The Nomiotic-Wave Theory of Mind and Inherent Logic

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σοφόν ἐστι πάντων κεχορισμένον

(Heraclitus, Fr. 108)

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FOREWORD

This book formulates a theory of the mind, grounded in five fundamental aspects: 1) the mind is different from the brain as a whole because its processes directly involve the neocortex; 2) the mind generates *significant* processes and configurations; 3) the mind possesses an architecture and works with operational modalities; 4) the mental processes work with the transmission of *informational waves*; 5) the mind consists of several minds or mental units that operate independently or in synergy with each other in a parallel and syntotic way; 6) the mind possesses a logic that we call *inherent logic*.

Chapter One introduces a fundamental conception which is called *monist dualism*: *structural monism* and *operational dualism*. Structural monism states that there is only one matter; that is, the central nervous system (CNS) and especially the brain. Operational dualism holds that the CNS operates in two ways: one directly involves the neocortex and the other doesn't directly involve the neocortex.

Chapter Two, on the basis of monist dualism, analyzes the differences between brain processes and configurations, and mind processes and configurations, thus holding a distinction between the nonmental brain and the mental brain. The latter is characterized by the direct activation of different areas of the cortex, with the involvement of information coming from cortical, subcortical and noncortical areas.

Chapter Three presents an articulated theory of the mind that is called the *nomiotic theory of the mind*, the fundamental characteristic of which is the generation and processing of significances (nomiosis). The nomiotic theory of the mind is completed with many other topics: the relationship between the mind and language, locality and non-locality of the mind, mental expression and extension, metamental processes, autonomy and the unpredictability of mental processes.

Chapter Four deals with the architecture of the mind and the formation of mental structