de France.
Piaget, J. (1970). *Epistémologie et sciences de l'homme* [Epistemology and the sciences of man]. Paris: Gallimard.
Piaget, J. (1971). *Psychology and epistemology* (A. Rosin, trans.). New York: Grossman. (Original work published 1970).
Saint-Hilaire, G. (1854-1862). *Histoire naturelle générale des règnes organiques* (Vols. 1/3) [Natural history of the organic world]. Paris: V. Masson.
de Saint-Simon, C.H. (1925). Lettres d'un habitant de Genève à ses contemporains [Letters from a Genevan citizen to his contemporaries]. In *Oeuvres*, Vol. 1. Paris: Alcan. (Original work published 1802).
de Saint-Simon, C.H. (1964). *Selected writings* (F.M.A. Markham, trans.). New York: Harper and Row.
de Saint-Simon, C.H. (1966). Travail sur la gravitation universelle [Essay on universal gravitation]. In *Oeuvres*, Volume 5. Paris: Alcan. (Orignial work published 1813).
de Saint-Simon, C.H. (1966). Mémoire sur la science de l'homme [Essay on the science of man]. In *Oeuvres*, Volume 5. Paris: Alcan. (Original work published 1816).
Shapley, H. (1959). *Of stars and men*. Boston: Beacon Press.
Schelling, F.W.J. (1946). *Idées pour une philosophie de la nature* [Ideas for a philosophy of nature] (S. Jenkélévitch, trans.). Paris: Aubier. (Original work published 1797).
Spencer, H. (1861-1902). Genesis of science. In *Works* (Vols. 1-19). London: Williams and Norgate. (Original work published 1854).
Spencer, H. (1861-1902). Classification of the sciences. In *Works* (Vols. 1-19). London: Williams and Norgate. (Original work published 1864).
Stroumilin, S. (1954). Nauka i razvitye proizvoditelnyh sil [Science and the development of the productive forces]. *Voprossii Philosophii*, 3, 50-65.
Ward, L. (1894). *Dynamic sociology*. New York: D. Appleton.
Wundt, W. (1880-1883). *Logik* (Vols. 1-2) [Logic]. Stuttgart: F. Enke.
Wundt, W. (1909). *Einleitung in die Philosophie* [Introduction to philosophy]. Leipzig: N. Engelmann.