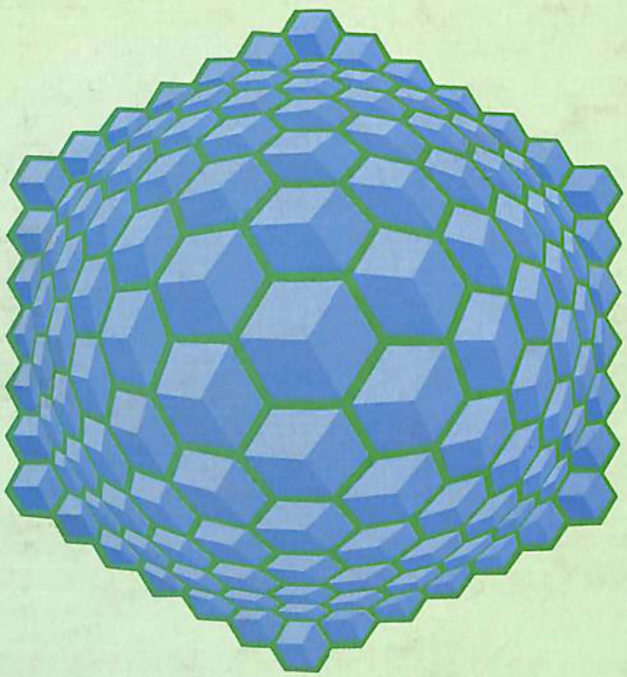
The Mind of Society

From a Fruitful Analogy of Minsky to a Prodigious Idea of Teilhard de Chardin

Yvon Provençal



World Futures General Evolution Studies
Volume 12

Gordon and Breach Publishers

The Mind of Society

WORLD FUTURES GENERAL EVOLUTION STUDIES
A series edited by Ervin Laszlo
The General Evolution Research Group
The Club of Budapest

VOLUME 1
NATURE AND HISTORY: THE EVOLUTIONARY APPROACH FOR SOCIAL SCIENTISTS
Ignazio Masulli

VOLUME 2 – KEYNOTE VOLUME
THE NEW EVOLUTIONARY PARADIGM
Edited by Ervin Laszlo

VOLUME 3
THE AGE OF BIFURCATION: UNDERSTANDING THE CHANGING WORLD
Ervin Laszlo

VOLUME 4
COOPERATION: BEYOND THE AGE OF COMPETITION
Edited by Allan Combs

VOLUME 5
THE EVOLUTION OF COGNITIVE MAPS: NEW PARADIGMS FOR THE TWENTY-FIRST CENTURY
Edited by Ervin Laszlo and Ignazio Masulli with Robert Artigiani and Vilmos Csányi

VOLUME 6
THE EVOLVING MIND
Ben Goertzel

VOLUME 7
CHAOS AND THE EVOLVING ECOLOGICAL UNIVERSE
Sally J. Goerner

VOLUME 8
CONSTRAINTS AND POSSIBILITIES: THE EVOLUTION OF KNOWLEDGE AND THE KNOWLEDGE OF EVOLUTION
Mauro Ceruti

VOLUME 9
EVOLUTIONARY CHANGE: TOWARD A SYSTEMIC THEORY OF DEVELOPMENT AND MALDEVELOPMENT
Aron Katsenelinboigen

VOLUME 10
INSTINCT AND REVELATION: REFLECTIONS ON THE ORIGINS OF NUMINOUS PERCEPTION
Alondra Yvette Oubré

VOLUME 11
THE EVOLUTIONARY TRAJECTORY: THE GROWTH OF INFORMATION IN THE HISTORY AND FUTURE OF EARTH
Richard L. Coren

VOLUME 12
THE MIND OF SOCIETY: FROM A FRUITFUL ANALOGY OF MINSKY TO A PRODIGIOUS IDEA OF TEILHARD DE CHARDIN
Yvon Provençal

This book is part of a series. The publisher will accept continuation orders which may be cancelled at any time and which provide for automatic billing and shipping of each title in the series upon publication. Please write for details.

The Mind of Society

From a Fruitful Analogy of Minsky to a Prodigious Idea of Teilhard de Chardin

Yvon Provençal

Collège de Granby
Québec, Canada

Gordon and Breach Publishers

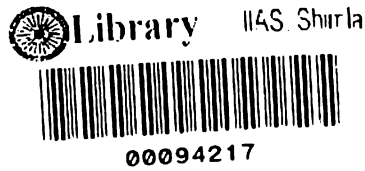
Australia • Canada • China • France • Germany • India •
Japan • Luxembourg • Malaysia • The Netherlands •
Russia • Singapore • Switzerland

Copyright © 1998 OPA (Overseas Publishers Association) N.V. Published by license under the Gordon and Breach Publishers imprint.

All rights reserved.

No part of this book may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, without permission in writing from the publisher. Printed in Malaysia.

Amsteldijk 166
1st Floor
1079 LH Amsterdam
The Netherlands



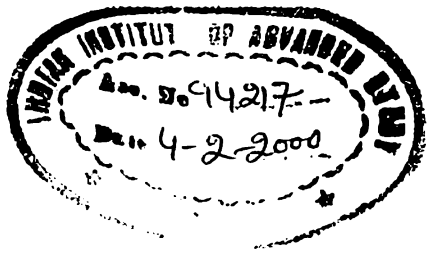
Cover photo: Victor Vasarely, *Cheyt Pyr* (1970–71) reproduced with permission of Janus Pannonius Museum, Pécs, Hungary.

British Library Cataloguing in Publication Data

Provençal, Yvon
The mind of society : from a fruitful analogy of Minsky to a prodigious idea of Teilhard de Chardin. – (World futures general evolution studies ; v. 12 –
ISSN 1043-9331)
1. Consciousness 2. Brain – Evolution
I. Title
155.7

155.7
P948M

ISBN 90-5700-514-X



Contents

Tables

Introduction to the Series

The *World Futures General Evolution Studies* series is associated with the journal *World Futures: The Journal of General Evolution*. It provides a venue for monographs and multiauthored book-length works that fall within the scope of the journal. The common focus is the emerging field of general evolutionary theory. Such works, either empirical or practical, deal with the evolutionary perspective innate in the change from the contemporary world to its foreseeable future.

The examination of contemporary world issues benefits from the systematic exploration of the evolutionary perspective. This happens especially when empirical and practical approaches are combined in the effort.

The *World Futures General Evolution Studies* series and journal are the only internationally published forums dedicated to the general evolution paradigms. The series is also the first to publish book-length treatments in this area.

The editor hopes that the readership will expand across disciplines where scholars from new fields will contribute books that propose general evolution theory in novel contexts.

Acknowledgments

Eighteen years ago, at the University of Montreal, I defended a doctoral dissertation on the subject of the observer's consciousness in physics. My dissertation director, Prof. Yvon Gauthier, had encouraged me to use a mathematical model that would allow me to formalize the situation of the observer in my undertaking, which was founded upon quantum mechanics. In this way I was able to find some formal properties that characterized the relationship between the observer and what he observes or, more generally, between what I have called an "embodying" element and an "embodied" one. This can be seen as a relationship of "alterity." I wish to thank Prof. Gauthier and express my debt to him for the time and unfailing support he provided from the very beginning.

I am also grateful to Gilles Lane of the University of Montreal and Serge Robert of the University of Quebec, both of whom showed early interest in my research and gave me their support. For the past ten years I have conducted my research project as intensively as possible. Moreover, it has widened in scope from a simple project into a major research program focused on the integration of knowledge. To arrive at the present point of view, I have had to create a method of connecting ideas belonging to separate fields of knowledge. These connections appear initially as systematic analogies satisfying certain formal criteria.

I had already made substantial progress in my research when I learned of the existence of the Association for the Unity and Integration of Knowledge. The first meeting of this organization, founded by scholars from various countries, was held in Calgary in 1994. A second meeting, in Montreal in 1995, was coordinated by Prof. Georges Hélal, whom I wish to thank here for his work. At that second meeting I spoke about the method described in this book, and met professors Peter Morgan of the University of Toronto and Ronald Glasberg of the University of Calgary. Subsequently, I met both again at the Eighteenth Conference of the Ultimate Reality and Meaning Society in Toronto, in August 1995. I was touched by the warm reception I received on this occasion. I feel I must express my gratitude to these people and to the entire URAM Society. More particularly, I wish to thank Father Tibor Horvath, founder of the Society, who invited me to the Toronto Conference, and Father John Perry, who took care of the organization

of the activities. The URAM Society has enabled me to submit my ideas to qualified people and to receive their comments.

In addition, I would like to mention here professors Patrick Mohr of the University of Scranton and Thomas Krettek of Creighton University. My gratitude also extends to Dr. Louise Sundararajan and Prof. Paul Dumouchel, who kindly read some of my texts and commented on my work. I thank Yvonne Christiansen and Donald McGrath, who helped me translate my text into English. I conclude in giving my warmest thanks to Monique Fleury and Romain Labrie, my colleagues and friends at the Cegep in Granby. For several years now, I have benefited from their tireless hospitality and appreciated our numerous conversations on ideometry.

1: IDEOMETRY

Ideometry is to be understood as the study of *ideas* just as they are. The word "ideas" here has a very broad meaning; rather than properly defining it, however, I will simply describe it. It concerns all that pertains to human creativity and taking form in symbolic language. "Ideas" therefore include concepts, principles, scientific laws, theories, philosophical systems and, in general, all that can be considered as constituting human creation in the domain of thought.

I intend to illustrate how ideometry provides a new way of integrating ideas. This integration will involve identifying original relationships among numerous concepts belonging to domains of thought that ordinarily remain distinct and separate from each other. Thus, I will show how these relationships connect certain fundamental concepts belonging to different disciplines and create, in each case, a certain formal structure which is always essentially the same.

The most original aspect of ideometry consists in the special relationships (herein called "ideometric relationships") it establishes among ideas, relationships that express an especially new kind of signification. The term I use to designate this approach is intended to establish an analogic bond with mathematics (and with "geometry" in particular). However, this approach in no way pertains to mathematics. We know that geometric relations deal with elements which appear as idealizations of forms perceived in space. In comparison, ideometric relations appear as conceptual relationships between idealized elements of thought.

The units of thought implied in ideometric relationships generally appear, first of all, to be endowed with a cultural significance associated with science or literature. Examples of such cultural units can be "Plato," "Descartes," "Marx," "Galileo," "Darwin," "Einstein," "Giotto," "Michelangelo," and "Renoir." They can also be concepts such as the genetic code, biological evolution, the evolution of the nervous system, the prebiotic evolution of macromolecules, the Florentine School of painting, the Elizabethan Theater, Impressionism, etc. More precisely, the units of cultural signification implied in these relationships are considered first as cultural "references". These units will be said to be "idealized" because, as known references, they meet certain

norms which happen to have been established inside a certain cultural framework (scientific or other kinds of culture). We will see that the ideometric relationships connecting such idealized elements create, in a formal way, linguistic relationships of signification connecting language units (for example morphemes or monemes) with the objects they signify. However, ideometry is not a language in the usual sense of the word. It consists, rather, of a certain structure of differences which reproduce certain formal characteristics of a linguistic structure.

The name "ideometry" was formed from two Greek words: *idea*, which means form or appearance; and *metron*, which means measure, space, proportion, verse, meter. "Ideometry" thus literally means the "measure of ideas as forms"; here, the word "measure" is used in its original sense, meaning "proportion," that is to say, an idealized relationship between a set and its elements or parts, or a relationship between these elements and parts.

Although ideometric relationships first appear to be like analogies, they are not ordinary analogies. On the one hand, they are founded on a relation of similarity but, on the other, they are founded on an *alterity* relation which is at least as essential. For instance, I will establish an ideometric relationship between, on the one hand, articulate and symbolic human language and, on the other hand, a biological kind of language which is to be associated to the "genetic code" and which enables "information" to be encoded in the DNA of living beings. In this correspondence of one type of language with another, we must acknowledge a profound similarity based on several precise features of resemblance, as well as an equally profound alterity that no scientist should neglect if he does not want to fall into confusion.

2: THE CONCEPT OF COMPLETE STRUCTURE

The concept of complete structure will be useful as a way of introducing the ideometric approach to the integration of knowledge and the establishment of special correspondences across different scientific fields. Complete structures are transdisciplinary and meaningful. They represent entities that play a fundamental role in contemporary science. The definition of this transdisciplinary concept is relatively simple to state.

Definition of a Complete Structure

By definition, a complete structure is a *constitutive unit of a whole range of reality*. The expression "range of reality" must be taken here to mean a general domain of objects in a science. This definition is expressly very general because of its transdisciplinary characteristic.

Thus, for example, the *atom* is the constitutive unit of all physical objects, whether we are talking about a star, a planet, a gaseous nebula or smaller objects such as rocks or molecules. Space, time or force fields are significant entities in physics but they are not generally called physical objects. These can be located and are made up of something "material". Therefore, the atom is a particular case of a complete structure.

The *cell* is such a unit, this time within the biological domain. For it is the constitutive unit of all living beings, whether they be simple or complex. Microbes, as well as large vertebrates, are made up of cells.

In the same way, a *human being* is a complete structure, if it is understood as an individual or personal entity. The human being is a constitutive unit of all human societies or cultures, whether they form a family, village, city, nation or civilization.

The atom, the cell and the human being are all known cases of complete structures in the reality studied by the sciences. That is why these three entities together can be used to define the de facto concept of complete structure. This is an extensive definition of the concept rather than a comprehensive one.

Remarkable Characteristics of Complete Structures

The existence of these three kinds of complete structures is in itself a remarkable fact which, as such, remains unexplained in contemporary

science. The fact that the atom, the cell and the human being appear as three distinct levels of a more and more embodying complexity has been explained by neither physics, biology nor anthropology (or social science, if one prefers). These three kinds of entities play a fundamental role in their respective domains. Moreover, they have certain additional common characteristics which emphasize what is remarkable in each.

In every known case of a complete structure, there is a very problematic substructure. Both the origin and the conceptual complexity of this substructure raise many difficulties in the scientific discipline concerned.

Thus the atom comprises a remarkable substructure known as the "nucleus". This is composed of *particles* such as neutrons and protons, which are bound together by nuclear forces. Research into the characteristics of these particles and forces is of prime importance for the whole of contemporary science, although the focus is generally on nuclear and particle physics. What is the exact relation between these forces and the other known forces in physics, such as electromagnetic forces and gravitational interaction? Is it possible to find a genuinely unitary theory? Can one determine the basic reason why these particles exist and why they have such characteristics? These are among the most disconcerting questions raised by contemporary science.

In biology, the cell possesses a substructure that is problematic for contemporary science. Because the cell comprises a nucleus, it plays a major role in the functioning of the genetic code.[3] Many fundamental problems have to do with the specific molecular structure of DNA. As a problematic substructure of the cell, this can be conceptually correlated with the elementary particles of nuclear physics. How did DNA, which is a self-replicating macromolecule, take form as life emerged on the Earth? Another fundamental question concerns the exact functioning of the genetic code itself and of the respective parts played by the nucleus and the remainder of the cell in this functioning.

Accordingly, contemporary science sees the human being as having a highly problematic substructure, that of the human brain. How did this take form? How did it emerge from the less complex animal nervous systems? How exactly does the human brain function? These questions along with the preceding questions about the atomic nucleus and the genetic code have provided the basis for an entire research program.

The expression, "*complete* structure," which has been used here to designate three kinds of very different structures, means that, in these three cases, the structure appears as a highly perfected system with

regard to its efficiency and its actual universality. There is a kind of misunderstood "perfection" of the respective funtionings of these structures, that is to say, there is a structural and functional *completeness* in them.

We will conclude this section with Table 1, giving an overview of the complete structures.

Table 1 The Complete Structures

	Complete Structure	Problematic Substructure
Physics	atom	nucleus
Biology	cell	DNA
Anthropology	human being	human brain
...	...	...[4]

3: THE CONCEPT OF ALTERITY

The new concept of alterity will now be introduced.[5] Alterity, in this case, must be understood as being a very strong sense of difference. It is called "anti-equivalent alterity" in accordance with the formal properties that define it.

To begin with, let us consider the formal properties of *equivalence* in mathematics. A relation r(A, B) is called a "relation of equivalence" in a domain of objects designated by A, B, C,... if and only if it has the following three properties:

reflexivity	(for all A, r(A, A) is true),
symmetry	(for all A and all B, if r(A, B) is true, then r(B, A) is true),
transitivity	(for all A, all B and all C, if r(A, B) and r(B, C) are true, then r(A, C) is true).

These three properties of equivalence in mathematics can define equivalence in general. In fact, they denote many objects belonging to one class. They also state that these objects are identical to one another. The relation of equality (A = B) is a particular case of this.

My approach is original in that it defines alterity precisely by giving it properties which are *contrary* to the three properties of equivalence. In this way, the notion of alterity is freed from the features it is generally and implicitly supposed to possess.[6] Therefore, the three formal properties of alterity are:

anti-reflexivity	(for all A, R(A, A) is false),
anti-symmetry	(for all A and all B, if R(A, B) is true, then R(B, A) is false),
anti-transitivity	(for all A, all B and all C, if R(A, B) and R(B, C) are true, then R(A, C) is false).

Let me now compare these properties — which I will call "anti-equivalence properties"— with the properties of alterity as it is traditionally understood. Alterity is characterized an anti-reflexive (as in "A differs from B": one cannot say "A differs from A"). This does not change here. As it turns out, this is the only formal property of difference (in the usual, intuitive sense of the term) that remains unchanged.

As such, this property is consistent with the initial purpose of the method, which defines alterity as being provided with formal features contrary to those of equivalence.

Moreover, the properties of anti-symmetry and anti-transitivity are posited here for precise reasons. Symmetry can be seen as a characteristic of alterity taken in a conventional sense. However, symmetry wrongly or superficially characterizes alterity. Thus I would rather deal with anti-symmetry instead of symmetry. Anti-symmetry conveys the idea of an oriented and irreversible change, instead of a neutral and reversible one. Anti-transitivity, for its part, is a formal property opposed to the presumption of difference that encloses its objects in a structure of opposites. Anti-transitivity breaks out of this impasse and allows for the addition of several terms, each of which expresses alterity with respect to the preceding term in a sequence.

It is worth noting that anti-transitivity, as defined here, is not equivalent to intransitivity (that is to say, to the *unnecessity* of the transitive relation), a property already assigned to alterity by some logicians. For anti-transitivity implies that transitivity *never occurs* in the envisaged class of objects, and this creates a formal situation very different from that characterized by intransitivity. In brief, anti-transitivity essentially expresses the recurrence and irreversibility of a development.[7]

Now let me illustrate this sense of alterity, formally characterized in this way. It must first be admitted that, for any given instance,[8] this new concept of alterity consists in a way of being *Other* that is not tantamount to a simple difference. An instance which is *truly other* is not simply "different" from a second instance, nor it is simply "independent" from nor "exterior" to it. The usual philosophical language includes some terms that express what I mean here. For example, in certain contexts the word "emergence" or the verb "to emerge" have the properties of anti-equivalence defined above. When one says that "life *emerged* from physical matter at a certain moment in the history of the universe," or that "there was an *emergence* of culture from biological nature," one means that a certain reality — life or humankind, as the case may be — is so different from its environment of origin that it cannot be inferred from laws describing that environment (although it is indeed compatible with these laws). Expressed in this way, alterity has in fact the formal properties of anti-equivalence. If one considers the expression "A emerges from B," it is clear that the relation of A to B is anti-reflexive (A does not emerge from A), anti-symmetric (if A emerges from B, then B does not emerge from A) and anti-transitive

(if A emerges from B and B emerges from C, then A does not emerge from C). The notion of emergence expresses the alterity of an irreducible, radically original instance, introducing a directional vector into separation and proceeding by way of discontinuity. The anti-transitivity of the relationship represents the multiplying facet of the alterity, which reproduces itself on another level and, in doing so, avoids getting locked into a dualism (or opposition of contraries). Coming back to the above example, one would say that "culture differs from biological nature as biological nature differs from physical matter." This creates an effect of irreversible succession and, at the same time, a very particular sort of conceptual overlap [*emboitement*]. Thus defined, the idea of emergence makes it possible to conceive of new ways of representing relationships between theoretical concepts.

This formal characterization of alterity can be applied to many cases other than those described above. This alterity, which expresses a strong sense of difference, is particularly akin to relations that express creativity, originality and the emergence of the novel and the irreversible. It gives us a way of formalizing concepts that were, in general, very vague and it establishes instructive relationships between categories of ideas that do not seem to have anything in common. The ideometric approach is, therefore, a precise tool that allows us to establish numerous relations between domains that normally remain separate, structuring these relations in a way that results simply from the properties of anti-equivalent alterity.

Ideometric formal structure is comprised of the following elements:

- a *domain of ideas*
- several *sub-domains* of ideas
- differences and similarities between these sub-domains (or between the ideas pertaining to distinct sub-domains)
  - a particular sort of difference, comprised of the formal properties of *anti-equivalence*, is designated *"anti-equivalent alterity"*
    - moreover, the sub-domains are comprised of the following characteristics:
    - they are spaces that can be characterized, in part, by an *order*;
    - these spaces are comprised of elements that are proper to this order and that form *combinations* that give rise to higher orders of units;
    - the expression, *emergence by change of order*, is used to designate the relationship of anti-equivalent alterity found between the units of two successive orders;

– changes of order are *recurrent*, that is to say, they produce, in principle, an unlimited number of new emergences.

This general, transdisciplinary, framework, is illustrated by Module 4.

4: THE IDEOMETRIC SEQUENCE OF PHYSICS-BIOLOGY-ANTHROPOLOGY

The word "sequence" means here that several terms form an *oriented* series. I will represent this sequence by the following terms: physics, biology, anthropology. There is, conceptually speaking, a direction to this series, one that runs from physics to biology and from biology to anthropology. Thus the sequence goes from a more "a priori" science to a less "a priori" one — for physics is a science that applies to all that is material,[9] and its laws apply equally to all living beings. This theoretical fact will be expressed as follows: physics is a "substratum" of biology just as biology is a "substratum" of anthropology. The "substratum" relation established between two scientific domains is anti-symmetric (if A is a substratum science of B, then B is not a substratum science of A). This formally expresses the fact that there is an orientation implied in the ideometric sequence of physics-biology-anthropology.

If science A is a substratum of science B, then we are dealing with a theoretical fact that has an important ideometric signification. This case is fundamental for an understanding of several remarkable epistemological characteristics. For example, the laws of science A *partially determine* the objects of science B in the sense that that which exists in B, as systems or processes, is not entirely *determined* by the laws that regulate A, but must be *compatible* with these laws. This situation makes it possible to speak of the *emergence* of the objects of B with respect to A.

Note that the substratum relation holds equally between mathematics (science A) and physics (science B), since movements and transformations of physical bodies must be compatible with laws of a mathematical type. Moreover, as in the above cases, the existence of physical bodies, in general, is not entirely determined by mathematical models alone. The irruption of physical reality from a base of mathematical rationality has been philosophically designated by the expression *hiatus irrationalis*. And this is the guise under which the above defined emergence appears. Physics is, with respect to mathematics, a sort of emergence that differs from other types of emergences, such as that of life with respect to physical laws, or of humankind with respect to biology.

The Sequence of Interactions

Let me begin by illustrating the ideometric method with a twofold relation. The first part shows the correspondences between a *physical type of interaction* (for example, a force field between two particles) and a *biological type of communication* (for example, one animal seeing another); the second correlates a biological type of communication with an anthropological one, that is to say, with the *transmission of a work of human creation* (for example a scientist transmitting the results of his research to the scientific community). Both of these relations form an ideometric sequence connecting three terms that pertain to different levels of reality.

In this case, the basic terms for ideometric relationships are "interaction," "communication" and "transmission of work." However, each phase of the ideometric sequence may be represented by one and the same term — "interaction" — simply by qualifying it as either "physical," "biological" or "anthropological". This gives the following three kinds of *interactions,* each of which is implied in one of the above-mentioned ideometric relationships:

Physical interaction: This presupposes two physical bodies and a *field of interaction* which is generally defined mathematically; physical interaction as such is irreducible to mathematics.

Biological interaction: This is the name we will give to *communication* as such, which takes place between the two opposing poles of output and input, that is to say, between two poles that temporarily assume these respective functions. Between these, a coded message is communicated. This type of interaction already exists in the animal world and, although it is normally considered to be irreducible to a simple physical interaction, it generally implies such a relation.

Human interaction: This is concerned with the transmission of works of creation. It implies a *creator* and a *public*. The work of creation, as such, is usually considered to be irreducible to simple coded messages pertaining to the theory of communication and, of course, to purely physical interactions.

This sequence constitutes a series of profound differences denoted by the term "emergence," as defined above. And it constitutes a *structural repetition* in that it reproduces the formal characteristics of emergence at each phase. In other words, the sequence of physics-biology-anthropology constitutes a series of units that have ideometric significance, with

each term formally repeating properties of the preceding term in the series. This does not stem from some mysterious harmony in things, a condition consistent with an equally mysterious kind of finality. Contrary to such a supernatural harmony, what happens is actually quite rational and derives from the way in which ideas are objectively constituted. The emergence of life is, in a way, similar to the emergence of physical matter because it implies, in the very manner in which scientific knowledge is carried out, a theoretical alterity that takes the form of a de facto epistemological irreducibility. This also holds for the emergence of human beings from the condition of animality.

The Correspondence of the Arbitrary

Symbolic language, like many cultural products, is a manifestation of what is new and arbitrary (i.e., it is undetermined by a biological substratum) at that level of reality which corresponds to anthropology or, more broadly, the social sciences. It is one of the effects of that alterity which human reality represents with respect to biological reality, just as biological reality represents an alterity with respect to physical reality. Here the word "alterity" does not, let me repeat, mean contradiction but transcendence (*dépassement*) by means of another sort of differentiation. Within the bounds of the experimental sciences, this differentiation can only take the form of an arbitrary feature, that is to say, of an accident or a chance occurrence. This represents a new kind of liberty, one without any preconceived finality. This epistemic alterity has been variously recognized by certain contemporary authors who have reflected on the relations between the anthropological and the biological.

Anthropologists have a convention which attributes all that is particular and changeable to social and human processes, and all that is universal and stable to natural or biological processes. The same could be said of life in relation to physical-chemical processes: in other words, everything particular or changeable is attributed to individual and biological processes, whereas everything universal or stable is attributed to material or physical processes. In both, anthropology and biology, an additional degree of liberty appears. However, those who speak in this way do not seem to be especially conscious of using the words "universal" and "steady" in very relative senses. Human processes are quite specific when compared to biological processes, but these are in turn quite specific when compared with the processes described by physical laws.

Let me offer other examples of anthropological conceptions that correspond to biological ones in ways intimately bound up with the ideometric correspondences of emergence. Human beings have the capacity to produce arbitrariness. This appears in their works of art, their technical inventions and generally in the products of their imagination (including such linguistic productions as words, sentences, questions, hypotheses and theories). In fact, this capacity to produce arbitrariness is the hallmark of human creativity and represents a real achievement in that the human being is the only primate who has managed to transcend the limits of tropical zones and populated almost the totality of dry-land environments. In other words, this species transgresses normal biological limits.

However, this transgression is a replica of another to which it corresponds on a conceptual level. I am referring to the transgression represented by life itself. By the arbitrariness of a code founded on macromolecules (that is to say a genetic code), life can produce forms which are not predictible by physical laws. Accordingly, it has allowed the aqueous environment to transcend itself through the creation of terrestrial organisms that carry the water they require within their own bodies.

There is a link between the arbitrariness of the genetic code and the arbitrariness of human symbolic language. Both are objectively produced by chance. Both manifest the irruption of chance itself into an environment that was not initially constituted to produce such things. The idea of transgression is useful here for establishing a continuity between epistemic passages (from physics to biology and from biology to anthropology). Also it is useful for maintaining, at the same time and in an essential way, the specificity of the domains and the integrity of the differences between them. The genetic code is not a language, nor can it become one. This would be contrary to the epistemic purpose of science, which rejects finalism. Again, it must be assigned to chance and, in this case, to physical chance which takes root in physical processes only. This is why we must speak about a transgression. In the same way, human language must be assigned first to biological chance (that is to say, especially a condition devoid of any conscious intention or purpose).

However, from an epistemological point of view, these transgressions are not manifestations of a pure irrationality within the bosom of natural science. Is this not a transgression with respect to rationality qua mathematical rationality? In this sense, the set of elementary particles

and fundamental interactions constitutes a kind of physical "code" that generates all the forms of material reality. This "code" is as arbitrary as the preceding codes, and as productive.

In Table 2, the first line shows the sequence of emergences. This is followed by a summary of various concepts or ideas which correspond to them ideometrically. These concepts or ideas are related in a formal, anti-equivalent way and thus form other ideometric sequences. For example, the passage from physical evolution to biological evolution, as well as the transition from this to anthropological evolution, express the same profound alterity as we find across the sequence of emergences. And such passages have the same formal properties.

Table 2 Synoptic Table of the Ideometric Correspondences within the Sequence of Physics-Biology-Anthropology

Physics	Biology	Anthropology
hiatus irrationalis (or emergence of physical matter)	emergence of life	emergence of humankind
physical-chemical evolution	biological evolution	evolution of human societies
Complete fundamental structures (constituted units):		
elementary particle (atom)	DNA (living cell)	human brain (human being)
Other ideometric correspondences:		
physical interaction	animal communication	transmission of human works of creation
physical stability	biological stability	
	biological variability	human variability
arbitrariness of particles	arbitrariness of the genetic code	arbitrariness of human languages

5: THE MIND OF SOCIETY: FROM MARVIN MINSKY TO TEILHARD DE CHARDIN

Let me now return to the beginning of our discussion, where I drew parallels between the ideas of Marvin Minsky and Teilhard de Chardin, between the "society of mind" and the "mind of society." When I speak about the "mind of society," I am referring to what is common to their respective ideas, keeping in mind, however, that Minsky's expression is the inverse of Teilhard's. This inversion of terms will be justified by the results of my analytical approach. As a matter of fact, Minsky has defined the word "society" as "an organization of parts of a mind". He has explained that he is using the term "community" to mean an organization of people, because he did not want to "suggest that a human mind resembles a human community in any particular way."[10] Therefore, I will use the concepts which Minsky has worked out despite his own reservations.

Minsky's terms can, independently of his own intentions, be correlated with those of Teilhard. For example, Minsky defines "agents" as parts or processes in an organization of parts of the mind; and he conceives of them as being relatively quite simple. These agents represent neurons, while society represents the whole human brain. Minsky's agents correspond to Teilhard's "elementary individuals," while Minskian society can be correlated with the latter's "mind of Earth." In the same way that Minskian society is naturally endowed with consciousness and personality, this "mind of Earth" is itself endowed with a "super-consciousness" and a "transcendent form of Personality."[11] While Minsky describes the mind in rather sociological or anthropological terms, Teilhard uses biological metaphors to describe human society. The latter refers to human society as a unique species capable of covering "Earth with a single organized membrane."[12] Minsky, for his part, describes the human brain as resembling "a great nation of cities and towns, linked by vast networks of roads and highways."[13]

"Mind" Taking Form

The social human mind is presently taking form, just like the individual mind of a very young child. Teilhard speaks about "the

Noosphere" as a spiritual layer which took form over the surface of the Earth during Man's evolution from a primate into the Man of today, and which will accompany his evolution into the Man of the future. Minsky also, at his own level, contemplates the growth of the mind. This, which is likened to the functioning of a child's or an embryo's brain, proceeds along the same lines as an organized society. For Minsky, "the embryonic brain resembles a complex animal ecology which even includes predators programmed to find and kill the many cells that happen to reach 'wrong' destinations" (p. 310).

Some topics correspond in a general way. For example, one appreciates the fact that a neuron, by itself, is relatively "primitive." It is a very simple cerebral element. The basic mechanism used to transmit information in the neuron (i.e., to trigger the release of chemical intermediaries which affect the external membranes of other cells) can be found again in the most rudimentary bacteria. In the same way, in the domain of anthropology one often emphasizes the primitive nature of human beings, who have remained morphologically the same for tens of thousands of years.

Other Correspondences between the Brain and Society

Other topics, including individual and social memory and what Minsky calls "robustness," lead us to more detailed descriptions. "Robustness" designates the special soundness of an organization, akin to that of the human brain. Human society too can be described in terms of robustness.

Let us begin with memory. Minsky uses the notion of "K-lines" (meaning "Knowledge-lines") to help us understand the functioning of memory in the brain.[14] In Minsky's view, these are like cables that are connected to active mental agents when an idea is produced. Thereafter Minsky, more or less in a deliberate way, uses several expressions which suggest to the reader that these K-lines are analogous to written texts in human society. K-lines evoke written lines, books and libraries and so on, thus representing the memory of a society.

I should clarify that Minsky himself does not posit an explicit relation between K-lines in the brain and texts in human society. I have made this connection myself, in accordance with my analytical method. However, Minsky's purpose strongly suggests such a systematic relation.

In Minsky's terms, every service in the brain has its own set of K-lines. Every part of the brain contains several kinds of memorization services, each having its own working mode corresponding to a specific

purpose. K-lines are specialized and are involved in various kinds of orders or hierarchies, in the same way that texts and writings are in human society. The proliferation of writing in a complex society corresponds, on a conceptual level, to the proliferation of intra-cerebral transmission lines. Minsky writes: "Indeed, no aspect of the brain anatomy is more striking that its huge masses of connection bundles" (page 107). He observes that two broad categories of memory are involved in brain functioning: short-term and long-term memory. This situation corresponds, at the social level, to the distinction between the publication of articles (magazines, newspapers, etc.), which concerns the short term, and the publication of books (treatises, reference works, etc.), which concerns the long term. Moreover, this author appreciates the fact that, in the functioning of memory, it is difficult to distinguish between *memories* and *memories of memories*. Thus it is possible that the earliest of recollections are merely reconstructions from old thoughts. Even late recollections may be reconstructed by agents in the brain. In historiographical terms, this situation corresponds to the fact that, in contemporary society, the reconstruction of the past — even of the recent past — requires continual reinterpretation. History is made in the present, one might say.

The topic of robustness also has the capacity to produce correspondences at the conceptual level. Robustness, according to Minsky, has several distinct features. One is *duplication*. Numerous areas of the brain have many duplicated elements and apparently useless repetitions are frequent. We can say the same about written texts in human society. Books are published in many copies and kept in numerous places that are more or less distant from one other. Moreover, brain processes are *distributed*, which means that the same function is effective in several places at once. Contemporary human society reproduces this distribution in its functioning, since each city and town has the same array of services, including schools, hospitals, highway departments, and so on, along with the required documentation in the form of registers, reference texts, etc. Another feature mentioned by Minsky is that of *accumulation*. This means that numerous sub-agents and sub-functions are involved in the pursuit of any given purpose. Specialized organizations are complex, as in modern human society. A simple census, for example, requires a whole army of servants.

Another aspect of human brain functioning remarked upon by Minsky corresponds to a precise feature in contemporary society. I am referring to the fact that the brain cannot regenerate its cells, probably

because, as Minsky explains, acquired connections between agents then are lost anyway. Now, the very striking fact that brain cells do not reproduce can be correlated with another equally striking fact of contemporary society, namely, that traditional values and functions are irreparably lost. Old religious values and the reasons which supported them die out, without being identically regenerated.

Let me illustrate here how my method allows us to find new elements of explanation or, at least, to clarify important points. A regeneration of dead cells in the brain by biological reproduction would doubtless be damaging to brain functioning, because it would interpose a biological determinism within the bosom of this functioning and consequently impede processes of (cultural) acquisition in the individual concerned. This explanation is suggested by a corresponding situation in contemporary society. This society must be liberated from certain traditions so that new institutions required by the functioning of modern society are not impeded by old cultural determinisms. These may have had a particular significance in the past, but have subsequently lost their justification.

Science as a Form of Consciousness

Social organization can be shown to correspond to cerebral organization in a number of essential ways, including memory. This situation prompts Minsky to describe the human brain as resembling human society. It also prompts Teilhard to describe human society as having a kind of distinctive consciousness. More precisely, Teilhard sees science itself as a sort of consciousness at the level of world society. He writes: "*Intellectually*, the progress of Science tends to build a synthesis of the laws of Matter and Life, which is basically nothing other than a collective act of perception: the World seen, in only one coherent perspective, by the whole of Humanity."[15] Thanks to science, the world acquires the "active consciousness of its unity."

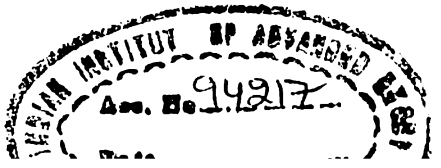
Indeed, Science is not merely a passive form of perception but an active construction of reality. We can say something similar about the consciousness of a subject as it arises in his or her brain. Minsky poses the problem of the knowledge of the subject's external reality as follows: "How can it [the brain] learn what it's like outside [of the skull]?" [...] "The surface of the brain itself has not the slightest sense of touch [...] Nor can a brain see [...]; it is only *connected* to eyes [...] We never actually make any *direct* contact with the outside world" (page 110; Minsky's emphasis). Therefore, perceptual consciousness is an elaboration

that gives an indirect grasp of the external world, just as science is, but on another level. It also implies an active construction of reality.

Using Minsky's Perspective to Confirm and Readjust that of Teilhard

One must admit that Teilhard's conception has not been very successful in convincing scientists and philosophers in general. Why is this so? One of the main irritants in his conception of the mind of society is the restrictive way he often describes this mind (l´ "Esprit") as a sort of compulsory path that human individuals must follow.[16] However, he denies wanting to sacrifice individuality and claims that individuals should be capable of "personalizing" themselves still further throughout the entire process.

Minsky, like other researchers who have studied cerebral processes, believes that the organization of thought in the brain is attained in the absence of any control program or absolute hierarchy. Therefore, the domain or society of neurons resembles a reign of liberty and, as long as one looks at it at its own level, comparing neurons to other existing cells, it is the most peaceful, creative and free society and, at the same time, the most diversified. As a matter of fact, the functioning of neurons in the human brain is unique in the world of biological cells; for it is determined not by genetic information but, rather, by external events which contribute to acquisition processes. Moreover, neurons generally do not fight each other for survival, the way unicellular organisms in the external environment do. Despite appearances, the latter are less free. The qualifiers used above to describe neuronal society (peaceful, creative, free, diversified) could not appropriately be applied to contemporary human society. It should be emphasized that the pattern of contemporary human society corresponds to the structure, not of the human brain as such, but rather to a brain that is still in its immature stages, evolving toward a higher level of organization. Now this result is not inevitable, since it is not determined by physical, biological or even cultural (religious, traditional, judicial) laws. Moreover, the same can be said of the evolution of the animal brain toward the human, for no physical or biological laws have determined this evolution. According to contemporary science, the latter is left essentially to chance in terms of genetic mutations and natural selection. Such a view confirms Teilhard's vision when he describes this evolution in terms of freedom and personalization, rather than obligation and fusion. Of course, it sometimes happens that his description


INSTITUT
Acc. No. 94217

uses the latter terms. Teilhard's perspective is colored by his religious feeling; for him, religion represents a strong cultural determinism. This is why his description, in the view of today's Man, is seen as somewhat suffocating. The correspondences established by my analytical method preclude determining the mind of society in this way.[17] Though, to do justice to Teilhard, we must recognize that he has insisted on the importance of Man leaving his "prison," which can be understood to mean the relative narrowness of the existing world.

6: THE PHYSIOLOGY OF SOCIETY

What initially strikes us about the respective definitions of the *economic* and *endocrine* systems is the broad scope of their meanings. In its usual definition, an economic system comprises all those activities of a human collectivity which concern the production and the consumption of goods. The word "economy" is made up of two Greek words: "*oikos*," meaning "house," and "*nomos*," meaning "order." "House" here can be understood to be a dwelling in the broadest sense of the term. It is a social place. Meanwhile, the "order" referred to is a human order, that is to say, one instituted and regulated by Man.

The endocrine system, by definition, directly or indirectly encompasses all morphological, physiological and metabolic phenomena in an organism. It is tightly linked to the growth mechanisms of an organism and to the development of most of its organs, among other things. It also plays an important role in the organism's reactions to what lies outside itself, and is in constant interaction with the nervous system, that is to say, the psyche and behavior. The Greek roots of the word "endocrine" signify "internal secretions." The endocrine glands secrete *hormones* (from the Greek "*hormân*," meaning "to excite"), which are transferred throughout the internal environment. According to our conceptual analysis, these hormones play a role analogous to that of *money* in the economy of a large modern society. The hormones have a very specific effect on the functioning of the so-called "receptor" cells, tissues or organs. One must take into account the fact that this effect is not in proportion to the contribution, in either material or energy, represented by the quantity of hormone acting upon the receptor. On the whole, the proteinic character or value of a hormone is the determining factor. That is to say, the asset value of a hormone depends on a sort of convention that is anchored in the genetic code rather than in the physical laws themselves.

Note that, in both of these cases, economics and endocrinology, the mechanisms are extremely diversified and contribute to very precise regulations. Moreover, as mentioned above, we must take into account the fact that the social organism is a kind of "child"[18] and that the existing economic system must then correspond to an endocrine system which shows some immature features.

A Growth Economy in an Immature Organism

First, connecting an economic system with the growing functions of an embryo (or infant) implies consideration of the *oneness* of the organism. That is to say, oneness is an essential character of the "market," as it is understood by today's economists. The whole world, our planet, is the field of action, and it matters little where the orders originate. Moreover, like an embryo (from the Greek word "*bruein*," meaning "to grow"), the global economy is growing remarkably fast. For example, the volume of trading on the world stock exchange is now at an unprecedented level. The growth of the economic system is so constant, in fact, that the word "recession" has come to replace the word "crisis" in economic jargon since the 1950s. Jolts in the progression are no longer seen as breaks, but simply as blips, momentary halts.

Money is the "hormone" of the growing social organism. The hormones produced by the endocrine system excite (or inhibit) certain specific organs. Since the latter's needs are variable, hormonal reserves are produced at different places in the organism. In various cases, they can be mobilized according to demand. Thus the analogy with money becomes obvious.

Sudden Market Fluctuations

Sudden fluctuations in the economy are well known and widely discussed in informed circles. In particular, the currency market or, more generally, the stock exchange, is subject to remarkable "mood swings." These apparent sudden impulses may be conceptually correlated with the changes of mood observed, for example, in a newborn child. This can be seen if we look at the precise relations between the economic and endocrine systems.

It should be noted here that the economic system is naturally embodied in particular individuals, who do business with each other in a relatively autonomous manner. I am speaking, of course, about what happens in a modern society such as our present global society, which has a market economy. In the market place, rumors travel fast, as does verifiable information. Thus sudden crazes can become important. Economists appreciate that psychological factors can be as significant as facts. The stock exchange, in particular, is inclined to exaggerate the significance of emergencies. This notwithstanding, researchers in economics have established that investors remain relatively rational and act in ways designed to maximize their profit margin. The apparently irrational character of market behavior arises from the fact that

a number of autonomous agents do not make concerted decisions and no global entity compels such them to be consistent with each other.

From the point of view of physiology, an analogous situation exists at the level of individual organisms. The emotions felt by an individual are "irrational" in that they often exaggerate the upsetting or dangerous side of an observed fact. They appear as excessive reactions to a particular situation. In this case, the relatively autonomous character of the cells of the nervous and endocrine systems corresponds to the relatively autonomous character of the agents within a market economy. Moreover, the fact that these cells, individually considered, behave in a normal and rational way, that is to say, in accordance with influences from their environment, means that the capacity for emotion is a character of an organism considered globally, rather than one of its elements considered separately. This situation corresponds, then, to that of the currency market, whose sudden fluctuations are collective rather than individual.

The Nervous and Endocrine Systems

The rather complex relations between the nervous and the endocrine systems correspond conceptually to the relation, in a society, between the system of communication and the economic system. The expression, "system of communications," must be considered here in a broad sense. It comprises, among other things, telecommunications, the media and the publication of books and magazines. This system, therefore, closely corresponds to educational and research institutions. This analogy with the nervous system of an organism may be rather obvious. We are concerned here with what I shall call an "anti-analogy." This, by definition, consists in connecting *differences*. In this case, the differences between the nervous and endocrine systems, that is to say, between what distinguishes them from each other and enables us to understand the autonomous nature of each, can be correlated with the homologic differences between the systems of communication and economics in a global society.

When physiologists compare neural and hormonal effects,they generally observe that the latter are more long-lasting but less rapid than the former. This is because hormones are not directly or expressly transmitted by unique passageways to their receptors. Rather, they typically enter the blood stream in a diffuse manner. In this respect, they resemble goods distributed by various means of transport throughout a society, rather than communications transmitted along fixed

channels to receptors. However, telephone transmissions and postal dispatches are analogous to neural transmissions. Electronic media and newspapers appear, on the other hand, to be linked to both systems. They reproduce an ambiguity which corresponds to that of certain substances (for example acetylcholine) that are at one and the same time both hormones and chemical intermediaries of neural activity. Researchers in physiology, in this case endocrinologists and neurobiologists, have established that the nervous and endocrine systems are interrelated. Nervous, endocrine or mixed-nature links exist between certain glands and the nervous system.

The neuro-endocrine correlation appears as one of the most promising concepts in the contemporary research of endocrinologists. This situation corresponds, on a conceptual level, to that of economists who now see wide-scale information exchanges as heralding profound changes in their economic ideas.

Naturally, economists know little about the endocrine system, just as endocrinologists know little about the economy. This goes a long way toward explaining why this kind of precise and systematic relation has never been made. One must acknowledge, however, that this kind of relation should be conceived of as existing between the *conceptions* as such, and not between the things themselves. This difference means that we must consider our ways of conceiving reality, as well as our questions and answers, our main hypotheses and the genesis of the theories we take to be real. What we consider "real" in the respective domains (endocrinology and economics) do not correspond at all; they do not "resemble" each other. Endocrinologists and economists see no real resemblance between hormones and money. And they are right. In fact, it is the respective moods of the objective constitutions that resemble each other, rather than their constituted objects.

The regulating mechanism of supply and demand has an equivalent in endocrinology. Like the economic system, the endocrine system needs very precise regulation. In order to do this, feedback mechanisms are used. If X denotes the quantity of a hormone produced in an endocrine gland, and Y denotes the quantity of a compound whose concentration depends on the quantity of this circulating hormone, then one can see that quantity Y has a regulating effect on quantity X. Thus X and Y represent, respectively, supply and demand within the organism. However, in both economics and endocrinology, the regulating mechanisms are much more complex than feedback based on supply and demand.

In a complex society, the various levels of government play a regulating and guiding role that is important, although nonexclusive. There is no absolute center of power. It is the same in the domain of physiology. The hypothalamus is that part of the brain which centralizes the information required in order to regulate the endocrine system. This is done by means of the hypophysis (the pituitary gland), which is another part of the brain. It was once believed that the hypophysis functioned as an "orchestra conductor" in a sort of symphony of the glands. However, this has since been shown to be merely a link that does not directly receive information from the other parts of the organism. Neurobiologists now think direct control of an endocrine gland by a part of the brain to be rare.

Both of these systems, nervous and endocrine, have an integrating role in the organism. They even seem redundant in certain respects. This overlap appears as an organic intricacy, the product of an evolutionary trend that can be seen in most vertebrates. Even antagonistic regulating systems seem to have an organic control function, acting in opposite ways on the same receptor. This situation naturally recalls the tendency of complex societies to have regulating systems with an increasing number of levels between the decision-making level and the base. Global organization has adopted this type of system in order to establish maximum control and efficiency without, however, exerting control over every point. As hormonal secretions must be subject to demands and brakes in accordance with the needs of the organism, so economic activities must be regulated by a relatively independent system.

The Immune and Judicial Systems

The analogy between the sick cells of an organism and deviant members of a society is not new. One can obviously compare, for example, cancer cells to outlaws. This is often nothing but a shallow analogy made in order to argue a point. It seems to easily support the idea that delinquency is a sickness that must be treated as such, or that criminals must be eliminated from a society just as sick cells must be eliminated from an organism. My method of conceptual analysis does not, however, involve these conclusions. Rather it allows for a better understanding of the ways in which a judicial system functions by comparing it with an immune system, and vice versa. This comparison involves showing certain profound conceptual connections between biological determinisms (especially genetic)

and cultural determining factors (for example traditions and morals). In this connection, the lack of known determinisms is as important as the determinisms themselves.

Correspondences Among Definitions

Immunology is, by definition, the science that studies the protective systems of living organisms. It is tightly linked to other disciplines. In particular, bacteriology plays a strong role in searching for and identifying pathogenic microbes.

The administration of justice is itself a function of a sovereign state, and is essential in maintaining law and order. It is one of the principal subjects in the study of law. There are also a number of related disciplines. In particular, criminology is the science that studies the etiology of crime. One of its main purposes is to understand the various forms of delinquency and to establish their underlying causes.

Above and beyond the obvious analogy that can be made between two different domains, I am concerned with showing how a conceptual connection can be made between the main kinds of determinism, namely, the physical, biological, anthropological and cultural. An anti-analogy is more far-reaching than a simple analogy because it connects the differences in determinisms rather than the determinisms themselves. For example, the existence of an immune system in a particular organism is determined by the genotype of this organism. However, the precise character of an immune system at any given moment in the life of an organism depends on the events that have intervened in this particular life and is, therefore, not entirely determined by the genotype. This indeterminant feature of the immune system is fundamental for an understanding of how the system functions. Now this form of *biological* indeterminancy corresponds to another form of indeterminancy — an *anthropological* one — in the judicial system. The laws of large-scale modern society change to reflect certain events unanticipated by the traditional forms of culture in this society. The judicial system expresses or reflects these changes. In order to do this, it manages to partially or completely escape cultural determining factors, which are constantly being questioned in a changing society.

The Evolving Judicial System as a Modified Immune System

Today's global society is changing fast. This is also true of the various systems that make it function. Among them, the judicial system

is significantly marked as well by deep changes. Laws, as they are understood today, are embodied in history. They express a social vision. Laws tend to multiply, because a complex society needs to adjust to particular situations. Thus laws correspond conceptually to antibodies, which are specific to the antigens that the organism must confront. Anti-bodies, like laws, change and adapt themselves to the circumstances or to the various experiences of specific organisms.

According to my approach, the fact that society is changing fast means that the immune system should be considered an organism in the making, like an embryo or a young child. This system has to become more and more integrated, just like, in other respects, the nervous and endocrine systems. Something similar has happened in the history of human societies, where the administration of law has tended to become more and more complex and integrated. Originating among small groups who applied it directly to right perceived wrongs, it has, in our global society, become the province of international organizations that have been trying to act in terms of universal principles.

The "Hidden Coefficient"

All criminologists know the importance of the "hidden coefficient," that is to say the ratio between the *real* and the *apparent* crime rate. The real crime rate is defined as the total number of infractions, while the apparent crime rate refers to the total number of *known* infractions.[19] While the hidden coefficient is undoubtedly high, its exact value is unknown. Although the available data could be taken as evidence of a rise in the apparent crime rate, the real crime rate generally remains unknown. Legal services tend to be used to the full, without much regard for fluctuations in the real or apparent rate.

Pathologists are also familiar with a sort of "hidden coefficient." An individual may be a germ carrier without being apparently sick. Moreover, normally commensal bacteria may become pathogenic. Certain bacteria, such as the golden staphylococcus, have been known to become virulent after a prolonged period of latency. Such "unapparent illnesses" are extremely frequent. The ratio between the rate of latent illness and the rate of apparent illness is a very important concept in immunology, even though it is practically impossible to estimate it precisely. In a complex organism like the human body, a great number of factors determine whether a germ can suddenly cause a severe infection.

Correspondences Among Paradoxes

Criminologists sometimes acknowledge a paradox that is of some importance to them in their understanding of penal institutions. They have observed that the enforcement of penal laws can actually provoke crime. As a matter of fact, penal laws could be considered equivalent to rules of conduct, outside of which someone's behavior is considered to be deviant. In being judged and condemned, an offender is banished from society. And this only confirms his deviancy; indeed, it even exacerbates it. Likewise, it has been observed that imprisonment contaminates malefactors. And this calls the very idea of prison into question; for how can one help a delinquent to become responsible by keeping him out of society and by depersonalizing him? However, since the total abolishment of prisons appears to be a utopian idea, one should try as much as possible to promote prisoners' contact with the outside world through visits, newspapers, electronic media, and so on.

Immunology provides us with a related paradox, one that essentially deals with the largely unexplained "immunogenic properties" of pathogenic agents. Certain viruses and bacteria have the capacity to resist the immune system and, moreover, can multiply within cells that are equipped to kill them. For example, the staphylococcus is now resistant to penicillin and many other antibiotics. This phenomenon may be partially explained by the selection of natural mutants that adapt to the antibiotics. Thus the use of antibiotics paradoxically promotes the pathogenic agents they are supposed to kill, because it allows the latter to develop a greater resistance. The only effective remedy happens, in fact, to be responsible for aggravating the problem.

Thus, in both criminology and immunology, one observes two paradoxes that correspond at a conceptual level. In both cases, the only known answers to certain serious problems consist in using a means that increases the capacity for the roots of these problems to persist. This parallelism is no accident. In each case, it is closely related to a form of indeterminancy: on the one hand, that of human individuals with respect to cultural determinants; on the other hand, that of biological cells with respect to determining genetic features. In other words, neither of these cases presents a completely deterministic program that could be considered a panacea. Moreover, this correspondence of paradoxes in criminology and immunology underlines their relations with their respective "hidden coefficients," which also exhibit a conceptual connection. In the two cases examined above, the hidden coefficients and the paradoxes, a real but concealed part plays

a key role and is, in an implicit manner, determining for an apparent part that can be acted upon directly only by experts in criminology or immunology.

Problems of Growth

Modern society is subject to specific problems, such as those that come with massive urbanization. Thus a number of cities are witnessing a rise in crimes such as burglary, armed robbery, fraud, possession of stolen goods and vandalism. Any complex organization enjoying sustained growth is generally subject to the often acute problems that come with growth. It is the same for rapidly growing organisms, such as newborn children, who are particularly subject to severe illnesses. According to pathologists, this situation can be linked to the specific physiology of young human beings. Let us examine certain known remedies for infectious diseases, which are the natural targets of the immune system.

Within the framework of correspondences I have established between the immune and judicial systems, one can see how known therapeutic means such as serums and vaccines can be correlated with certain methods used by modern society to deal with the problems of delinquency. Serums fight pathogenic agents quickly but only temporarily. They consist of antibodies and antitoxins introduced into the infected organism, which naturally eliminates them. Vaccines are more risky, but more efficient in the long run. They are produced by introducing weakened microbic cultures into the organism. In the case of the so-called active vaccines, microbes may even multiply. The normal result of this treatment is the immunization of the individual against the microbe in question.

In a conceptual view of physical, biological, and cultural determinisms, the treatments of serotherapy and vaccinotherapy correspond to the main treatments provided for in the penal code of a complex society: imprisonment, re-education, and social rehabilitation. Imprisonment, appears to be the rapid treatment but its long-term effects are uncertain, to say the least. One renders a delinquent harmless by depriving him of his freedom. By itself, this treatment is at best an expedient. In this sense, it corresponds to serotherapy, which facilitates the rapid treatment of disease but cannot guarantee the future condition of the patient. At the societal level, the conceptual counterpart to vaccination resides in the use of re-education techniques and includes general education likely to change certain culturally determinant

features. These factors, which criminologists believe to be essential in influencing crime, include poor family education, environmental factors and a lack of the kind of training likely to help social rehabilitation. These factors have an effect upon individuals and, up to a point, determine delinquent behavior. Of course, they are not absolute determinisms, since a human being can never be entirely determined by such factors and, in any case, it is generally possible to modify their effects. This situation corresponds to that of vaccines, where an agent originating outside the organism changes the effects of a biological determinism within it. A biological determinism alone is never sufficient to determine the immune system of a particular organism.

Correspondences with Progressive Ideas

Contemporary researchers are often wary of analogies between the biological and human domains, since these can sometimes lead to the conclusion that human beings are determined by so-called "natural" factors. And this in turn promotes fatalistic or conservative attitudes as well as resistance to change. My approach is very different. The establishment of correspondences between biological, anthropological, sociological or other conceptions bears on indeterminations as well as determinations. This is one of the meanings of the term, "anti-analogy"; one establishes correspondences across profound differences between various kinds of determinisms. In this sense, there are no "resemblances" between the biological and anthropological domains from the point of view of the determinations themselves. (This statement runs counter to accepted beliefs, which are based on overly simple analogies.) Rather, one kind of indetermination in the realm of biological ideas corresponds to another kind to be found in anthropological ideas. Thus, for example, the effect of vaccination can be seen as a phenomenon that expresses a divergence with respect to a biological (genetic) determinism in an organism. The latter cannot change the character of its immune system solely through the deterministic apparatus of its genome. Vaccination can, however, effect this kind of modification. Likewise, in the human domain, punishment or imprisonment consistent with ancient cultural determinisms cannot generally change attitudes toward violence, that is to say, attacks against someone's integrity or liberty. A general re-education can, however, create such a modification. In this case, it is generally admitted that this general education cannot be defined solely with reference to

cultural determinisms (traditions, morals, etc.) and in the absence of criticism. The latter, by definition, escapes these determinisms.

I would like to clarify the difference of my approach by means of another example. Nineteenth-century comparisons of delinquents to microbes or parasite were often meant to illustrate that delinquents were dangerous to society (the organism being attacked) and greatly different from "honest citizens." This way of seeing delinquents was in fact a reassuring habit and a kind of justification for those who would eliminate them. Biologists themselves helped to invalidate this view when they discovered that commensal bacteria normally exist in a human organism without causing disorder. The pathogenic character of bacteria is generally not a specific feature of the bacteria itself, but is attributable rather to a disruption in the balance of the entire host organism. Illness results from the interaction of many factors rather than from one particular factor. According to criminologists, the same holds for social pathologies. The problems in this case are attributable to a complex interaction, and it is not possible to identify one particular determinism as the sole cause. In both cases, biology and the social sciences, general answers do not exist precisely because no particular determinism can be found to neutralize a non-existent determinism that is purportedly the cause of the problem. This explains the great sense of disappointment we find in the histories of medical and judicial ideas, a disappointment that followed on immense hopes which were simply the fruit of a delusion. In the 19th century, it was believed that the development of new penitentiary techniques and public education in certain countries would lead to the near disappearance of delinquency. Likewise, the discoveries of vaccines and antibiotics gave rise to exaggerated hopes of eradicating all disease. The actual progress in both domains has, however, never created panaceas; rather, it has merely contributed to a greater awareness of the work that still remains to be done.

7: THE CONSCIOUSNESS OF SOCIETY

According to Minsky's analogy, the human brain may be seen as a large-scale society whose individuals are neurons. I have proposed the opposite, considering the present global human society as a complex organization in the making, analogous to the brain of a young child on the point of discovering a whole world around him. I repeat that this is no ordinary analogy since it differs in certain essential respects from that normally goes by that name. I am referring particularly to its systematic character (which Minsky had begun to elaborate) and to the parallelism of deep relationships of indeterminancy across the main levels of scientific description: physical-chemical, biological and anthropological.

In this chapter, I will describe in more detail how the developing super-brain of the infant or very young child functions. And I will utilize this description in order to glean certain information on future developments. In this way, several characteristics of today's human society may appear in a new light, and we may begin to catch a glimpse of what the future holds in store. We are an integral part of this "child." Our consciousness of the situation indirectly represents his, and our actions represent more or less well-ordered processes within this complex organism in the process of development.

Preliminary Remarks upon the Child's Consciousness

In what way can we understand this "Child's consciousness"? How does it manifest itself to us? To answer these questions, I will proceed by way of anti-analogies, that is, establishing systematic analogies between different modes of determination. To do so, I will use expressions such as *metasubject* and *metaconsciousness* to designate this "child" and his "consciousness." In order to discern something of this metaconsciousness, our situation as an integral part of the child will be seen as analogous to that of particular neurons with respect to the consciousness of the embodying individual.

Let us consider a human individual. According to today's science, this individual's consciousness is embodied in his brain and, more particularly, is closely linked to the way in which the neurons in this brain act or react. No neuron can be said to be "conscious" of the thought of

its embodying individual, since it is obvious that one simple cell cannot be conscious, at least not in the same sense as that of a human being (and even most animals). The neuron is a centre of nervous impulses, but it is not "conscious" in any normal sense of this term. However, several neurons become active in some way when the embodying individual begins to think. And this neuronal activity is at the same time the cause, effect and the very substance of this thought. According to my approach, the same is true of human individuals with respect to the metaconsciousness of their embodying entity, designated above as the "child." Their activity constitutes the substance itself, as it were, of the "child's" metathought. However, we cannot say that human individuals, considered separately from each other, have any metathought. More precisely, they have no capacity for metathinking.

This child is, for the moment, only just beginning to think. He is awakening little by little, becoming gradually conscious of external reality. This is a metareality that we still are not ourselves aware of; we become aware of it only when the child itself begins to be conscious of it. Contemporary Man, with all the scientific resources available to him, knows as much about this outer world as a young child who has only a vague consciousness of his surroundings.[20]

The psychologists of learning are unanimous on this point: a newborn child has no consciousness of himself.[21] This is in keeping with Jean Piaget's observations, which show that an infant feels sensations and experiences without being able to determine whether they come from the outside world or not. At this stage, the child does not distinguish between the outside world and himself. Piaget uses the word "egocentrism" to designate this initial mental condition in the development of a human being.

According to this view, we are all components of an "egocentric" subject. In such a situation, what can we ever really know about reality? The latter, as an *exoreality* (that is, a truly external reality), does not coincide at all with what existing sciences such as astronomy and chemistry expound. This is because these sciences only represent what could be known by cells-in-a-metasubject, in other words, by cells inside the brain of a young child who is still largely unconscious of reality. Today's science represents the embryonic state of the young child's consciousness. No doubt, it will have to undergo profound mutations before it can constitute a genuine knowledge of exoreality.

Of course children, including newborns, quickly become conscious of features of the world around them even though they cannot clearly

distinguish between their bodies and what lies outside them. They are, for example, conscious of the existence of their mother. For a certain time, the mother is probably the only discernible external entity. Thus she represents the tutelary divinity of a society whose consciousness is in an embryonic state. During a certain period of time, the only means of action available to a newborn are behaviors such as crying, smiling and turning the head to signify lack of interest — in addition, of course, to their sleeping and waking states. Through these behaviors, the child quickly learns how to have his needs answered. He is in a state of very great dependency. Later, he will become more autonomous, especially when he learns to walk and talk. Meanwhile, however, he has no inkling of this autonomy or the shape it is likely to take.

My approach views a young child as an image of modern society. He is fragile and exposed to all sorts of possible dangers. He has very little knowledge about what he can do, or what his role may be in this external world. However, the progressive consciousness that he develops with respect to what exists around him corresponds to the kind of collective consciousness represented by modern science in general. The latter can, at a conceptual level, be closely coordinated with means of action derived from modern technology. Today's science thus represents the child's awakening consciousness, while technology represents the new means of action which he discovers progressively. Although science and technology are extraordinary for this child who still has the whole world to discover, they are grossly inadequate with respect to what still needs to be learned if one is to be truly in contact with external reality.

Since psychologists have observed that the self-identification of a young child comes about only slowly and tentatively, we may suppose that it will be some time before today's science can acknowledge the existence of an exoreality profoundly different from what it now considers to be real.

Presently Recognizable Forms of the Child's Consciousness

The word "consciousness" can be understood in several ways. For example, it can mean an intuitive sense of the content of one's own thought, or an immediate knowledge of something, the word "knowledge" being taken here in a broad sense. My approach, however, implies a correspondence between a very special kind of mind — the so-called mind of human society — and the mind of an individual understood

(as in Minsky's work) as the product of the functioning of a brain. Therefore, it seems appropriate at this point to take the objectivist point of view of a neurobiologist. J. Allan Hobson (1988, p. 133), who had a great deal of interest in scientifically observable phenomena of consciousness, defined consciousness as follows:

> "Consciousness is the continuous, subjective awareness of the activity of billions of cells firing at many times a second, communicating instantaneously with tens of thousands of their neighbors. And the organization of this symphony of activity is such that it is sometimes externally oriented (during waking), sometimes oblivious to the outside world (during sleep), and sometimes so remarkably aware of itself (during dreams) that it recreates the external world in its own image."

This definition could, with certain modifications, be applied to metaconsciousness. "Cells," for example, could be replaced by "human individuals." Moreover, the reaction times could be adjusted to those of human beings engaged in communication, taking into account the number of correspondents that an individual can have at any one time and the presently foreseeable possibilities of communications technology. Above all, one must admit that a metasubject exists and has, at this level of complexity, its own specific form of subjectivity and capacity for understanding. What kind of perception could such a metasubject have? How could we even imagine it?

The "continual apprehension" that Hobson speaks of in his definition of consciousness has a parallel in global society: what is reported, at any one time, by the whole range of media inclusive of newspapers, magazines, books, etc., as well as other information such as research reports, treatises, and so on, that reaches us by way of various print and electronic media. To be conscious, in this extended sense, means to observe, register and memorize as members of a global collectivity and as particular individuals (even as individual neurons). Works of fiction (novels, novelettes, films, etc.) represent the *metadreams* of global society, while reports of current events, especially in science or politics, represent an *awakened metaconsciousness* of it.

The Dreams of the Child

A metadream, as defined above, corresponds to what is usually called a "dream" for an individual; and like individual dreams, the metadream

has a gratuitous, creative and often disconcerting character. Although nobody knows what specific function is served by an individual's dreams, dreaming is apparently necessary since all individuals engage in this activity, especially when they are still very young. The same holds for literary expression and for works of fiction in general, for it seems that they too meet profound needs in human societies, all of which practice them in the forms of myths, songs, novels, etc. These forms have, to date, no generally recognized social function. Thus literature appears to have a profound connection with dreams, not in the sense that it "resembles" the latter or is, as one might say, "like a dream," but in the sense that it reproduces, at another level of organization, all the essential features of dreams presently known to neurobiology: gratuitousness, suddenness, diversity, a disconcerting quality, etc.

The Awakened Consciousness of the Child

With respect to awakened metaconsciousness, the current events broadcast by the various media represent the equivalent of an immediate form of consciousness. This can be fleeting or long-lasting, depending on the nature of the broadcast. News items, for example, tend to be quickly forgotten unless they are subsequently connected with some important event. They are analogous to the little commonplaces of daily life, which individuals tend to forget in a matter of days unless, of course, something unusual results from them.

On the other hand, consciousness becomes more durable when a fact is memorized. This presupposes a sort of study of the fact's characteristics and the recording of a number of more or less integrated details. Neuro-biologists and researchers in artificial intelligence have established a high level of complexity in an operation as simple as grasping an object. This involves a joint effort on the part of millions of neurons. To begin, a great number of these register sensory data, while others integrate this data into perceptions. Still others react upon these perceptions in an attempt to coordinate an adequate response at the level of motor activity. Likewise, each of the subject's actions is analysed and integrated within a sensorimotor framework of operations until the desired result is achieved.

At the level of metaconsciousness, there are parallels to lasting consciousness and memory in scientific activity. Data is gathered by a host of researchers, who then register, revise and publish it in a methodical fashion. The relevant hypotheses are then refuted or corroborated and,

if necessary, new hypotheses are advanced to deal with unexplained points. A number of theoreticians then try to integrate the results into an explanatory system.

The Child's Mechanisms of Perception

The conceptual correspondence between cerebral mechanisms of perception and the collective mechanisms of scientific discovery can be seen in striking detail. The mechanisms of vision, such as they are now understood by neurobiologists, display a number of parallels with what we currently know about the way in which science works.

Neurobiologists have observed that certain neurons in the retina react to a maximum extent when there is a *concordance* between, on one hand, the form and size of a visual stimulus and, on the other hand, the form and size of a corresponding receiving field in the retina. This concordance, which has a specifically physiological meaning, is equivalent, in the domain of scientific research (or, more properly, in epistemology) to the *corroboration* of a theory by means of experimentation. The theory corresponds to the field of the receptor on the retina, and experimentation to the visual stimulus. In science, one speaks of corroboration when an already existing theory that has been acknowledged by the scientific community is capable of being refuted or corroborated by experimentation.

It is possible to draw more far-reaching parallels between epistemological and physiological ideas. For example, the concept of the scientific *paradigm* can be seen to correspond to that of *codes* or *precodes* critical to the stimulus. Neurobiologists who have studied vision have observed that certain mechanisms dubbed "codes" or "precodes" are linked to receptor fields and, in this connection, play an essential role in the detection of external objects. For example, they have given the name of "fly detector" to a mechanism which, in the general mechanism of vision, facilitates the recognition of a certain form-in-movement.[22] From the standpoint of epistemology, this corresponds closely to a paradigm, that is, to a form of knowledge or a structure of thinking that is used as an organizing basis for the integration of observed facts.[23]

Scientific research and mechanisms of perception in the brain also exhibit other parallels associated with the proliferation and selection of information. We know, for example, that eyes are equipped with several hundred million detection devices (cones and rods). Our initial visual data are reduced to about one million messages in optical fibres that conduct the relevant information to the areas of the cerebral

cortex associated with vision. Neurobiologists have tried to understand how the eye's nervous system can compress the initial information to such an extent. Analogous problems appear in epistemology. For example, how can one select the most relevant information from among the huge bulk of articles published throughout the world? What criteria can be used? Both physiology and epistemology provide answers to these questions; yet the answers are still vague in both cases (which makes for yet another parallel). It is likely that progress in one of these domains will shed light on the other.

One of the fundamental problems for contemporary neurobiology concerns the exact process by which axons are directed towards their target zone across the brain. This corresponds to an equally fundamental problem in epistemology, namely, the problem of the formation of scientific theories. In the first case, of course, one looks for explanations in terms of physical-chemical or genetic determinisms and tries to understand the precise role played by other processes determined neither by genetic factors nor by the chemical processes of nervous systems. Likewise, in epistemology one looks for institutional, social-cultural or psychological determinants and tries, as well, to understand the part played by the vicissitudes of history. The process of death in brain cells, which happens after connections have begun to be established between receptors and target zones in the brain, corresponds to the process by which hypotheses and theories become obsolete after they have been refuted by the scientific method. Neurobiologists have observed changes in the way that growing brains are "wired"; these correspond to significant paradigm shifts. Such changes are particularly important when the brain of an immature subject (embryo or foetus) begins transforming into an adult brain. Some axons are eliminated, leaving the entire structure profoundly changed. Prior to this transformation, at a certain early stage of the brain's development, a part of the cortex normally reserved for sensory data appears to be connected to neural pathways that conduct motor impulses.[24] A change as significant as this corresponds to a paradigm shift as important as the epistemological revolution brought about by Galileo and Newton. The transition from an Aristotelian type of science based on common sense to our so-called modern science based on the experimental method and complex mathematical models constitutes a restructuring of the first order. In this case, release from the constraints of Aristotelian common sense, especially in physics, has meant a relative liberation from certain cultural determinants. One can anticipate other equally important changes analogous to the changes in "wiring" in

the metabrain of the child-society. This means that the conception of reality held by contemporary scientists and philosophers is on the verge of profound change. This issue will be developed in a later chapter, which shows *the ideometric correspondences between the stages* in the child's mental development as described by Piaget and the main stages of recent physical science.

Publishing as a Mechanism of Memory: The Hippocampus of the Child

Neurobiologists have credited the cerebral structure known as the "hippocampus" with an important role in memory function, specifically via the *selection* of data. In this respect, some psychologists have spoken of the function of indexing stored information.[25]

In a complex society, this kind of function is served by *publishers*, who must select texts from the many submitted to them. Such selection is extremely important, since it determines what will ultimately become the memory of a society. No one place has a monopoly over our textual reserves; books can be found in private homes as well as in public, school and university libraries. Even specialized works are widely disseminated, in places where these specialties are taught as well as in private residences. This lack of a fixed place exhibited by social memory is also a character of cerebral memory. No part of the brain has a monopoly over an individual's memory. This includes short- and long-term memory as well as the memory of names, places, and so on, each of which can be regarded as a "specialty."

Publishers play an important role in the memory of a society such as ours, that is, one in the process of transformation. A similar function may be attributed to the hippocampus of a young child. Since today's society exhibits parallels with the brain of a young child, it is understandable that such important functions as social-mnemonic selection are changing quickly. The function of the publisher is relatively new in history, with mass publications appearing only in the 20th century. Since that time, publishing has continued to grow throughout the world, with more titles and larger editions each year. The whole structure is becoming more organized, consolidating its resources and distributing the memory it produces to a greater and greater extent.

The Discovery of Proximate Reality

The newborn child's first experiences bring him into contact with a completely unknown world, one that begins with the proximate reality represented by his mother, father or other individuals, and by his crib,

bedroom, and toys. The discovery of more remote features of reality comes later, after the child has grown. The newborn's experience points us toward one of the most astonishing consequences of my approach, which brings us closer to a new kind of reality never before described (and only barely hinted at) by existing science, a reality infinitely richer and more diverse than all that humankind has been able to discover up until the present time.

A growing brain develops in accordance with one of its main functions, which is adaptation to the *external* environment. Emphasis of the word *external* is simply a reminder that the young child knows almost nothing of this external environment and that what appears "external" to his neurons is, in fact, only the internal environment of his own organism. The word "exoreality" will be used to designate a world that is truly outside the subject.

According to neurobiologists, the pattern of a brain cell's response is not in itself sufficient to determine whether a given datum originates in the internal or external environment.[26] In other words, at the level of the neuron or its activity, there is nothing to distinguish whether an impulse received, emitted or transformed by it results from an external cause or comes from the brain itself. A single neuron cannot distinguish between a detail of external reality and a detail of an imagined or dreamed world; rather, a complex arrangement of neurons is needed in order to make this distinction. "Externality," or the embodying reality, can be recognized only in a collective manner. Thus it has a collective character. Extrapolating to human society, one can say that reality as such has the characteristics of objectivity or universality. An individual by himself has only subjective opinions, and it is only through interaction with others that the possibility arises of acknowledging something more objective or real than a mental impression or opinion.

The objectivity we know from contemporary science, which undoubtedly has a relationship with exoreality, is as rudimentary as a young child's perceptions of the real world.[27] For the time being, we know as little about our capacity to discover exoreality as we do about the ways in which a young child apprehends space and gradually comes to recognize the objects within it. This is one of the main problems currently facing researchers in the psychology of learning or in artificial intelligence.[28]

However, it is already possible to ascertain something about the way in which exoreality has begun to be foreshadowed in existing ideas. It can be essentially noted that a newborn child recognizes human

beings first, amid everything in his surroundings. Inanimate objects are ignored at this stage. The human beings recognized are the child's first caregivers and usually include the mother. As a matter of fact, a newborn child recognizes the presence of people in a practically instinctive way, that is to say, consistent with a standard biological determinism. However, one must also admit that the mind of the newborn does not acknowledge these people as having separate existences, and even takes their presence to be an extension of its own body. And with regard to the environment, there is at this stage no instinct that would allow the child to recognize any surrounding object.

This situation corresponds to the simple fact that the human societies described by ancient history or contemporary anthropology recognize a kind of distorted external reality that comprises a divine being who is believed to watch over them. Therefore, the belief in a divinity represents a kind of "social instinct," or more precisely, a kind of cultural determinant that renders the social mind capable of apprehending the presence of a personal external being. However, as in the case of a newborn child, this presence is at first only barely distinguishable from society itself. The latter exhibits the characteristic that Piaget called "egocentrism." It would be preferable to replace this term by "anthropomorphism" since it is applied to a society/child and not to a child in the strict sense. Thus the "God-Creator" appears as the "infant's mother," that is to say, as a sort of helpful being whose presence can be felt in a confused way by human society as a kind of "Providence." Like the mother of an infant, who is able to do everything for him and whose absence he can eventually feel, humankind endows divinity with the characteristics of "omnipotence" and "omniscience," in addition to a distinctive "personality" that harbors inscrutable and sometimes even cruel designs.

The Child's Intimations of a More Remote Reality

Contemporary science tends more and more toward new perceptions of our world, and several indications of the existence of an exoreality can be found within certain contemporary ideas. Loosely, these include Teilhard's synthesis, the concept of "parallel universes" or the "anthropic principle" advanced by certain physicists, and the "Gaia hypothesis" sustained by certain biologists.

Teilhard de Chardin's synthesis is still within the realm of religious thought and represents an attempt to reconcile science and religion. In this instance, one can see that the young child is beginning to

discern that along with his mother come certain objects (a spoon, toy, etc.) that he learns to recognize. This means that the child associates what he perceives and handles (domains with parallels in science and technology) with the helpful hand whose presence he had instinctively felt. This form of recognition is still instinctive, that is, subject to certain determining features (biological in the case of the baby, cultural in the case of Teilhard).

The parallel universes of the physicist Hugh Everett (1957), for example, proceed from a conception proven to be mathematically equivalent to the orthodox interpretation of quantum theory. These "multiple worlds" represent co-existing universes, only one of which appears to be real at any given time. The other universes, in a sense, constitute an external reality, since they are also real but not within the consciousness of a particular observer. This conception of external reality is purely formal and essentially does not imply any new discoveries with respect to the existing scientific laws, for example, since these determine all possibilities beforehand. This conception is, then, analogous to the psychological situation of a newborn child who has discovered the existence of space outside his apartment. This child would most likely imagine that the whole external universe is entirely composed of an infinity of similar apartments, each containing a similar mother, crib, comforter, etc. Thus the child imagines a pattern of "external" reality that is not really different from the one he already knows.

As for the anthropic principle, this is equivalent, in terms of the young child's knowledge, to the recognition of the tender smile of his mother, which makes him so happy that he returns it to her. In the view of certain physicists,[29] this principle is useful in explaining the particular numerical values of fundamental constants in physics.[30] They argue that these values are necessary for the existence of life and conscious observers. According to this view, the universe exists only in order to allow the existence of Man, who resumes his pre-Copernican position at the centre of the universe. Indeed, certain physicists who uphold the anthropic principle deliberately take an anti-Copernician position. This is a sunny view of reality, but no doubt a little egocentric. The newborn child tends to believe that everything including his mother and all his surroundings exists only in order to address his immediate and elementary needs. Of course, this view is not entirely erroneous. Indeed, it is true to the extent that the subject is still at the stage of total dependence, which is precisely the situation of the present

society/child. Science is the consciousness of this society and cannot but reflect its egocentric character.

Gaia, or J. E. Lovelock's (1979) conception of the terrestrial biosphere, corresponds to the newborn's dawning consciousness of itself as a distinct entity. According to Lovelock, the biosphere must be seen as a self-regulating entity with the capacity to "preserve the health" of the Earth. This self-regulation is achieved by means of certain mechanisms which are still poorly understood by scientists. They concern, for example, the concentration of oxygen in the atmosphere, the degree of acidity in the environment and the concentration of salt in the oceans. One observes that such regulation works exactly as it should in order to maintain life.[5] This observation is commensurate with the anthropic principle which implies a "sunny" view of reality as something that is benevolent to Man. And thanks to researchers such as Lovelock, the planetary organism becomes conscious of its own identity, although this identity is essentially of a biological type. Anthropological reality is not involved, unless it is completely subsumed under the biological substratum. This view corresponds to that of the young child who is acquiring the rudiments of self-consciousness but is not yet able to see that he has a character or nature different from that of the inanimate objects in his crib.

The Approaching Discovery of a More Remote Reality

The newborn child gradually comes to discover the world by opening his eyes, grasping various objects close to him and noticing that there are many other things to look at or touch. Later on, he will learn how to talk and engage in verbal exchanges with his mother or other close relatives, and will begin to understand more and more, thanks to the answers that he is able to obtain from others.

Everything indicates that contemporary humanity has not learned to "talk" but that it is, however, on the point of doing so. Through his senses and language, the child discovers a reality he never suspected possible. The "senses" in this example correspond to experimental science, which has already enabled the child/society to become partially conscious of a reality made up of proximate objects or beings. By extending this capacity for enhanced perception, the science of the future will facilitate much greater discoveries. The little that is known now is almost nothing compared with what will be known later. The child, in learning to interact by means of language, will become capable of a

completely new level of understanding. Then he will see that reality is so vast that he will comprehend how little he really knew.

The above anti-analogy is an attempt to understand present and future humanity in terms of our present understanding of child development. If this anti-analogy is right, then we can expect to make fantastic discoveries.

Global human society should exhibit some parallels with those apparently useless or poorly developed organs one finds in immature organisms. For example, the lungs and cerebral cortex of a fetus are of no use to it prior to birth. Can these be said to correspond to certain apparently useless activities such as pure science? For the latter can be seen as a cultural construct that is initially quite gratuitous but subsequently very useful.[32] The fruits of pure research are ultimately manifold, as we can see from the case of modern technology. These gratuitous but ultimately very profitable activities correspond closely to the apparently useless organs of the embryo or fetus. The brain of the newborn is still in large measure an organ whose functions are invisible. Consequently, one may suppose that some apparently useless and even bothersome characteristics of modern society will be transformed and revealed to be prodigiously profitable.

Possible examples of social structures with comparable latent functions might include institutions devoted to general education and pure scientific research. One could also mention the evolution of democratic institutions, a development which has involved the apparently useless and costly emancipation of various alienated groups in society. Is it not true that pure scientific research, general education and democracy exhibit parallels with complex cortical structures in the newborn's brain? These structures are on the verge of profound transformations that will be accompanied by a radically new form of consciousness which will soon make him capable of opening up to and discovering a whole new world.

8: THE DEVELOPMENT OF SCIENCE AS THE GROWING SELF-CONSCIOUSNESS OF SOCIETY

If brain functioning can be explained by an analogy with the functioning of human society, one may logically conclude there is something in that society which corresponds to individual consciousness as such. Now, the latter can be defined as an immediate knowledge of one's own existence, and understood as a kind of internal representation of this existence in relation to an external environment. Upon first reflection, the equivalent to consciousness at the level of human society can be seen as the whole array of scientific ideas held by this society at any particular moment. Indeed, scientific conceptions constitute a kind of institutional (i.e., created in this society) representation of its existence, of what constitutes its reality or origin within a universe that embodies it.

The analogical method used here requires that we consider global human society, which is undergoing rapid change, as a self-organizing structure similar to a young child's brain. We know, or feel, that modern society is changing into something very different. This situation is analogous to that of a young child during his first two years of life. According to child psychologists, the young child experiences extraordinary mental development, which Jean Piaget (1964b, p. 15; author's translation) has described as "a whole Copernician revolution on a small scale." At this phase of his life, the child is awakening to the complexity of the surrounding world, which, as he soon discovers, comprises a range of objects that are more or less unfamiliar to him. Furthermore, he discovers other people and is increasingly able to acknowledge them as being different from himself.

The correspondence between two kinds of profoundly different structures is more than simply an analogy; it brings to light a deep-seated identity between two complex organizations. This is why the analogy becomes systematic and methodical and allows us to comprehend certain unsuspected relations between things that are usually seen as unrelated in any real way.

Thus the comparison between the young child and modern society allows a better understanding of the tormented character of this society, in comparison with that of other societies throughout history. Almost

everything about modern society is new, and practically all of its undertakings bring into play new techniques or new ways of using existing ones. Therefore, almost every undertaking is unusually risky. States are constantly experimenting with new policies, often with surprising results. As child psychologists know, it is the same for the toddler, who, in the words of Donald W. Winnicott (1973, p. 70), experiences "tremendously intense" sensations and whose "life is just a series of terrifically intense experiences."

By comparing the respective developmental stages of society and the child's brain, each of which is evolving toward higher levels of complexity, we can have a better understanding of each and lay the foundations for an original futurological method. While the future changes in modern society remain to be discovered, the developmental stages experienced by young children have been extensively studied. Some of the most well-known investigations of this type have been carried out by the psychologist, Jean Piaget, and the stages he has so carefully described are the very ones I will be using here to shed light on impending developments in human society. As the latter are still completely shrouded in mystery, we must proceed rigorously and consistently, framing our correspondences not on vague similarities but on formal relations between differences of determination. To understand the correspondences between the developing consciousness of a young child and the progress of modern science, the reader will be required to refer constantly to a basic relation. And for reasons that will become clear later, this basic relation is posited between the *being-for-itself* of the child and the conception of *physical reality* produced by science.

Physical Reality as the "Being-for-itself" of the Child/Society

The correspondences between physical reality and an individual's being-for-itself are not immediately obvious. Note that the expression "physical reality" designates here the *conception* of physical reality produced by global human consciousness at a certain moment in its development. Hence physical reality corresponds more properly to what could be termed "self-image".

Physical reality is understood as something objective. Likewise, a person's self-image is understood as something authentic and real by the individual concerned. It is *himself*, as he understands himself at a certain moment.

The expression "being-for-itself" will be interpreted here in a very specific sense. Thus being-for-itself will be understood by way of contrast with that of *other individuals*. Accordingly, an individual's being-for-itself is a characteristic of his knowledge of himself as a conscious being, as opposed to that of any other individual whom he meets or imagines. Individual being-for-itself appears to be *unique* because an individual's consciousness has direct access to only one being-for-itself — his own. Conversely, he has only indirect access to the being-for-itself of other individuals. And it is the very absence of this direct access which allows us to say that an individual who acknowledges the existence of others is able to transcend himself, to move outside himself and escape egocentrism.[33]

Figure 1 shows the following two properties of an individual being-for-itself:

a) The capacity of *embodying* (in Figure 1, E, the particular being-for-itself considered here, embodies a representation of the universe of which it is itself an element; while (E) denotes a representation of itself as it appears in it, other individuals are given as E_1, E_2,....,E_i, etc., and are equally represented in the field embodied by E).

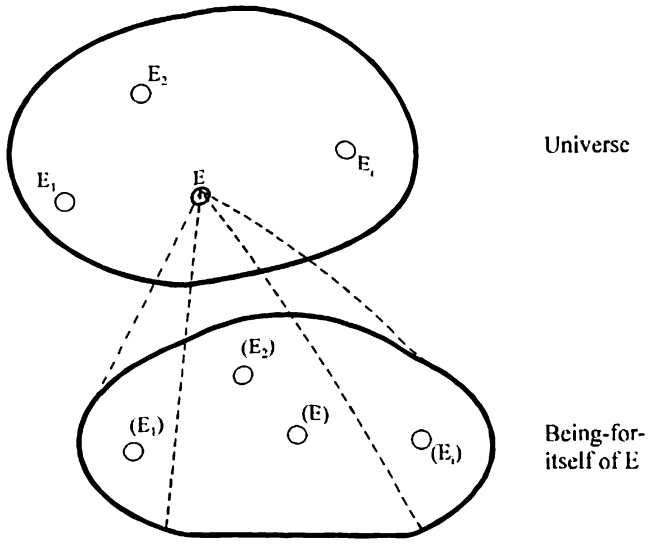


Figure 1

b) The *unique* character of a being-for-itself (in Figure 1, being-for-itself E is arbitrarily selected and distinguished from other instances of being-for-itself; E has no direct access to what is embodied by other individuals E_i, just as individuals E_i have no direct access to what is embodied in E).

These two properties characterize an individual being-for-itself in an approximate manner[34] and mark the beginnings of a formal characterization that will allow us to establish a precise ideometric link between a being-for-itself and physical reality.

Physical reality as described by contemporary physicists has certain conceptual characteristics that generally remain implicit but that are, nonetheless, very clear. Physicists working in astrophysics or cosmology express the reality of the physical Universe by saying that it represents one of the possible models of the Universe. These possible models are in fact various mathematical models and include "Friedmann's model" as well as the various "closed," "open," "flat" and static or non-static models of the Universe. Thus, one distinguishes between these *merely possible universes* and the *real Universe* as such, which is one and only one of the many possible universes. The Universe is a *unique* as a being-for-itself, and is so in a precise way that will be described below. Moreover, the physical Universe is generally described as *embodying* objects and beings. Among these, there is one particularly significant sort of being, one who is able to observe physical phenomena and form theories about them. Some theorists of physics have made this into a logical constraint capable of explaining the numerical values of certain fundamental constants or parameters in physics.[35] The real physical Universe has an inner representation of itself and of other possible universes, a representation created by the physicists themselves.

Figure 2 illustrates the following two properties of the real physical Universe:

a) The capacity of *embodying* (in Figure 2, the Universe U embodies a representation of a whole set of possible universes, while (U) denotes a representation of itself appearing in this set; other possible universes are denoted by U_1, U_2,...,U_i,..., and are equally represented in what is embodied in U).
b) The *unique* character of the real Universe (in Figure 2, the Universe U is arbitrarily selected and distinguished from other possible universes; in U one has no direct access (i.e. no real access) to what is

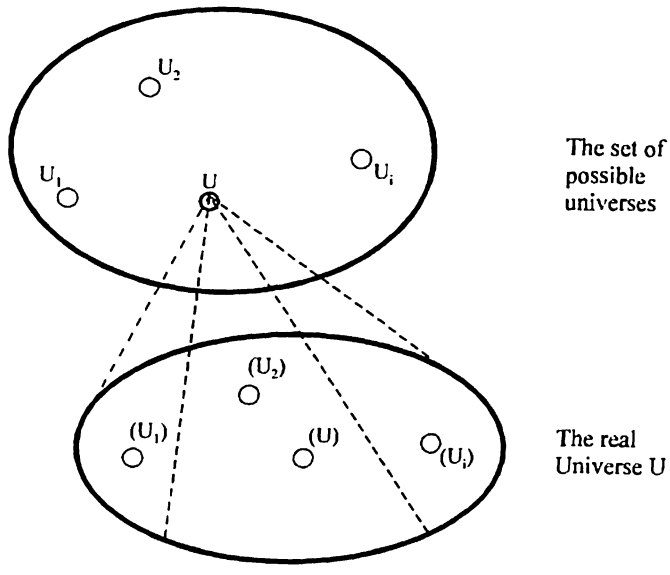


Figure 2

embodied in the other universes U_i, just as, in the latter, one has no direct access to what is embodied in U).

The formal similarity between these two properties and the former two characteristics of a being-for-itself is fundamental for the correspondences to be established between the being-for-itself of a growing child and physical reality as conceived by modern science. This physical reality is formally analogous to a conscious being. It should be understood that this analogy is based upon precise criteria and is not merely derived from a certain resemblance between two terms that are, in other respects, very different from each other.[36]

Therefore, the notion of reality as such comes into play at this point and should be coordinated with the notion of consciousness. The word "reality" will be understood mainly by way of contrast with that which is "only possible." When one considers "physical reality," the "only possible" usually comes to be identified with mathematical models that are not "made real" in a physical sense; in other words, they are not consistent with physical observation. Hence, to ensure the consistency of the conceptual correspondence between physical reality and being-for-itself, one must consider these unrealized mathematical

models as equivalent to objects and beings external to the child himself, in other words, to his being-for-itself. That which the child identifies as being himself corresponds to physical reality, while that which he sees as being different from or outside himself corresponds to possible models of physical universes that have not been realized.

From an Individual Being-for-itself to a Present Being-for-itself

Inquiry into the stages of infantile consciousness described by Piaget and other child psychologists reveals that they do not explicitly and formally characterize being-for-itself in the way that I have done above. Of course their object is not the same as mine. They are not particularly concerned with establishing correspondences between the development of infantile consciousness and that of scientific concepts. Nevertheless, it will be useful to translate their observations in terms of an individual being-for-itself. This will make it possible to establish connections between concepts of child psychology and physical reality. However, the being-for-itself that is implicitly described by child psychologists is not consistently an *individual* being-for-itself, but more often a *present* being-for-itself. This is the case especially when they speak about the important topic of the "permanence of objects," that is to say, the question of understanding the way in which a child succeeds in acknowledging an external object subsisting as such.

Although present being-for-itself differs from the individual being-for-itself described above, their respective formal properties are similar. Present being-for-itself is defined here as an individual's consciousness of the present, as opposed to his consciousness of past or future time. In other words, a present being-for-itself represents, for the concerned individual, his consciousness of his present self as opposed to his consciousness of himself as existing in the past. Thus one can easily see that the same properties of embodiment and uniqueness are involved in this present being-for-itself, just as they are in the case of an individual being-for-itself (or of physical reality).

Figure 3 illustrates both of these properties as they apply to a present being-for-itself.

a) The capacity of *embodying* (in Figure 3, a present being-for-itself, Pr, embodies a representation of the duration of which it is an ele-

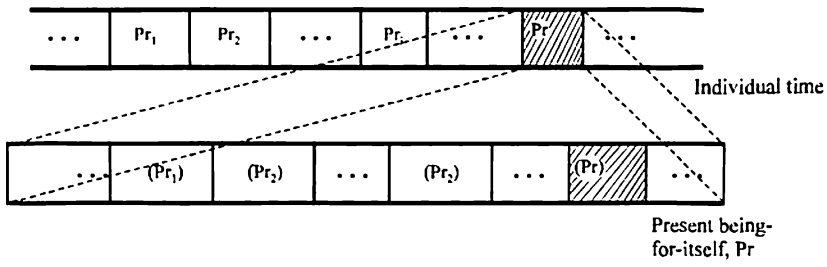


Figure 3

ment; a representation of itself (Pr) appears in it; other moments are denoted by Pr_1, Pr_2,..., Pr_i,..., and are equally represented in what Pr embodies).

b) The *unique* character of a being-for-itself (in Figure 3, the being-for-itself, Pr, is arbitrarily selected and distinguished from other instances of being-for-itself; Pr has no direct access to what the other moments, Pr_i, eventually embody, just as the latter have no direct access to what Pr embodies).

Thus we have a threefold structure in which the same formal properties recur:[37]

1. A present being-for-itself;
2. An individual being-for-itself;
3. Physical reality.

To understand what follows in more detail, the reader should keep this table of formal correspondences in mind. As in the preceding chapters, the analogies are not independent of each other but proceed, on the contrary, from one and the same basic formal correspondence. In this instance, the basic correspondence is between an individual being-for-itself and physical reality, and this allows us to establish a systematic analogy between the developmental stages of infantile consciousness and the stages in the development of our physical conceptions of reality. The present being-for-itself will also play a role in these correspondences, although in an indirect way. The difference between a present being-for-itself and an individual being-for-itself will be shown to correspond to another difference, namely, that between an individual being-for-itself and physical reality.

Infantile Egocentrism

This type of formal relation will enable us to better understand certain aspects of theory in modern physics. Physicists often describe physical reality using the notion of a conscious observer. This situation arises particularly in quantum theory and raises serious conceptual problems for contemporary physicists. Ideometric correspondences will allow us to see that a child who is discovering the external world and other conscious beings happens to be in a situation which has a formal similarity to the preceding one.

As an infant, a young child has but a very partial consciousness of the existence of others. Piaget has used the term "egocentrism" to characterize this situation. When, in early life, a conscious subject is in a state of infantile egocentrism, its situation is analogous to that of classical science, which has not yet acknowledged the "possible universes" that correspond to mathematical models different from those used in classical physics. The progressive discovery of these possible universes, one of which coincides with the real Universe, is equivalent to the discovery, by the young child, of other beings and objects that exist outside himself. He appreciates that a part of what he is perceiving coincides with himself. I am referring to his own body, with which his individual being-for-itself is naturally identified. His own body, then, exhibits a formal correspondence with the real Universe, while objects or beings distinct from it correspond to the possible models. Among the latter, there is one that physicists have for a long time identified with the actual behavior of physical bodies. This is the model of classical mechanics, which can be defined using the equations of Newtonian dynamics. This model assumes absolute time and space, and accounts for physical space by means of Euclidean geometry. Prior to the theories of relativity and quantum physics, the classical model was held as an absolute truth. Not just one among a series of possible models, it was considered the only one really and truly possible. This situation corresponds, for example, to that of the newborn child, who does not yet consider any reality external to his "self." This self, as such, is barely taking shape and is, in practice, confused with the child's own body and with parts of the maternal body.

Classical physics, which is the first type of physics worthy of full scientific credentials, corresponds to the first months in the child's life. Important subsequent developments in physics are owing to Faraday (1839) and Maxwell (1890), who were among those who contributed the most to the establishment of the physical reality of the *field*, whether

electric, magnetic or otherwise. A field was simply, at first, a mathematical concept. Then it became a physical concept, embodying something real. Thereafter, with Einstein and his general theory of relativity, it was discovered that the physical Universe can be non-Euclidean and can conform to a very different geometry. Thus a progressive differentiation developed from an initially undifferentiated situation, and quantum theory played a very important role in this process. As discussed later, quantum theory represents a crucial stage, one in which physical reality undergoes a complete change in appearance due to the fact that it must be understood according to the logic of alterity. In brief, alterity, in quantum theory, is tightly linked to the existence of a twofold principle of the evolution of physical systems. One of these is called the "equation of motion" (or "Schrödinger's equation") and the other the "reduction of the state vector" (according to the terminology that became more prominent with John von Neumann).

The classical child, that is the child who holds a classical conception of physical reality, is only a "newborn" — in the sense intended by child psychologists. Then this child becomes an "infant," and remains at this stage until he is able to walk by himself. It is during this infant stage that the child begins to discover the existence of *something different* from his rudimentary self. His self changes in that he comes to understand himself by way of contrast with what is outside and different from himself. His progressive understanding of his relation with others corresponds to physics' progressive understanding of reality by way of contrast with the merely possible.

According to contemporary psychology, self-knowledge does not exist at the beginning, at birth. Rather, one can know oneself only through one's relationships with others. This means that others play an essential role in personality formation. And this is not inconsistent with the fact that, for a very young child, the other as such does not initially exist. The correspondence with conceptions of reality derived from modern physics suggests, then, that these conceptions were transformed. They began with a kind of initial indistinctness with respect to the inherent reality of other universes as such, and will continue to be transformed until there is an acknowledgement that other so-called "merely possible" universes can accede to such a reality. Here the expression "inherent reality" has a new meaning which is as yet unintelligible to contemporary science and philosophy. We can understand it, at the moment, only by means of ideometric relations.

The Stages of Childhood and the Developments of Modern Physics

Piaget was not the only one to describe the development of thought in terms of stages. However, his work is generally considered to be the most influential in the domain of child psychology. This is why, in spite of certain lacunae that some people believe to have found in his work,[38] I will look mainly to the stages described by this author as I develop the correspondences between the child's being-for-itself and physics' conceptions of reality.

A methodological precision may be useful at this point. My own approach is an experimental one in the sense that it consists of observing ideometric relations between domains of ideas. One perceives certain analogical relations and appreciates that these are organized into a systematic and internally consistent working order. It is not possible here for me to give all the reasons or indications that led me to discover these relations. Some of them I found in the history of ideas, while others were discovered in disciplines that, at first glance, appear to have nothing to do with either child psychology or physics. Thus, what I am presenting here is a sort of finished product, or at least one that has been worked out slowly over time. It would be difficult, for example, to give all the reasons which have led me to conclude that today's human society corresponds to a given stage as described by Piaget. However, the following pages will enable the reader to appreciate all the points of correspondence and to see that they form a very consistent whole.

The Six Stages of the Sensorimotor Period

Piaget characterizes four major periods in the development of an individual's intelligence from birth to adulthood. The first of these periods, the "sensorimotor period," coincides with the first two years of the child's life and is the one that holds the greatest interest for us. It corresponds to developments presently known to science, as well as to certain developments still to be discovered. The second period, the "period of symbolic thought," covers the child's developments from about two to six years of age. It will also be interesting to consider this period, so that we can catch a glimpse of other developments in science in the more distant future. For us, the end of the first period and the second period represent a relatively imminent time in the future of science,[39] while the following periods represent a more remote future. I will concentrate initially upon the first period, reserving my comments on the second period for later in this work.

Piaget divides the first period into six "stages." Each new stage, by definition, integrates elements from the preceding stage, while reorganizing them and adding new elements. According to Piaget, these stages constitute passages from one state of equilibrium to another, and are designed to increase the capacity for adaptation in an organism.

This characterization by means of stages can also be applied to the development of major physical theories. Each major theory (for example, the theory of relativity or of quantum mechanics) integrates elements of various preceding theories, especially observed facts and certain theoretical relations. It then restructures this data, adding new elements (previously unexplained observations and theoretical relations that make for a reduction in arbitrariness).[40]

One can see that the present state of scientific conceptualization corresponds to the fifth stage of the sensorimotor period. At this point, the child is about 12 to 18 months old. However, let me first describe these stages. In doing so, I will borrow certain terms and expressions from psychologists who have interpreted or commented upon Piaget's work.[41] And I will be looking mainly at the way the child comes to recognize external objects and thus constitute himself as a self, while at the same time becoming more and more capable of acknowledging the existence of other instances of being-for-itself. Subsequently, I will draw the relevant parallels with theories in physics, while going into a more detailed description of the stages.

The First and Second Stages (0 to 4 Months)[42]

The child exhibits reflexes such as sucking or manual prehension. Actions, such as visual exploration and babbling, are made for their own sake. These give rise (in the second stage) to the "first motor habits," such as thumb-sucking. The child follows a moving object with his eyes. These are the first organized perceptions. If an object disappears from his sight, the child does not look for it. One might conclude that at this point he has no notion of the permanence of objects and no consciousness of having a self, in other words, no conception of self which would allow him to differentiate himself from someone else, such as his mother.

The Third Stage (4 to 8 Months)

The child begins to open up to the surrounding world. He demonstrates that he is able to foresee certain movements of objects. However,

if a veil is placed over an object which was at first visible, the child makes no attempt to find it again. He develops a fledgling capacity to imitate certain sounds or motions. His own motions demonstrate that he is beginning to distinguish between his goals and the means he uses to achieve them. To put it in more technical terms: his sensorimotor adaptations integrate his "intentionality." After five months, the child shows interest in his mirror image: he looks at it, comes near, touches it, smiles and vocalizes. His behavior is the same whether it is his own image or those of others, and whether he sees them in a mirror, in a photo or on video. There is no evidence of any perception of a Self as a causal agent.

The Fourth Stage (8 to 12 Months)

The child begins to be able to foresee external events. He can follow through with his intentions, pushing away an obstacle in order to reach an object and linking together a series of actions in order to achieve a goal. Also, he can hold his hand out in anticipation of grasping an object. Indeed, objects are a source of great interest to him, and he is curious to see whether they can be dismantled. Turning over a box or rumpling paper gives him a kind of well-being similar to that derived from eating. The child now appears to be able to find an object that was at first visible and then hidden under a veil. However, he is still incapable of finding a hidden object if the latter is shifted under the veil, and persists in trying to find it in the same place he had seen it before. Finding his efforts unsuccessful, the child stops his search instead of looking elsewhere. This is what Piaget has called the "error of the fourth stage." An object is an entity that is still not completely independent of the subject's action. After the age of nine months, the child comprehends his reflection in a mirror and plays with it. He distinguishes representations that correspond to himself from those that do not. The child perceives his Self as a causal agent. He is conscious of the causal or active relation that exists between his own body and its mirror image. However, he is not yet able to differentiate himself from others in this way.

The Fifth Stage (12 to 18 Months)

The child is able to change his strategies in order to find a hidden object and is no longer subject to the "error of the fourth stage." This means that he does not necessarily repeat a particular successful strategy,

and is no longer dependent on the habit of success. While he cannot yet relocate objects moved behind a screening device, he can use reflections in a mirror in order to locate persons and objects in space. He apparently distinguishes the virtual space (behind the mirror) from the real space (in front of it). He differentiates his Self as an active agent who is independent from the Selves of others. After the age of 15 months, the child will display intentional patterns before a mirror or video. For example, if, looking in a mirror, he sees a red spot on his nose, he reacts by rubbing it. He recognizes himself from his personal facial features, etc.

The Sixth Stage (18 to 24 Months)

Mental representation tends to replace actual motion in the child's strategies for finding an object. The child imagines trying and devises a solution before proceeding to action. The object has acquired a new permanence, since the child now no longer "loses" it, but is able to keep it in memory and imagine its hidden movements. For the first time, the child pays attention when a conjurer makes objects disappear into a hat and is able to wonder about it. Moreover, the child understands by now that pointing to an object is a way of denoting it. Symbolic representation is acknowledged as such; any given image, word or impression can be co-opted to serve this function. In seeing himself in a mirror, the child names himself (he pronounces his name or he says, "This is me"). He thus acknowledges his Self and distinguishes it from the Selves of others.

The Self emerges as conscious of itself at the fifth stage, when the child is 15 months old, and this consciousness is reinforced during the sixth stage. This is the process by which the child becomes conscious of his individual being-for-itself. At this point, the child's consciousness acknowledges itself in its singleness. He knows that he knows, and he knows that he is "unique." The word "unique" is taken here in the sense described above, and may be expressed by the words "insular" or "separated." At the fifth stage, then, the child constructs his individual being-for-itself. And at the sixth stage he becomes conscious that others also have one.

Emotional Aspects

Piaget (1964b, pp. 12 ff.) gives a detailed account of the levels of emotional development. During the first, sensorimotor, period, the

child experiences his first emotions and differentiated feelings. Towards the end of this period, the elementary emotional regulations and first external fixations of affectivity make their appearance. We would do well, at this point, to provide further details, particularly with regard to the circumstances surrounding birth and the relationship between the child and mother (or any person playing the mother's role). For such details are relevant for the correspondences we are establishing with developments in modern science.

With respect to the circumstances surrounding birth, it is not easy to describe the characteristics of an individual being-for-itself in its beginning stages. A newborn child probably has no consciousness of himself as such. Therefore, the description one can make of his individual being-for-itself concerns mainly visible physiological reactions. In this case, the relevant ideometric correspondences would be made not with scientific conceptions of reality, but rather with conditions of human society itself. The latter constitutes a kind of global organism whose being-for-itself appears within scientific conceptions developed in this organism. It is hard to think of a newborn child as having a being-for-itself, because he is barely "conscious" of that which he is. Likewise, before developing sufficiently advanced scientific conceptions, human society still had a rudimentary conception of physical reality, that is to say, relatively too simple and conforming far too much to traditional common sense. However, the external features of this organism may be described without too much difficulty. Thus, for example, the distress of childbirth corresponds to the particular difficulties of modern society, especially with respect to politics, education and the economy.

Certain researchers have focused their attention on the emotional dimensions of infantile experience. The relations of the young child with his mother and with the first people with whom he comes into contact, are considered especially significant by psychologists such as R. A. Spitz and W. G. Cobliner (1968). My approach will allow us to see the parallels that global modern society exhibits with the infant's feelings and with the "mother." I will show that the mother, being "external" to the child's individual being-for-itself, must correspond with a "merely possible," or "merely mathematical but non-physical," entity.[43] The conception of reality in this case is the one established by *classical physics* and supported by Newtonian dynamics, the mathematical formalism of Lagrange and Hamilton, and Maxwell's electromagnetic theory. This general model of classical

physics has become only an approximation of physical reality and, being merely approximate, is in fact not real and should be classified among the merely possible universes. Thus, it corresponds to an entity which is external to the child's being-for-itself. Because of its "approximate" yet relatively proximate character, this entity appears to be a being which is different from the child yet also very close to him namely, the mother.

It has been widely established that birth is traumatic for the person most directly affected. At birth, the child suddenly receives a large influx of new sensations. Once born, he curls up in a fetal position and is almost constantly somnolent and able to make only non-adaptive movements.

Let us compare this with society in the modern period, particularly in the 19th and 20th centuries. Comparing human society to a child, the modern period corresponds to the first months of the child's life: it appears, as well, to be comparably difficult and tumultuous. If human society is seen as an organism in the process of formation, the accession to modernity represents a great opening into a new, but also an excessively unbalanced period. Modern society is reputed to be "in crisis," that is, in an excessive state of disturbance and indecision in almost every domain. There has been a crisis in knowledge and beliefs, a crisis of values and ethics, in art and literature, in politics and economics, and so on. There are no benchmarks because there are no historical precedents for the developments in modern society. Modern Man is confronted with something new, disquieting and frightening. In the political domain, profound upheavals are underway in the relations between groups, peoples and nations. People are trying to establish and affirm their identity.

The 19th century has been called the "century of nationalism." This period was characterized by widespread demands for recognition and for liberation from foreign tutelage. In geopolitics, an even more troubling period began with the advent of decolonialization, which saw the creation of many new states that had to organize themselves in often very maladjusted ways. Moreover, this was also a period of opposing ideologies: the Left versus the Right, socialism versus liberalism, and so on. In economics, developments were sporadic, moving through crises and recessions. For nations throughout the world, there has been no respite, stability of balance. Nevertheless, as in the case of the young child, a far-reaching organization is in the process of formation, with evolution continuing through all

these crisis and troubles. Confronted by all this confusion, we naturally worry and aspire to a more harmonious world; but we can also appreciate that we are not living in a formless chaos. As a matter of fact, something comforting has appeared in spite of all this agitation. Some people point to the extraordinary progress of scientific knowledge, or the irresistible appeal of various new technologies, such as the new communication technologies. Others give high marks to a new openness that is bringing people together despite their differences. This is the sunny aspect of modernity, its way of smiling beneficently at us. Despite its confusion, our collective consciousness sees this "smile," and its perception of it corresponds to the young child's perception of the maternal gaze. For the smiling mother brings confidence and consolation even in the depths of chaos.

When it is about three months old, the infant first responds with a smile to the appearance of the mother's face. According to Spitz (1968), this is the "first organizer," an element that will become more and more significant in allowing the child to extricate something from the chaos and meaninglessness around him. Subsequently, at about six to eight months, the child develops the ability to distinguish his mother from other people. As in Piaget's third stage, one observes that the child acquires this capacity even before he becomes conscious of his own self. His mother, therefore, appears as only slightly dissociated from himself, though having a separate identity with respect to others. So it is really the mother-child duo that distinguishes itself from what surrounds it. In other respects, the child manifests some anguish when confronted by someone unknown. One can assume that, at this point, the initial chaos is pushed back beyond a perimeter, which is now expanded in comparison with the preceding situation, where almost everything was strange and threatening. The acknowledgement of the mother as a global object will also allow the child, according to Spitz, to acknowledge himself as a personalized subject. Certain psychologists or pediatricians speak about a more generalized anguish felt by the newborn. D.Wallon (1978) has written that a newborn's life begins in a symbiotic relation with the mother that is a continuation of the fetal symbiosis. The child's consciousness starts in and by the separation from the mother-origin: "His first awakening to consciousness is the contrast between the happy security he feels in the presence of his mother and his anguish at the prospect of being abandoned, a primal fear which seems to be one of the most primitive and visceral emotions..."[44]

The Correspondence with Ideas in Physics

The main stages of physics will be identified here as follows: (1) Newtonian dynamics and the classical theories as they were understood at the beginning of the 19th century; (2) Maxwell's electromagnetic theory; (3) Einstein's theories of special and general relativity; (4) quantum theory. Our correspondences will roughly conform to Table 3, which identifies the various stages of physics with simple expressions:

Newtonian Dynamics and the Classical Theories

The expression "classical theories" designates the classical theories of physics such as they were understood toward the beginning and middle of the 19th century, that is, before J. C. Maxwell expounded his theory of electromagnetic energy. They include, as distinct theories, mainly Newtonian dynamics but also, for example, optics and the theories of electricity and magnetism. Although Newtonian dynamics originated with its eponymous founder back in the 17th century, it had to wait until the beginning of the 19th century for its most complete, rigorous, and formal formulation, in the work of Euler, Lagrange, Laplace, Jacobi, Hamilton and others.

The overall conception of the physical world in this period has been designated the "mechanical view" of reality.[45] According to this view, which followed from Newtonian dynamics, all physical bodies were conceived as made up of particles bound together by forces dependent only on the distance between them. However, optical and electrical phenomena were not completely in accordance with this view. Optical phenomena involved waves (cf. Young's and Fresnel's optics) that were not ruled by classical dynamics, despite certain formal similarities.

Table 3 Correspondences between the stage of physics and Child development

Stages of Physics	Stages in child Development
Newtonian dynamics and classical theories	1 and 2
Maxwellian theory	3
Einstein's theories	4
Quantum theory	5
(the next stage to come)	6

And electrical phenomena involved forces which depended not only on the distance between particles, but also on their speed. This appeared somewhat mysterious, in the conceptual framework of the time. Moreover, electrical and magnetic phenomena began to be described in terms of *"fields,"* a new notion that could not be reduced to the concepts of classical dynamics. Therefore, scientists were faced with several physical domains without any overall theory to make sense of them. In classical dynamics, space and time were conceived of as infinite and absolute, and the geometry of space could be conceived only as Euclidean.

In accordance with the preceding table, these classical conceptions exhibit analogies with Stages 1 and 2 in the development of infantile consciousness. Let me demonstrate how this is so. By the beginning of the 19th century, Newtonian dynamics was already a traditional conception with some two hundred years of history behind it. Thus its influence on the scientific ideas of the time was akin to a kind of "cultural reflex." Let us first, however, be clear about our terms. In biology or physiology, a reflex is an action determined by heredity rather than acquired by experience. This is particularly true with respect to the reflexes of the newborn child, such as sucking or manual prehension. The latter are biologically, not culturally, determined. Likewise, the Newtonian tradition functioned as a cultural reflex in the sense that it acted as a culturally determining factor upon the initial conceptions of the 19th century. Only later discoveries could appear as acquired, "non reflex" forms "liberated," as it were, from this pre-determination.

At this stage, the child exhibits no distinct sense of self, but exists rather in a kind of symbiosis with the mother. He does not even distinguish himself from the external world, which, in a certain sense, does not yet exist. This situation corresponds to a specific feature of the classical physics of the period, namely, the conception of absolute space and time, with its attendant view of Euclidean geometry as the only conceivable model capable of describing reality. Physical reality, as a realization among a host of possibilities, does not yet exist. Instead, what exists is a kind of symbiosis, conceived as being *a priori* necessary, between the entire physical universe and Euclidean geometry, including the idea of absolute and infinite space. The "Mother" coincides with this obvious and a *a priori* necessary mathematics. The "child," for his part, coincides with physical reality and is indistinguishable from it. In this respect, human society during this period did not have a "self" of its own. For the latter was confused with the

Absolute, with the product of a kind of cultural determinant or reflex. Thus the Mother is at one and the same time Science and the tutelary Divinity, who bestows all her protection and ontological guarantees on Man, who is an integral part of Her.

The first motor habits and organized perceptions mentioned by Piaget (with respect to the second stage), have parallels within the classical framework of the 19th century. Now, this correspondence with science and human society must be understood in a consistent way. In this case, the "habits" mentioned by Piaget must be seen as acts that are liberated from the purely instinctive determinism of the initial reflexes. The child is gradually liberated from the latter by his sensorimotor experiences, which replace reflexes with motor habits. Piaget's examples of such habits include holding the nose, exploring the face with the hands, rubbing the eyes, thumb-sucking and scratching fabric. The newly acquired coordination of the child's sensory and motor capacities makes these habits possible.

According to our system of analogical correspondences, the sensory capacities of vision, hearing, touch, etc. correspond to the various scientific disciplines of mechanics, electricity, optics, etc. Thus specific motor capacities correspond to scientific techniques developed in human society. One can see that the technical inventions established within society become "habits" analogous to those mentioned by Piaget with respect to the child. More often than not, these are, at first, purely gratuitous or of dubious utility (or even, in some cases, somewhat harmful). However, they appear as the first steps toward what will ultimately become useful forms of conduct. This is precisely the kind of connection that should be made here, since we are dealing with liberation from a cultural determinism composed of traditions and ancient beliefs, rather than with a biological determinism composed of instinctive or hereditary reactions. The science of this period arose from an unprecedented level of technological development. The discoveries of the dynamo and electric transformer (1831), the electric battery (1836), the electric motor (1837), the locomotive (1839), the electric telegraph (1839), etc., attest to the fact that the technical capacities of human society have developed along with, and thanks to, acquired scientific knowledge. In this sense, society's "perceptions" have also undergone a process of organization, since they consist essentially in the progressive acknowledgment of physical reality.

The main correspondences described above are summarized in Table 4:

Maxwell's Theory

The second half of the 19th century saw the introduction of new concepts in physics, concepts that had revolutionary effects on the conception of reality at that time. The works of Faraday, Maxwell and Hertz were to form the basis of modern physics. Historians of physics have often considered the concept of *"field"* the most important invention since Newton and, indeed, it has profoundly changed the mechanical view of reality. At first, the field appeared to be a purely mathematical artifice, an imaginary construction added to the particles and forces, which were the only features actually considered to be real. Thus the field, as artifice, was seen as only an equivalent but more convenient means of representing the interactions of the particles. At this period, first under the impulse of Faraday and subsequently under Maxwell and Hertz (who experimentally confirmed Maxwell's electromagnetic theory), the fields acquired a kind of real existence, a physical character equal to, or greater than, that of the forces and particles. Faraday showed that (electrical or magnetic) fields have a real effect upon each other, and that this effect can be observed visually. In this view, then, these fields are a real physical substance, part of the fabric of reality. Maxwell took this idea further, mathematically demonstrating that fields are oscillating phenomena such as electromagnetic waves or visible light. The famous "Maxwell equations" govern the relationship between particles and fields,

Table 4 Synoptic Table of the Correspondences Between Piaget's First Two Stages and Classical Physics

Infantile Development (Stages 1 and 2)	Developments in Science (Pre-Maxwellian stage)
Reflexes (biological origin)	Newtonian dynamics (originating in tradition)
Organized perceptions (vision, touch, hearing, etc.)	Technical applications (mechanics, electricity, optics, etc.)
(capacity to follow a moving object with the eyes)	(capacity to develop new applications from acquired knowledge: the locomotive, the electric motor, etc.)
No sense of self (self completely confused with the mother)	No physical reality apart from classical mathematical formalism (absolute and infinite space and time, Euclidean geometry, and Galilean relativity)

and describe their respective motions. They also form the basis of our entire modern understanding of electricity, magnetism, and optics. Maxwell's theory constitutes a remarkable synthesis of these three physical domains, which were previously seen as separate from each other. He predicted that new and as yet unknown kinds of electromagnetic waves would have the same speed as visible light in a vacuum. This prediction received spectacular confirmation when Hertz, twenty-four years later, succeeded in proving experimentally the existence of radio waves, or "hertzian" waves. The notion of field appeared, thus, to be genuinely real. And thanks to its explanatory character, it has accounted for the profound relations between things and facilitated the discovery of a completely different side of reality. Electromagnetic waves, which include radio waves and visible light along with X and gamma rays, have considerably expanded the scope of human observation. Astronomers, for example, can now study the sky with its galaxies, stars and other heavenly bodies not only by means of visible light, but also by means of invisible waves such as radio waves and X rays. Radio waves, whether short-wave, AM or FM, have become a privileged means of human communication throughout the world.

Certain formal characteristics of Maxwell's famous equations must be underlined in order to explain the transition to the following stage, represented by Einstein's theories of relativity, and to understand the importance of the conceptual problems posed by these equations. To begin with, Maxwell's equations easily fit within the formal framework of the equations of classical dynamics, as expressed, for example, by Hamilton and Jacobi. In them the physicist-mathematician readily recognizes the general character of classical formalism, in other words, its dynamical features, or the way in which objects and motions change with time within one spatial frame of reference. However, Maxwell's equations present an anomaly: although they are not consistent with Galilean relativity, they are so with respect to another type of relativity later recognized by the mathematician, Henri Poincaré. I am referring to the relativity described in Einstein's theory of special relativity, which has had such an impact on physics. For evidence of the theoretical difficulties that arose during this period, we need only look to the failure of Michelson's attempt to show the relative motion of the Earth with respect to space, which, at the time, was thought to be filled with ether. (And here we are dealing with Galilean relativity.) The anomaly exhibited by Maxwell's equations led to a profound renewal of the conceptions of space and time, and consequently of physical reality itself.

This stage of physics, which is represented essentially by Maxwell's theory, is analogous to Piaget's stage 3 of infantile development. At this stage the child, who is only four to eight months old, is about to embark on an astonishing adventure. He is now able to coordinate his movements with his various sensory impressions, particularly vision, touch, and hearing, and can synthetically integrate these sensations and anticipate the movements of objects in his environment. He discovers a new efficiency in the system of his own body. The integration and efficient coordination of the child's visual, tactile, and auditory sensations correspond, in the world of physics, to Maxwell's synthesis of several domains, namely, electricity, magnetism, and optics. The child at Stage 3 becomes capable of manually grasping objects and bringing them to his mouth. He can now explore further and round out his discoveries with respect to himself and the surrounding world. In his world, these developments are akin to a small technical revolution, analogous to the discovery and use of radio waves. All this linking-up of the various sensory areas in the child's brain is quite similar to what happened in technological society, when a number of scientific domains were connected for the first time. The interconnections between the neurons belonging to these areas are also analogous to the global network of telecommunication made possible by radio waves.

At Stage 3, the child is also capable of distinguishing his mother (or, more exactly, the entity that he and his mother together constitute) from other people in his surroundings. He acquires a capacity for discerning "alien" beings and discovers the particular feeling of uneasiness generated by the awareness of the unknown. Here, a precise conceptual connection can be made between the history of physics and child psychology. When physicists realized that Maxwell's equations were not consistent with Galilean relativity and when, moreover, Michelson's experiment did not succeed in demonstrating this relativity in the case of the Earth's motion, they too developed a sense of uneasiness before the unknown. In this case, the unknown took the form of the mysterious anomaly in Maxwell's equations, which were, however, obviously in agreement with physical reality. Although Maxwell's equations have the same general form as the classical equations of Newtonian dynamics, they are inconsistent with the equally classical notion of Galilean relativity. The classical matrix seemed to remain, in a contradictroy fashion, faithful, while at the same time behaving in a strange way. The child at stage 3 is, overall, in a similar

situation and can now distinguish the maternal face from that of a stranger. However, when confronted with an unknown face that is, in many respects, quite similar to the face of his mother, he experiences a sense of anxiety. At such moments, his pout is evidence of his inability to solve this contradiction by himself. To extend our parallel further, the inability of physics to understand the failure of Michelson's experiment is analogous to another difficulty confronting the child. The reader will recall the futile attempts of H. A. Lorentz to explain the lack of results in this experiment by means of a classical, material and mechanical contraction conforming exactly to what is required to compensate for the expected distortion of the waves. The science of this period was powerless to escape certain frameworks. This is the same for the child at Stage 3, who, we remember, is unable to look for an object once it has been covered by a veil. Nothing exists independently of his own body or what is in direct contact with it.

Table 5 summarizes the main correspondences described above:

Table 5 Synoptic Table of the Correspondences Between Piaget's Third Stage and Maxwell's Theory

Infantile Development (Stage 3)	Development in Science (Maxwell's theory)
Openness to the surrounding world (distinction between himself and certain external beings, if they remain visible or in contact with his body)	The acceptance of new mathematical models (notion of field, Maxwell's equations; partial abandonment of Galilean relativity)
The coordination of several sensory organs (especially sight and touch)	Maxwell's synthesis of several domain (electricity, magnetism, and optics)
The ability to anticipate the movements of objects	The prediction of the existence of electromagnetic, invisible waves
No sense of self apart form the mother	No physical reality apart from classical mathematical formalism (absolute space and time, Euclidean geometry)

Einstein's Theories

The special theory of relativity originated in the problems posed by the concept of field and, more particularly, from the fact that Maxwell's equations were inconsistent with the Galilean principle of relativity. Maxwell's equations are, however, consistent with the Einsteinian principle of relativity (or they are according to the group of Poincaré). Historians of physics are divided on the question of whether the change in the conception of the physical world produced by this theory is equal to that which resulted from quantum theory. However, one can be sure that both relativity and quantum theories together led to a major change in the conception of physical reality. The special theory of relativity, by itself, has profoundly altered our notions of space, time, matter and energy. Measurements of space and time were henceforth deemed to be relative to the speed of the observer's motion. A spatial length measured by an observer who is moving with respect to another observer appears to be *contracted* along the direction in which the former is moving. However, measurements of time made by this same observer appear to be *expanded* with respect to measurements made (of the same phenomenon) by the second observer. The *simultaneous* character of two events (provided that they are not co-punctual) is also relative to the state of motion of the observer. Thus two observers, who are moving with respect to one another, can disagree regarding the simultaneous character of two observed events. According to this theory, the mass of a body in general is a form of its energy, and is dependent on the motion of the observer who is measuring it. Note that all of these results, although extraordinary from the point of view of classical (Newtonian) physics, are mathematically deducible from the simple fact that the Einsteinian principle of relativity has replaced the Galilean version. Einstein also demonstrated that these relativistic effects may essentially be inferred from the principle of the constancy of the speed of light in a vacuum. One can easily see that the speed of light in a vacuum cannot be exceeded by the speed of any real physical body. This is calculated to explain that the physical relativity which is involved here in no way amounts to a relativist view that would reduce the reality of bodies to mere appearances. Contrary to such a relativist view, physical relativity confirms the belief that a physical body has a distinct reality consistent with the requirements of objective thought.[46]

Numerous other results which are important for our conception of reality also follow from the general theory of relativity. Einstein conceived of this as a generalization of his special theory of relativity, one

intended to integrate gravitational effects. One of the most startling consequences of this theory is the realization that physical space can no longer be seen as consistent with Euclidean geometry, even though physics has previously considered the latter to be an obvious and inescapable fact. One of the effects of the general theory of relativity upon our conceptions of physical reality has been the creation of mathematical models which represent the Universe globally. In this context, the real Universe appears to be one among a host of possible models. Thus a new discipline, scientific cosmology, is born. The real Universe is consequently endowed with a number of new characteristics which 20th century science deems, if not certain, at least highly likely, to hold: it is seen to be finite, although unlimited[47] and expanding; and it probably had a beginning in a huge explosion, such as in the Big Bang theory. As opposed to what has been previously believed, the Universe is constituted of a great number of galaxies, not only of ours, the Milky Way.

It is relevant to mention here Einstein's strong reservations with respect to quantum theory, the next major stage of physics. The very author of the revolutionary theory of relativity did not want to admit that quantum theory, as such, was a valuable theory. Einstein tried to create a unifying theory that would encompass all the main physical interactions. But, as Stephen Hawking (1988, p. 155) wrote, "the time was not ripe" for Einstein. Hawking meant that this project was premature as long as the existence of strong and weak nuclear interactions remained unknown. As well, Einstein was hampered by his a priori rejection of quantum indeterminism.

This stage of the relativity theory is analogous to Piaget's Stage 4 of child development. At this stage, the child shows that he is able to handle objects, and explores with a specific intention in mind. He is able to find an object hidden under a veil, provided that it has not been moved surreptitiously. The child now has a better notion of the permanence of an object, although this notion is still defective. According to Piaget, the so-called "error of stage four" supplies evidence to this effect. One can see, for example, that the child recognizes a given object even through the visual distortions of perspective and distance. This means that his perceptual centers or areas are coordinated in a more complex way than at the previous stage.

However, the most remarkable feature of the child's development at this stage is his revolutionary capacity to acknowledge his Self as causal factor. For the first time, the child understands himself to be an independent entity from his mother. The child has thus recognized his

body's image, either in a direct way or in mirror (or video image), and he knows that this image represents his own impact on things.

This primary acknowledgement of his causal Self, together with his capacity for distinguishing his own body, means that the child, for the first time, has acknowledged the latter's boundaries. His body is no longer a vague entity in a symbiosis with the mother, but appears, to him, to have a precise location in space. He realizes and understands that a number of objects or beings coexists with his body and, therefore, with his Self. This new consciousness of having a bounded being-for-itself is analogous to the original limitations in the special theory of relativity with respect to the limited character of the speed of moving bodies. No physical body can have a speed greater than that of light. This limitation in physical reality corresponds to the limitation in an individual being-for-itself. In both cases, this is fundamental knowledge, profound in its consequences. The child, who has become aware of the limitations inherent in the fact that he has a body of his own, now sees objects from a point of view relative to his position. His hand appears to him as being large or small depending on its distance from his eyes. Thus it becomes an object of relative size, while remaining the same part of his own body. In this respect, the "relativity" of a body (or part of a body) strengthens rather than weakens the sense of its inherent reality. Bodies and objects show an intrinsic capacity to remain themselves in spite of changes in the observer's perspective. (Here the word "observer" represents each kind of sensory ability.) Nevertheless, the child does not yet conceive of objects as completely independent of himself, and objects that appear to change in accordance with his point of view are not yet completely distinguished from the parts of his own body. By the same token, he is not yet able to distinguish other people as separate persons having their own individual Selves. They are still likened to objects, and considered as extensions of his causal Self. The error of the fourth stage is linked to this confusion. Because the child is not yet able to conceive of the independence of an object with respect to himself, that is to say with respect to this own body, he cannot yet imagine an object which moves "by itself" (i.e., changes place because someone else has shifted it) while hidden under a veil. The child, at this stage, does not conceive of the existence of other instances of being-for-itself, and is unware of the kind of indetermination that proceeds from them. What he sees, or what he loses sight of temporarily, does not change its state haphazardly, that is to say, in an undetermined manner. It is either determined or it ceases to exist.

The situation in physics is quite analogous. At the stage of relativity, before quantum theory, physicists witnessed a revolution in the conception of physical reality, in terms of time, space, and matter. Nevertheless, they were unable to imagine a physical reality that would behave in an undetermined manner.

> Thus Einstein wrote in a letter to Max Born in 1926: "The [quantum] theory produces a good deal but hardly brings us closer to the secret of the Old One. I am convinced that He does not play dice."

It is amusing that Einstein failed to recognize the Child, but instead imagined a rather Old Man, one too serious to play! Moreover, his Old Man is an "Old One," confirming that his conception of reality was somewhat defective. It is possible to see this kind of defectiveness as corresponding to the "error of the fourth stage." For him and for all the other physicists who did not accept the indeterminism of quantum theory, there was only one physical reality and only one essential form of determination originating from this unique physical reality. This unique reality corresponds to the child's unique causal self during the fourth stage of development. Just as this child does not conceive that other people possess an individual being-for-itself, pre-quantum physicists did not conceive that physical reality could be twofold (or manifold) in accordance with the possibilities of other universes. These universes are mathematical, not physical. It is as difficult, for pre-quantum science, to imagine a mathematical possibility becoming a reality-in-itself as, for the child at the fourth stage, to imagine that someone has surreptitiously moved an object under a veil.

Here, the reader must be careful of a particular feature. The language and the notions used here to describe science and its understanding of reality are not yet totally acceptable to the current way of thinking. Our science of child development is, as it were, in advance of our contemporary science of reality, which coincides in fact with physical science. The reader must not forget that the comparison of reality to a Child's being-for-itself is metaphorical. This child in the making, who is being formed through scientific developments, has been described using an ordinary child's characteristics only because we know no better means of doing so.

Table 6 summarizes the main correspondences described above:

Quantum Theory

I have ancipated the description of quantum theory somewhat, in order to show what the error of Stage 4 corresponds to in modern

Table 6 Synoptic Table of the Correspondences Between Stage 4 and the Theory of Relativity

Infantile development (stage 4)	Developments in Science (Einstein's Theory)
Openness to the surrounding world (exploration of objects, faces, his mother's and his own body)	The acceptance of new mathematical models (non-Euclidean geometries, cosmological models of possible universes and the real Universe)
The acknowledgement of a causal Self (separate from the mother)	The acknowledgement of space-time as non-Euclidean (the rejection of absolute space and time)
(the acknowledgement of the boundaries of his own body)	(the acceptance of the principle of the speed of light as the maximum speed of physical interactions)
The "error of Stage 4" (the object not yet independent from the subject)	The error of accepting only a non-probabilistic physics ("hidden-variables"theories)

science. More than any other physical theory, quantum mechanics has become the fundamental theory of physical reality. Material properties, chemical reactions, colors of substances, freezing and boiling, even the very fact that *solid* bodies exist, are now understood according to quantum mechanics. This theory, more than any other, has completely upset the scientific conception of reality.

According to quantum theory, every material body behaves as if it were both a particle and wave. From the point of view of classical physics, and indeed from that of Einstein's physics, this is nonsense. This is why the theory of relativity itself is often considered to be a "classical" theory by several historians of physics. According to a classical physics inclusive of the theory of relativity, there exists an objective world external to and independent of the subject-observor. In quantum physics, one must now admit that the state of a physical system is determined by whether or not it has been observed by a subject. The point is not whether this state is *known* or not *known* depending on whether it has been observed or not.

This would be obvious. Instead, it is fully *determined* by the fact that an observation has happened. Before being observed, a physical system is considered to consist of a *superimposed series of quantum states*, each of which has a certain probability of occurrence. And this probability of occurrence may be calculated using the equation of motion dubbed the "Schrödinger equation." The formal framework of this equation is similar to that of Hamilton's classical equations of dynamics. However, Schrödinger's equation differs from the classical equations in that it gives only the probability of states, and not the states themselves. Nevertheless, one must consider that the physical system as such is entirely determined by Schrödinger's equation. Therefore, it would be wrong to conclude that there is no longer any determinism. The physical system is perfectly determined. However, its global states are superimpositions of probabilistic states in themselves. It is not possible, even in principle, to ascertain the state of the system prior to measurement. It is not simply question of being more or less precise in actual practice. For it is not possible, even in principle, to determine this state more precisely, even providing that a greater effort has been made, in principle one cannot know, except in a probabilistic way, the resulting state of the system. This probabilistic way, however, is exact and determined to the maximum extent.

Thus it is admitted, in quantum theory, that two distinct basic prodcedures describe the way in which the state function may change in time:

Procedure 1: *Schrödinger's equation*, which describes the continuous and deterministic change in time of a system; the function is that of a so-called probability wave.
Procedure 2: the *reduction of the state vector,*[48] which describes the discontinuous change caused by the observation of a measurable quantity; the probability of the reduction in a certain state is equal to the square of the absolute value of the wave function, which is mentioned in Procedure 1.

It should be noted that what goes by the name of the *complementarity principle* in quantum theory is a consequence of this twofold procedure of change in physical systems. It is concerned with the fact that all physical bodies at one and the same time have wave and particle characteristics. Every physical body or system (material, luminous, etc.) is accompanied by a so-called probability wave, which obeys the equation of motion described in Procedure 1. However, the measure of the

state of the physical system must indicate results in accordance with Procedure 2, showing a particletype behavior. The famous *uncertainty principle* signifies that it is impossible, even in principle, and regardless of the expenditure of time and effort, to ascertain precise and simultaneous measures of the position and speed of any physical body. The precise mathematical expression of this principle indicates that the product of the numerical errors, upon both these measures, must exceed a certain numerical value. The latter is identified as Planck's famous constant, within a constant factor.

It should be noted that the quantum theory, which appears to be one of the most precise theories in physics, has never been experimentally refuted. Furthermore, numerous kinds of new technical applications have arisen from this theory in chemistry, metallurgy, laser techniques, etc.

The analogy with Stage 5 of the child's development involves something special that was not considered in describing the previous stages: the child's behaviour in front of a mirror. As already noted, the child, at Stage 5, is apparently able to distinguish between virtual space (behind the visible surface of mirror) and real space (in front of the visible surface of a mirror). For the first time, he shows that he is able to use the reflection in the mirror practically, i.e., in order to locate an object, rub out a red spot on his nose, etc. Therefore, the experience of a child in front of a mirror becomes significant. In principle, one may admit that a mirror, as such, is not really required in order to allow the child to reach this stage of development. Instead, one can concede that a mirror reveals the child's new aptitude for being conscious of himself and his surroundings. Moreover, the mirror experience reveals that this aptitude presupposes that he discerns entities in space according to a new mental condition.[49] Now, this capacity for making a new distinction is analogous to that of modern science, when the latter uses the previously described distinction between both the procedures in quantum theory. The distinction between virtual space, created by the mirror, and real space, corresponds to the distinction between both kinds of temporal change, one being linked to the equation of motion (Procedure 1) and the other to the reduction of the state vector (Procedure 2).

Here, more precisely, is what happens in each of these cases, in both the child's consciouseness and modern science. The child thinks: "I am seeing myself, there, in the mirror." He knows that this is the visual image of his own body. Nevertheless, he feels his own body internally (by means of touching, or via internal senses such as kinesthesia or somesthesia) and knows: "I am here, in front of the mirror," Then

he is, at one and the same time, there, behind the mirror surface, and here, in front of the surface. However, both these "Selves" are distinct from one another, owing to their respective ways of being comprehended. One is purely visible and intangible, while the other is essentially tangible and only partially visible (that is to say, the child can see, without a mirror, a smaller part of his own body). The child, at this stage, seems to experience this quite naturally. As a matter of fact, in a practical way, he uses reflections in the mirror, which are precisely comparable to the visible objects in the real space. However, there is no doubt that something special is happening in the child's brain at this time. A restructuring of his global perception, including the perception of himself, takes place on this occasion.

According to the above, the essentially new element developing in the child's consciousness corresponds exactly to the new conception of reality that has developed with quantum theory. This consists in acknowledging that other people have also a causal being-for-itself and consequently, an independent existence apart from the child's. This discovery is as fundamental to the development of the child's Self as quantum theory is to the conception of reality constituted by modern science. This discovery is analogous, in terms of the child, to that of the uncertainty principle, in terms of modern physics. In effect, discovering that other people exist as causal agents means appreciating that objects are no longer subject, *even in principle*, to the action will of the child alone. One should understand, here, that the discovery of the will and actions of others is not merely tantamount to the admission that things are often unforeseeable. This was already largely known by the child. Instead, his discovery consists of something else. No matter how great his effort, the child discovers he cannot entirely determine what the objects and beings around him do or become. For example, he is now able to understand that an object, which had been covered with a veil, may be surreptitiously moved by an invisible hand. Consequently, the child has now escaped the "error of stage four." Escaping this error is equivalent to admitting that there is an essential element of uncertainty in beings.

It may be useful to mention here that the discovery of a causal being-for-itself in others contributes to the child's consciousness not only of his individual being-for-itself. As emphasized above, this means in effect that the child is able to imagine that others exist independently of himself, and can act in an unforeseeable way, even in principle. However, as noted in connection with the new capacities of the

child at this stage, it is apparent that he is able to vary his strategies in order to find an object hidden under a veil. This means that his present Self is no longer tied to the habits of success he had acquired previously. In a profound sense, this also means that his present Self is no longer determined by his past Selves, and that the child appreciates his present Self as unique or distinct from his past Selves. Thus the child discovers his present being-for-itself as he discovers his own individual being-for-itself.

Several other features of quantum physics correspond to elements of Stage 5 of the child's development. While the child has become able to ascertain the difference between virutal and real space, his primary experience in front of a mirror involves several really surprising elements. While this experience is particular, it is nevertheless generally significant in the conception of the child's individual being-for-itself. Likewise, in quantum physics certain (real or "gedanken," meaning "thought") experiments are used as paradigms in order to illustrate certain specific characteristics. The so-called "double-slit experiment" is one of these.

The double-slit experiment consists in making a ray of light pass through two long, narrow, parallel slits in order to obtain an interference phenomenon (see Figure 4). Monochromatic light is used to simplify the process of analyzing the results. One observes alternately bright

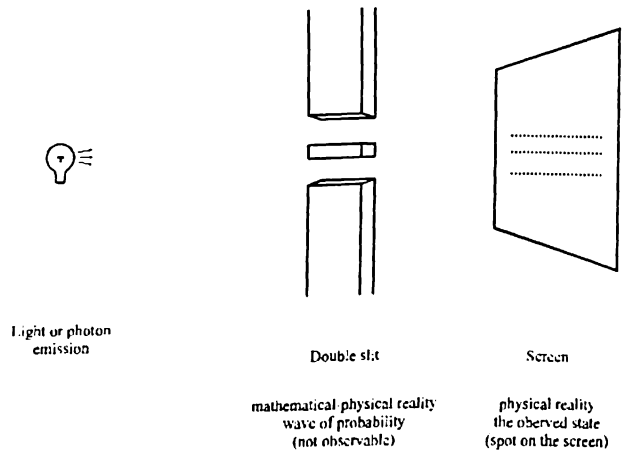


Figure 4

and dark bands or interference fringes on a screen placed behind the double-slit device. According to the classical wave theory of light, the observation of such fringes does not pose any problem since their production is naturally involved with the fact that light is a wave phenomenon. However, one runs into problems if light is conceived as composed of particles. That light is composed of particles has been experimentally demonstrated (especially by the photoelectric effect). In quantum physics, a narrow light ray behaves as a wave when it passes through the double slits, and as a particle in terms of its location on the screen. In this case, the light is considered to be passing through both slits *at one and the same time*, even though there is only one spot pinpointed on the screen. In this case, the light is considered to be passing through both slits *at one and the same time*, even though there is only one spot pinpointed on the screen. This means that only one particle, or photon, has passed through the slits. This photon will be recorded on the screen according to a probability of presence expressive of its wave-like behavior. In other words, the probabilities of presence are at their maximum at the centre of the bright fringes, and null at the centre of dark fringes. Figure 4 is made up of two parts. The first, associated with the double-slit device, deals with the mathematical-physical aspect of reality, which shows the "wave of probability." The other, associated with the screen, deals with the strictly physical aspect of reality, that is to say, the actually observed photon spot on the screen.

A physicist can easily verify that, if only one slit is open, the photons will not be distributed as interference fringes on the screen. Instead, they will be distributed rather uniformly. In this case, there is in fact no interference.

Let us consider the case in which a photon is presented with a double-slit device and an interference phenomenon is observed. A physicist might then wonder how it is possible that one photon passes through two slits at one and same time and thus interferes with itself. How does a photon "know" that there are two slits opened, rather than just one, and how does it manage to prohibit itself from going to certain places on the screen (dark fringes)?

Let us now consider a child in front of a mirror. He is fascinated by what he sees in it and can amuse himself for a while there, observing various strange phenomena. He sees his own image far away, in the virtual space behind the mirror (see Figure 5). He also appreciates that his own image moves as he wishes it. Moving his hand here, he sees it

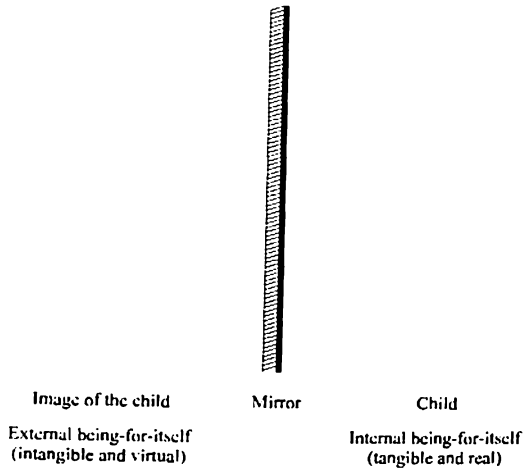


Figure 5

over there, moving in exactly the same way. The accuracy of the image is remarkable. The hand he sees over there is truly his. However, to go by his inner sense of how things are, following his sense of touch for example, he knows at the same time, and in an apparently inconsistent manner, that he is here and not there. The child, who is beginning to constitute his Self, that is becoming aware of the fact that he has an individual being-for-itself, ascertains, or believes he ascertains, that his being-for-itself, is twofold: one part is here, quite tangible, while the other is over there, intangible but eminently visible.

In Figure 5, the child appears on the right while his own mirror image occupies the left. The child has an inner being-for-itself, one that is both tangible and real. To his eye, his image represents another part of his being-for-itself, one that is external, intangible and virtual. Let me repeat that the child's individual being-for-itself corresponds to the scientific conception of physical reality. The child's mirror image is, in certain way, construed as a part of his being-for-itself. This confusion is easily understandable since the child is only beginning to form his being-for-itself. Now, in quantum theory physical reality appears in the form of a waveparticle that passes through two distinct places at one and the same time. This reality is fundamentally analogous to the virtual image of a child in a mirror. Indeed, a photon appears to be really a probability wave, that is to say, a mysterious mix

of physics and mathematics. Is this photon, as a waveparticle, truly a real object, or merely a mathematical entity? Mathematical formalism makes it possible to predict exact observable results — as exact, let us say, as one's own mirror image. The mix of virtuality and reality forms the basis for an analogy between the child's being-for-itself and physical reality. Just as the mirror gives rise to a doubling effect, or a doubling of individual being-for-itself, the behavior of the light or photon creates a split in physical reality. And the precise meaning of this analogy is entirely consistent with previous analogies with respect to other stages of physics.

The correspondence with the mirror experience is particularly revealing and suggestive in the case of the theory known as quantum electrodynamics. This is an extension of quantum theory, and deals specifically with electrons and photons. While its experimental predictions are remarkably precise, this theory is not entirely consistent since it generates infinite answers which are so cumbersome that they need to be reduced by means of an ad hoc procedure called "renormalization." In this can be seen one of the most disconcerting effects of quantum physics. While it is one of the most efficient and precise theories, some of its apparently necessary features are impossible to imagine. Let us consider another feature of this theory. Quantum electrodynamics makes it possible to create pairs of particles and antiparticles in a vacuum. The word "antiparticles" is in fact another name for "particles of antimatter." Antiparticles have the same mass as their corresponding particles (for example, the positron with respect to the electron), but their electric charge is the opposite (and the same holds for the leptonic or baryonic charge). When a particle meets its antiparticle, both are annihilated and produce an electromagnetic energy equivalent to that of their combined masses.

This situation in physics is analogous to that of a child who observes himself in front of a mirror. The image of himself, he perceives, is surprisingly exact. It is truly himself, down to the smallest detail. However, this exact image is accompanied by a strange unreality. The child may appreciate, though in a confused way, that his features are reversed, that is, his right hand is in the place of his left hand, etc. Moreover, curious inconsistencies and anomalies happen in the mirror. If he attempts to touch his own image, he will observe an extraordinary phenomenon. He will see his virtual hand coming near his real hand, and, in some way, it will prevent him from meeting his virtual body. Just as both hands come into contact, the child suddenly feels

the coldness of the glazed surface. He then appreciates that these two parts of his individual being-for-itself are cancelling each other out, leaving only a cold sensation in his fingers tips. Thus the child becomes conscious of the unreality in a good part of what he sees. As in the case of modern physics, he comes to appreciate that exactness sometimes strangely coincides with unreality. He becomes aware that his visual sensations can be organized into a perfectly symmetrical working order and then be annihilated, leaving another sensation, this time a tactile one, to become the determining factor in his consciousness. These are some of the peculiar mirror effects that correspond to the conceptual effects produced by quantum electrodynamics.

Table 7 summarizes the main correspondences described above:

The Stage to Come

Child psychologists are unanimous in recognizing that language acquisition in a child is of crucial importance to his whole understand-

Table 7 Synoptic Table of the Correspondences Between Stage 5 and Quantum physics

Infantile Development (Stage 5)	Development in Science (quantum physics)
The acknowledgment of objects and others as being independent from one's Self (the essentially undetermined character of the sensations caused by other)	Probabilistic physics (uncertainty principle: the essentially undetermined character of the position and speed of a physical, real body)
The mirror experience: ability to distinguish virtual and real space	The double-slit experiment: illustration of the complementarity principle and twofold procedure (the equation of motion and the reduction of the vector state)
The virtual self-image: purely visual; the real self: tangible and partially visual	Probability wave: physical-mathematical entity; reduced state: observed physical entity

ing of the world and, especially, himself. During the prelinguistic period, which broadly coincides with the first stages already described, the child advances from wailing to crying, and then to babbling. When he is about eight months old he pronounces "mama," further sparking his mother's enthusiasm. At the end of the fifth stage, the child has, on average, a vocabulary of eighteen words. He then begins to make one- or two-word sentences. One-word sentences are the most prevalent, and they are often used in the imperative. During the sixth stage, sentences composed of three or more words appear. Towards the end of the sixth stage, the child begins to speak about himself in the first person, using "I" or "me."

This moment is acknowledged to be critical, not only for the acquisition of the child's expressive capacity, but also in terms of his consciousness of himself and others. One should note that this is a critical moment for the acquisition of his self-consciousness *through* that of others. In other words, for the first time, the individual being-for-itself of the child creates itself through the acknowledgment of the existence of other instances of being-for-itself. This accords very well with the way child psychology describes the sixth stage of the sensorimotor period. The child can verbally identify himself in front of the mirror, and can also extend this operation to others. He recognizes himself in them and them in himself, inasmuch as he can imagine that they too have a self-consciousness, or individual being-for-itself, even though the latter is not directly accessible to him at all. This is revolutionary for the child. It undoubtedly corresponds to the no less revolutionary change in our scientific conceptions of physical reality.

The acknowledgment of the existence of other instances of individual being-for-itself corresponds to the admission by science of realities that exist separately from the reality of the physical Universe. And this conforms to the basic correspondence between a being-for-itself and physical reality. At the present time, this Universe is the only "real universe" to be acknowledged as such. The other universes are considered only as "possible universes." New developments in physics should make it possible to acknowledge that several other universes, which are now considered as only possible, are in fact as real as ours.

This approach therefore makes it possible to confirm the relevance of the "multiple universe" approach. However, we are concerned with something very different from what we generally think of when we use this term in contemporary physics. These multiple universes should not be thought of as abstract models that reproduce certain mathematical or

formal characteristics. Instead, they should be conceived as *universes of ideas* comprising not only mathematical and physical features, but also features from all scientific disciplines.

We may readily concede that other real universes are only indirectly accessible to us, just as other instances of being-for-itself can only be indirectly accessible to the child. Indirect access is made possible especially through language. The child's ability to talk with others about what he and they feel constitutes a privileged access to the others' "interiority" or being-for-itself.

The correspondence with physical reality presumes that we know what expressions such as "other instances of being-for-itself," "speaking" and "talking" translate into within the realm of physical reality. Quantum probabilism reveals a kind of relationship to "others" that appears to be enigmatic and disconcerting, or, to say the least, highly incongruous. A higher-order language would be, to be sure, a tremendous turning point in the view of today's science. However, this language will doubtlessly quite naturally compel its own recognition. We can still expect science to discover new realms of the fantastic.

We have been using our knowledge of the stages of child development to shed a little more light on future conceptions of physical reality. We are now in a position to make a number of predictions. First, it appears that the conception of physical reality taught by contemporary science will undergo great transformations, comparable, in fact, to those experienced by a young child learning to speak. On this point, it is interesting to note that several physicists are also expecting upheavals in theoretical physics in the near future. For example, Roger Penrose (1989, p. 368), recognizing the conceptual difficulties in quantum theory, foresees a "grand shake-up," one "even greater, perhaps" than that caused by the theories of relativity and quantum mechanics. This author has reason to believe that problems concerning the nature of human consciousness and physical reality should be dealt with together.

Systematic analogies between the developmental stages of the child and those of science appear to support yet another prediction. It seems that the next important stage in the conception of physical reality can be linked to the idea that the "child," represented here by global human society, is on the verge of learning language. But what language are we talking about? In other words, what kind of language is it? Obviously it is very different from the one spoken and understood by human individuals. Indeed, it is as different from language in the usual sense as science is from individual consciousness, or the scientific conception

of physical reality from the individual being-for-itself of a child. The kind of language we are talking about here is totally unheard of. Analogies based upon profound alterities, as in the approach used here, seem to be the only means we have to help us begin to describe and understand it.

We can, therefore, imagine a new physics and, by extension, a new science that is innovative with respect to language, just as quantum mechanics has been innovative with respect to the indetermination inherent in the existence of others, or relativity with respect to the limitation of one's own body. In this sense, the language of the above sentence already gives evidence of a new language that works by way of analogies and metaphors. However, this language is still at the same level as language in the usual sense of the term. We need, then, to find a way to shape a more complex and organized language, and I believe that this is what ideometry allows us to do. In a formal sense, ideometry is a kind of echo of another order of language in which ideas, in the broadest meaning of the term (i.e. principles, theories, questions, etc.,) take the place of phonemes and disciplines (scientific or otherwise) take the place of words. And, again in this language, ideometric relations among disciplines take the place of sentences.

Table 8 summarizes the main connections described above:

Although the few connections outlined here are very schematic, they shed light on the direction in which we are going. They are merely a first approach to some aspects of future science.

Table 8 Synoptic Table of the Correspondences between stage 6 and Post-quantum Physics

Infantile Development (Stage 6)	Developments in Science (the post-quantum physics of the future)
The acknowledgement of individual instances of being-for-itself in others	The acknowledgement that physical reality does not reduce to one "real Universe" but that other possible universes are real as well
The child's aptitude for language: the capacity to understand meanings from ideas connected with each other	The aptitude for another kind of language: science's capacity to understand a new kind of meaning from ideas connected with each other

CONCLUSION: THE AUTO-ORGANIZATION OF IDEAS: TOWARD AN IMPENDING EMERGENCE

I propose here that the set of our current scientific ideas be considered as a particular kind of self-organizing system. I refer to this phenomenon as the "auto-organization of ideas." In keeping with a practice that has become widespread, particularly in the cognitive sciences, the evolution of organized systems, or the phenomenon of self-regulation, can be seen as a process of increasing structural and functional complexity. This process generally implies a series of levels of increasing diversity. In this case, the system which has become more and more complex is the set of scientific ideas, inclusive of mathematics and the natural and social sciences. This approach is in conformity with what I have called "ideometry," because it has us consider the ideas in themselves, independently of any reality they supposedly represent. The complexity of this system of ideas naturally reflects that of the human brain. One can now pose the problem of the possible existence of a form of organization more complex than that of the human brain, a form that may already be making its appearance on the level of global human society. How can we establish that this form of organization exists? In what way would it manifest itself? What would it mean to us, to our conceptions and our plans?

The ideometric method enables us to begin to answer these questions. However, this requires a logic of alterity rather than one of identity (cf. Module 3). And it implies that the auto-organization of the system of ideas possesses a nature that is profoundly different from other forms of auto-organization already studied in physics and in biology in particular, although there are correspondences between them at the conceptual level.

The System of Scientific and Rational Ideas

The set of scientific and rational ideas exhibits a unity and an efficiency, as well as an overall stability, comparable to what we find in the auto-organizing systems that occur in the natural sciences in general (for example, in a cell or a nervous system). People usually overlook the fact that the set of contemporary scientific disciplines

forms a whole system; rather, emphasis is placed on the lack of unity exhibited by the specialization of disciplines. A global, external and long-range view is required if we are to acknowledge the existence of this system of ideas. Only in this way can we appreciate the fact that rational ideas form a set characteristic of human consciousness in any given epoch, and that its various parts are connected by many bonds. Moreover, we can see that this system of ideas has properties of resilience which correspond to those of systems such as the human brain or the genetic code. For the system of ideas retains its overall stability, even though particular theories are refuted and statements invalidated or challenged. Such rejections are tantamount to the formation of mutilations (or mutations) that generate a different closed network with a different structure. The system of ideas admits errors as part of its normal functioning. It is constantly undergoing perturbations, in the form of new discoveries or new criticisms. It not only outlives these perturbations, but uses them to transform and improve itself, assuming greater levels of complexity. The various disciplines composing this system are, in fact, connected by many bonds themselves, as all interdisciplinary studies show. In short, the system maintains its unity despite the relative independence of its parts.

It should be noted that the system of ideas, like the brain, does not have a central control unit or single discipline capable of regulating all the others. Instead, the various disciplines behave as a "tangled hierarchy" (to use an expression of Douglas Hofstadter [1979]). Mathematics, for example, appears to be at a higher control level than the natural sciences (in the sense that they set *a priori* constraints), just as the natural sciences are higher up in the hierarchy than the social sciences. However, the latter in turn allow us to place mathematics within a history that determines it.

The absence of a central control unit in auto-organizing systems has been ascertained not only in the human brain, but also in the genetic system of the cell. The genetic system is often described as a kind of "genetic program." It has been proven that this kind of "program" is not located in the DNA molecule itself, but is, as it were, distributed throughout the entire cell. It is indeed a very special kind of program which requires that the end results of reading and executing it be available in order for it to be read and executed. Something similar could be said about the system of ideas. There the exact sciences represent a kind of program that controls

the system. This kind of program would, then, have the very characteristics mentioned above: it would require the products of its reading and execution — namely, living and human beings — in order to be read and executed, that is to say, in order to become explicit and to be brought into play as a scientific conception.

Contemporary human society seems to have embarked upon an accelerated process of auto-organization. This situation corresponds ideometrically to those that led to the emergence of the human brain or the first living cell. A common point in these three situations is the emergence of a new kind of language. In the case of the living cell, the DNA and the genetic code constitute a kind of biological language whose sentences (composed of molecules) represent the various forms of biological organization. Having become more complex, these forms led to the emergence and auto-organization of the nervous system. When this had become developed enough to allow the emergence of human cultures, a new kind of language, very different from the preceding one, appeared. It was made up of all the tongues spoken by human beings. And this led to a gradual increase in complexity comparable to, although very different from, the increase in biological complexity made possible by biological language. The growth in complexity of human societies has given rise to an evolution of cultures profoundly different from biological evolution. The result is the current situation of human cultures.

The emergence of a new kind of language can be predicted from ideometric correspondences. This new kind of language is as different from the natural tongues as these are from the genetic code. In order to see what this new kind of language could be, let us consider the following sequence:[50]

Biological organization: genetic code (based on nucleic acid *molecules*)

Anthropological organization: human tongues (based on the *sounds* emitted by the human voice, i.e., the phonemes

Meta-anthropological organization: meta-language (based on *works of human creation*)

In line with this perspective, meta-language will be based on works of human creation, with the latter serving as meta-phonemes. In other words, creative works will be linked together to create new kinds of meaning or meta-meaning. Now this is precisely what ideometry has already set out to do, create new kinds of meaning through the linking together of ideas in "ideometric relationships."

The Hypothesis of the Existence of another Sort of Complete Structure

Whatever problems still prevent us from fully understanding the complete structures known to us, we can understand the situation more globally through the very concept of the complete structure. By considering the problems in a unified and global manner,[51] we can take a short-cut past them. The three kinds of complete structures presently known — the atom, cell and human being — evidently form a *sequence of embodiments* that can, in principle, be extended.[52] But what would follow the human being in this sequence? A much larger structure would have to be conceived, one that would have the human being as its basic element (just as the cell is the basic element of the human being, and the atom the basic element of the cell). Moreover, this larger structure would have to be very complex and integrate a multiplicity of functions. This notion becomes more and more conceivable when we think in terms of human history and the global human society that exists on Earth. Our world is beginning to appear as a more and more organized structure. And global humanity does really seem to be assuming the form of a highly complex organism. Thus the following hypothesis can be formulated:

Hypothesis H: Humanity, as we know it on this Earth, is taking the form of a complete structure.

This hypothesis arises naturally when we consider the above-mentioned characteristics of a complete structure, that is, the fact that it is highly problematic and organized. Relatively recent developments in global organization, particularly technological progress in the areas of communication and information, must also be taken into account. If we now take this hypothesis seriously and consider the global consequences, we can see that it should lead to a profound change in all our ideas, and even in rational thought as such. For if humanity is a complete structure in the making, then it could become a complete structure, in the full sense of the term[53] at some time in the foreseeable future. Moreover, this structure in the making should, like the other complete structures, coexist with many other homologous structures, in other words, with many other structures that are at the same level of complexity as humanity. At the moment, though, humanity is the only known structure of this kind.[54]

The advent of this new complete structure seems to be imminent within our historical horizon. Drawing upon the remarkable acceleration

of technological progress, we can forecast a probable change of this structure within the next few decades.[55]

The consequences of hypothesis H could extend even farther. For if humanity forms a complete structure, then, by definition, it will become a constitutive unit of another level of reality. This points to the existence of an exterior reality which has been ignored by the whole of present-day science. In this exterior reality, many other homologous complete structures would exist and interact with each other and with the structure in which we are the elements.[56]

In light of the above, ideometry appears as an echo of another type of language "spoken" by super-subjects whose higher-level structures represent "brains." Of course, we are using familiar terms ("spoken" and "brain") to designate something unknown which is undoubtedly very different from what these words usually mean. Although we cannot totally escape the anthropomorphism in our descriptions, we can free ourselves sufficiently from it by being aware of the huge difference between different levels of complete structures. Hence it is important to use a new concept of alterity in a strictly formal manner.[57]

NOTES

1. Therefore the properties of anti-reflexivity, anti-symmetry and anti-transitivity are involved.

2. The author has published several articles in which ideometric relations are applied to various domains: "Une analyse de la notion d´objectivité" ("An analysis of the notion of objectivity") *Philosophiques*, Vol. XIV, No. 2, 1987: 361–380; "Vers une éthique de la désacralisation de la vie" ("Toward an ethic of desanctification of life"), *Horizons philosophiques*, Vol. 4, No. 2 (Spring 1994): 81–110), "Exponentielles d'ordre supérieur" ("Higher order exponentials") *Bulletin AMQ. Association mathématique du Québec* (March 1994): 36–42.

3. I refer here to the "eukaryotic" cell, which has a true nucleus, unlike the "prokaryotic" cell, which is more simple. The eukaryotic cell appears as a fundamental constituent of all multicellular organisms.

4. The suspension points indicate that the sequence can be continued. In the last module, I have outlined what we can presently say about such an extension.

5. The concept of alterity, as defined here, precisely specifies the formal properties of the following relation between A and B: "A is a complete structure embodied in another complete structure B." Thus the reader can see that the alterity approach allows us to obtain results using the complete-structure approach. However, the former is more formal and more general.

6. These presupposed features are *symmetry* and *bipolarity*. It can be shown that the notions of identity and alterity, taken in their most general senses, involve certain hidden, presupposed features, that is to say, implicit features which constitute logical constraints on scientific or philosophical modes of thought. Elucidation of these features enables anti-equivalent alterity to be free of them.

7. The reader must pay careful attention to this point because it could be misunderstood. One can easily confuse anti-transitivity with intransitivity and thus think — quite incorrectly — that anti-equivalent alterity applies to more situations than, in fact, it does, especially to those in which there is simply a sequence of differences.

8. The word "instance" here can be taken to mean an entity, being, object or thing in general.

9. It will be convenient here to include chemistry in the so-called physical domain since all fundamental theories used to describe chemical phenomena are in fact theories derived from physics.

10. Marvin Minsky, *The Society of Mind*, Glossary, under "Society".

11. Teilhard de Chardin, *L'énergie humaine* (*Human energy*), p. 55 (my translation).

12. *Le Phénomène humain* (*The human phenomenon*) (Paris: Seuil, 1955) p. 268 (my translation).

13. Minsky, *The Society of Mind*, p. 314.

14. *Op. cit.*, p. 82 ff.

15. *L'énergie humaine*, p. 23 (my translation).

16. For example, in *L'énergie humaine* (page 25), he writes that "everything... *so long as it puts itself in the line of progress ...*, heats up, is illuminated and animated ..." [Teilhard's emphasis] He repeats that Man, as a species, is converging toward a unique point of perfection, akin to God.

17. Just as, on another level, the emergence of the human brain (and the individual human mind) has not been formally determined by physical or biological laws.

18. The word "child" here must be understood to mean a growing organism. This encompasses an unusually broad meaning, covering embryos, fetuses, newborns, infants, etc.

19. Known crimes can be defined as crimes reported to the police. The number of unreported crimes is doubtless large due to several factors, for example, reluctance on the part of the victims, or the deliberate distortion of the reported information.

20. I show below that this child is still at a relatively backward stage: that of a quasi-infant or, at least, of a child who is not yet speaking.

21. See for example Paul L. Harris, "Infant Cognition," in *Handbook of Child Psychology*, ed. Paul H. Mussen, 4th edition (New York: John Wiley & Sons, 1983) p. 744.

22. See, for example, J. Stone, B. Dreher, and A. Leventhal, "Hierarchical and Parallel Mechanisms in the Organization of the Visual Cortex" (*Brain Res. Rev.*, I, 1979) : 345–394; and M. Imbert, *La recherche en neurobiologie* (*Research in neurobiology*) (Paris: Editions du Seuil, 1988), pp. 120–124.

23. The topic of "paradigm shifts" has become very well known. A seminal work in this area is: Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970).

24. See Henry Kennedy and Colette Dehay, in *La recherche en neurobiologie*, p. 339.

25. See Bernard Cardo, *La recherche en neurobiologie*, p. 273 ff.

26. See J. Allan Hobson (1988), p. 203.

27. Ideometric correspondences with the stages of mental development place the approximate age of our present society/child at a little less than two years. In other words, it can walk but has not yet learned to talk.

28. On this point, see Marvin Minsky, *op. cit.*, p. 208.

29. See R. H. Dicke, "Dirac's Cosmology and Mach's Principle," *Nature* 192, 1961, 440 ff.; Brandon Carter, "Larger Number Coincidences and the Anthropic Principle in Cosmology," in M.S. Longhair ed., *Confrontations of Cosmological Theories with Observational Data* (Dordrecht: Reidel, 1974).

30. I refer here to the *strong* version of the anthropic principle rather than the *weak* one. According to the latter, only the relative temporal position of the observer in the universe is determined by his existence.

31. This situation poses a significant problem for scientists who wish to take the Gaia hypothesis seriously. If these regulatory mechanisms have become so efficient, one must suppose that there was something akin to natural selection. But then how could such natural selection have worked for Gaia, since it concerns only one individual? Where are the other Gaias? According to my approach, the Gaia concept and these related questions mean that the young child is beginning to suspect that his own existence involves that of other metasubjects in exoreality. As a matter of fact, if he were alone, he would not be able to understand his own existence and character.

32. A good example is in the development of mathematics by the ancient Greeks. The study of conic sections was quite gratuitous at first. More than a thousand years later, its results became of a crucial importance when Kepler discovered his famous laws, which describe the planets' movements. These laws were again recycled by Newton, thanks to his principles of dynamics, and thus will have initiated all of modern science.

33. I recall that, according to Piaget and most child psychologists, a young child is at first deeply egocentric. He progressively escapes this egocentrism and acknowledges the existence of others. In other respects, the expression "being-for-self" has denotations that vary according to philosophical traditions and authors. The denotation of the separation of a being-for-self appears more in the German tradition, where the expression *fur-sich-sein* has the meaning of being separated or isolated from other beings.

34. The property of uniqueness could be described otherwise. For example, one could replace it with the insularity, exclusiveness or absoluteness of being-for-itself. All of these expressions are somewhat imprecise and even inaccurate. A more precise and exact way of characterizing a being-for-itself would proceed by way of the *anti-equivalence* property, which would involve *anti-transitivity*.

The property of uniqueness is only a first, approximate approach to this method. See the chapter on anti-equivalent alterity.

35. For example, in formulating the "anthropic principle," Brandon Carter (1974) has tried to explain certain numerical relations which have been noted between physical constants.

36. This difference between the concepts of being-for-itself and reality is profound and constitutes a particular case of anti-equivalent alterity.

37. These three expressions, in the order in which they appear, constitute, an ideometric sequence. The formal properties of anti-equivalence allow for a better understanding of what makes this type of conceptual phenomenon possible.

38. Certain authors think that Piaget neglected certain fields of development, for example the emotional and social dimensions, or the respective cognitive developments of the adult and fetus.

39. In a very approximate manner (but one that will nonetheless help us to fix our ideas), the end of the first period corresponds to developments in science expected over the next few decades, while the second period corresponds to the scientific developments that will take place in the next century.

40. For example, Thomas Kuhn (1972) interprets these new structurings in terms of "paradigm shifts," while Imre Lakatos (1978) characterizes them as "research programs." In some ways, both authors would agree with the above mentioned points.

41. For example, E. B. Hurlock (1972) and D. Wallon (1978).

42. Both of these stages are often dealt with together due to the very limited character of the capacities developed during this time, especially with respect to the child's consciousness of himself and the permanence of objects.

43. See in Module 8: "Physical Reality as the "Being-for-itself" of the Child/Society".

44. Denis Wallon, *Votre enfant de 0 a 6 ans*, in collaboration with Michelle de Wilde (Paris: J. -P. Delarge, 1978) p. 16.

45. See, for example, Chapter 2 of Albert Einstein and Leopold Infeld, *The Evolution of Physics. The Growth of Ideas from Early Concepts to Relativity and Quanta* (New York: Simon and Schuster, 1961).

46. Concerning this particular point, see Marie Antoinette Tonnelat, *Histoire du principe de relativite* (*History of the principle of relativity*) (Paris: Flammarion, 1971) p. 7 ff.

47. Mathematicians and physicists usually make understand this by comparing it to the finite but unlimited surface of a sphere. In this case, however, we are concerned with a four dimensional universe, not a three-dimensional sphere.

48. Here I am adopting John von Neumann's terminology. See his *Mathematical Foundations of Quantum Mechanics* (Princeton: Princeton University Press, 1955).

49. In principle, the mirror is not necessary inasmuch as the virtual image of the child can be replaced by the presence of another child (or person). Essentially, if the other child (or person) is acknowledged as having his own individual being-for-itself (though one that is inaccessible in a direct way) then this exactly reproduces the relevant conditions of the mirror experience.

50. This sequence comes close to defining a new transdisciplinary concept (parallel to the concept of complete structure) which is that of the *linguistic element*. This is defined as a basic element for forming expressions in different ideometric levels of languages. Informally, one can see that linguistic elements within the third level of complexity should be related to what human individuals can do — just as nucleic acids are first produced at the physical-chemical level, and sounds at the biological level. Moreover, works of human creation are shaped and made distinctive by human individuals, just as sounds are formed and distinguished by the cells in the brain. Therefore, these are human works of creation themselves, whose mutual connections can create new levels of significance.

51. We are essentially referring to the problems of origin and function.

52. The formal justification of this assertion presupposes that the formal properties of anti-equivalent alterity have been used. In the present case, we will be content with informal evidence.

53. Let us recall that a complete structure is, by definition, a constitutive unit of a whole range of reality.

54. Our situation within a complete structure in the process of taking shape corresponds to that of neuron cells inside the developing infantile brain. Should we consider this higher level "child" to be at the embryonic or fetal stage, or rather at the "newborn" or "infant" stage? That this "child" is already "born" is suggested by the existence of modern science, which should be considered as a sort of evolving infantile consciousness that is continually in the process of discovering a new world.

55. With respect to the power of computers, we may cross a threshold in about 30 years. This power has accelerated at a significant and rapid rate for a number of decades, and may continue at the same rate for the next three. Cf. in particular Hans Moravec, *Mind Children: The Future of Robot and Human Intelligence* (Cambridge: Harvard University Press, 1988).

56. I have called this exterior reality "exoreality" to convey the sense of its "more exterior" nature. Exoreality must not be confused with physical objects, which are exterior only in an ordinary way, i.e., exterior yet part of the same universe (e.g. planets, stars, galaxies...). The way in which these are exterior is similar to the way in which various cells in an organism are exterior to brain cells of the same organism. In our case, however, exoreality represents the exterior of the organism itself.

57. We are concerned here with anti-equivalent alterity, whose formal properties are the inverse of those of mathematical equivalence. This shows that the complete structure approach converges with the results obtained by the alterity approach.

BIBLIOGRAPHY

Atlan, Henri 1983 L'émergence du nouveau et du sens. *L'auto-organisation: de la physique au politique* (The emergence of the new and sense. *Self-organization: from physics to biology*), Cerisy Colloquium, Paul Dumouchel and Jean-Pierre Dupuy, eds. Paris: Seuil.

Castoriadis, Cornelius 1989 *Autonomie et autotransformation de la société. La philosophie militante de Cornélius Castoriadis (Autonomy and self-transformation of society. The militating philosophy of Cornelius Castoriadis)*. Librairie Droz, Geneva, Paris.

Hofstadter, Douglas 1979 *Gödel, Escher, Bach: Eternal Golden Braid*. Amsterdam: Gordon and Breach.

Kuhn, Thomas 1970 *The structure of scientific revolutions*. New York: Harper and Row.

Lakatos, Imre 1978 *The methodology of scientific research programs*. Cambridge, New York: Cambridge University Press.

Laszlo, Ervin 1972 *The systems view of the world; the natural philosophy of the new developments in the sciences*. New York: G. Braziller.

Laszlo, Ervin 1991 *The age of bifurcation: Understanding the changing world*. New York: Gordon and Breach.

Lovelock, J. E. 1979 *Gaia, a new look at life on Earth*. Oxford University Press.

Minsky, Marvin 1986 *The Society of mind*. New York: Simon & Schuster.

Provençal, Yvon 1977 June. La conscience de l'observateur: de la physique théorique à la logique mathématique. (The consciousness of the observer: from theoretical physics to logic mathematics). *Dialogue* (Canadian Review of philosophy), Vol. XVI, *2*, 228–244.

Provençal, Yvon 1987 Fall. Une analyse de la notion d'objectivité. (An analysis of the notion of objectivity). *Philosophiques* (Université du Québec), Vol. XIV, *2*: 361–380.

Provençal, Yvon 1988 Spring. Remarques sur la notion de liberté dans l'histoire occidentale et sur son dépassement possible. (Observations on the notion of liberty in western history and on possibly going beyond it). *Philosophiques* (Université du Québec), Vol. XV, *1* 129–139.

Provençal, Yvon 1994 March. Exponentielles d'ordre supérieur. (Higher-order exponentials). *Bulletin A MQ. Association mathématique du Québec*, pp.36–42.

Teilhard de Chardin, Pierre 1955 *Le Phénomène humain*. (*The human phenomenon*). Paris: Seuil.

Teilhard de Chardin, Pierre 1958 *Construire la Terre.* (*To construct the Earth*). Paris: Seuil.

Teilhard de Chardin, Pierre 1959 *L'avenir de l'Homme.* (*The future of Man*). Paris: Seuil.

Teilhard de Chardin, Pierre 1962 *L'énergie humaine.* (*Human Energy*). Paris: Seuil.

Physiology:

Bach, J.F. 1981 *Immunologie*, (*Immunology*). Paris: Flammmarion, Médecine-Science.

Bach, J.F. 1982, February La reconnaissance de soi et ses dérèglements. (The acknowledgment of the self and its disordered states). *Pour la science*, no. 52, 68–79.

Barrington, E.J.W. 1978 Evolutionary aspects of hormonal structure and function. In *Comparative endocrinology*. J.P. Gaillard and H. H.Boer, Eds., (pp. 381–396). Amsterdam: Elsevier.

Bordet, P. 1972 *Traité d'immunologie.* (*Treatise of immunology*). Paris, Flammarion.

Cooper, E.L. 1979, September, L'évolution de l'immunité. (The evolution of immunity). *La Recherche, 10* (103) 824–833.

Fontaine, Y.A. 1984 Les hormones et l'évolution. (Hormones and Evolution). *La Recherche*, 153, 310–320.

Hedberg, A. 1983 Adrenergic receptors, methods of determination and mechanisms of regulation. *Acta Med. Scand.*, suppl. 672, 7–15.

Hobson, J, Allan. 1988 *The dreaming brain*. New York: Basic Books.

Imbert, Michel 1988 *La recherche en neurobiologie.* (*Research in neurobiology*). Paris: Seuil, pp. 120–124.

Klein, J. 1982 *Immunology: The Science of Self-Nonself Discrimination*. New York: John Wiley & Sons.

Malkinson, A.M. 1975 *Hormone action*. New York: John Wiley and Sons.

Rose, N. 1981, April Les maladies auto-immunes. (Auto-immune illnesses). *Pour la science, 42*, 50–62.

Social Systems:

Abraham-Trois, Gilbert. 1988 *Economie politique.* (*Political economics*). 4th ed., Paris: Economica.

Arndt, Helmut 1984 *Economic theory vs. economic reality.* William A. Kirby, trans. East Lansing: Michigan State Univ. Press.

Aubert, J.-L. 1979 *Introduction du droit. (Introduction to Law).* Paris: Presses Universitaires de France.

Borillo, Mario 1980 *Représentation des connaissances et raisonnement dans les sciences de l'homme (The representation of knowledge and reasoning in social science), Saint-Maximin Colloquium*, IRIA-LISH, (Sept. 17–19, 1979). Rocquencourt: Institut national de recherche en informatique et en automatique.

Burnstein, Meyer Louis. 1968. *Economic theory: Equilibrium and change.* London and Toronto: John Wiley & Sons.

Escarpit, Robert 1991 *L'information et la communication: théorie générale. (Information and communication: General theory).* Paris: Hachette.

Fusfeld, Daniel Roland 1982 *Economics: Principles of political economics.* Glenview, III, Scott, Foresman.

Jacquemin, Alexiz and Tulkens, Henry 1986 *Fondements d'économie politique. (Fundamentals of political economics).* Brussels: De Boeck-Wesmael.

Lenneberg, E. 1967 *Biological Foundations of Language.* New York: John Wiley & Sons.

Malloy, Robin Paul 1990 *Law and Economics: A Comparative Approach to Theory and Practice.* St. Paul, Minn: West Pub. Co.

Mercuro, Nicholas 1989 *Law and Economics.* Boston: Kluwer Academics.

Morin, E., et Piattelli-Palmarini, M. 1974 *L'unité de l'homme. 1. Le primate et l'homme. (The unity of Man: 1. Primate and Man).* Paris: Seuil.

Murphy, Robert 1988 *Stock prices, real exchange rates and optimal capital accumulation.* Washington, D.C.: International Monetary Fund.

Orianne, Paul 1982 *Introduction au système juridique. (Introduction to the judicial system).* Brussels: Bruylant.

Smith, Charles Williams 1981 *The mind of the market: A study of stock market philosophies, their uses and their implications.* Totowa: N.J. Rowman and Littlefield.

Child Psychology:

Flavell, J.H. 1985 *Cognitive development.* 2nd ed. Englewood Cliffs, N.J.: Prentice-Hall.

Harris, Paul L. 1983 Infant Cognition. In Paul H. Mussen (Ed.), *Handbook of Child Psychology*, 4th ed. New York: John Wiley and Sons.

Hurlock, E. B. 1972 *Child development.* New York, Montreal: McGraw-Hill Books.

Piaget, Jean 1921 Une forme verbale de comparaison chez l'enfant. (A verbal form of comparison in the child). *Archives de psychologie, 18*, 143–172.

Piaget, Jean 1922 La Pensée symbolique et la pensée chez l'enfant. (Symbolic thought and the thought of the child). *Archives de psychologie, 38*, 273–304.

Piaget, Jean 1926 *La représentation du monde chez l'enfant. (The representation of the world in the child)*. Paris: Alcan.

Piaget, Jean 1957 *Le jugement moral chez l'enfant. (Moral judgment in the child)*. 2nd ed., Paris: P.U.F.

Piaget, Jean 1963 *La naissance de l'intelligence. (The birth of intelligence)*. 4th ed., Paris: P.U.F.

Piaget, Jean 1964a *La formation du symbole. (The formation of symbol)*. Neuchâtel, Delachaux et Niestlé.

Piaget, Jean 1964b *Six études de psychologie. (Six studies of psychology)*. Paris: Gonthier.

Piaget, Jean 1967 *La psychologie de l'intelligence. (The psychology of intelligence)*. Paris: Armand Colin.

Piaget, Jean 1968 *La naissance de l'intelligence chez l'enfant. (The birth of intelligence in the child)*. Neuchâtel: Delachaux et Niestlé.

Piaget, Jean 1968 *Mémoire et intelligence. (Memory and intelligence)*. Paris: P.U.F.

Piaget, Jean 1970 In Mussen P.H. (Ed.). 3rd ed., vol. 1 (pp. 703–732). Piaget's Theory. *Carmichael's Manual of Child Psychology*. New York: Wiley.

Piaget, Jean 1977 *La construction du réel chez l'enfant. (The construction of reality in the child)*. 6th ed. Paris: Delachaux et Niestlé.

Piaget, Jean 1977 *La naissance de l'intelligence. (The birth of intelligence)*. 9th ed., Neuchâtel: Delachaux et Niestlé.

Piaget, J. and Inhelder, G. 1971 *Psychologie de l'enfant. (Psychology of the child)*. Paris, P.U.F.

Spitz, R. A., and Cobliner, W. G. 1968 *De la naissance à la parole: la première année de la vie (From birth to speech: the first year of life)*. (Trans. L. Flournoy) Paris: Presses Universitaires de France.

Wallon, D. 1978 *Votre enfant de 0 à 6 ans (Your child from 0 to 6 years of life)*. Paris: J.-P. Delarge.

Winnicott, D. 1973 *The child, the family, and the outside world*. Harmondsworth, Eng.: Penguins Books (First ed., 1964).

Theoretical Physics and History of Physics:

Brandon, Carter. 1974 Large Number Coincidences and the Anthropic Principle in Cosmology. *Confrontations of Cosmological Theories with Observational Data.* M. S. Longhair (ed.). Dordrecht: Reidel.

Cohen, David 1989 *An introduction to Hilbert space and quantum logic.* New York: Springer-Verlag.

Dicke, R. H. 1961 Dirac's Cosmology and Mach's Principle. *Nature, 192,* 440 ff.

Dugas, R. 1950 *Histoire de la mécanique. (History of mechanics).* Neuchâtel: Le Griffon.

Einstein, Albert 1989 *Quanta: mécanique statistique et physique quantique. (Quanta: statistical mechanics and quantum physics).* Papers selected and presented by Françoise Balibar, Olivier Darigol and Bruno Jech. Fr. Balibar et al., trans. Paris: Seuil.

Einstein, Albert et Infeld, Leopold. 1963 *L'évolution des idées en physique. (The evolution of ideas in physics).* Payot: Paris.

Everett, Hugh 1957 *Review of Modern Physics, 29,* 454 ff.

Hawking Stephen W. 1988 *A Brief History of Time. From the Big Bang to Black Holes.* New York: Bantam Books.

Penrose, Roger 1989 *The Emperor's new mind. Concerning computers, minds and the laws of physics.* Oxford: Oxford University Press.

Popper, Sir Karl R. 1982 *Quantum theory and the schism in physics.* Totowa, N.J.: Rowman and Littlefield.

Sakurai, Jun John 1985 In San Fu Tuan, (Ed.). *Modern quantum mechanics,* Benjamin/Cummings.

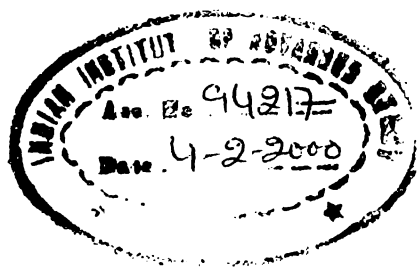
Taton, R. 1959–1966 *Histoire générale des sciences. (General history of the sciences). 4 vols., Paris: P.U.F.*

Tonnelat, M.A. 1971 *Histoire du principe de relativité. (History of the principle of relativity).* Paris: Flammarion.

Van Fraassen, Bastiaan C. 1991 *Quantum mechanics: An empiricist view.* Oxford: Oxford University Press.

Zohar, Danah. 1990 *The quantum self: Human nature and consciousness defined by the new physics.* In collaboration with I.N. Marshall. New York: W. Morrow.

INDEX



World Futures General Evolution Studies
Volume 12

The Mind of Society

From a Fruitful Analogy of Minsky to a Prodigious Idea of Teilhard de Chardin

Yvon Provençal

This book brings together the ideas of theoretician Marvin Minsky and philosopher Pierre Teilhard de Chardin. Provençal's theory inverts Minsky's "society of the mind" into the "mind of society," giving a new and firm basis to the Teilhardian idea of Noosphere and allowing for unsuspected transdisciplinary regularities between several scientific domains including physics, biology and anthropology. Provençal aims to show that a very special type of global, planetary consciousness is emerging and to explain better the way in which human ideas constitute a global, auto-organizing system.

About the author

Yvon Provençal is professor of philosophy at Collège de Granby, Québec, Canada, where he has taught for more than five years. Dr. Provençal also holds a master of science degree in physics and has taught physics at College Montmorency, Laval, Québec; Edouard-Montpetit, Longueuil, Québec; College de Victoriaville and Collège de Granby.

Also of interest

Evolutionary Change: Toward a Systemic Theory of Development and Maldevelopment
Aron Katsenelinboigen

Instinct and Revelation: Reflections on the Origins of Numino
Alondra Yvette Oubré

The Evolutionary Trajectory: The Growth of Information in th
and Future of Earth
Richard L. Coren

ISBN 90-5700-514-X
ISSN 1043-9331

Gordon and Breach Publishers Australia • Canada • China • France • Germany • India • Japan • Luxembourg • Malaysia • The Netherlands • Russia • Singapore • Switzerland

Library IIAS, Shimla
00094217

ISBN 90-5700-514-X
9 789057 005145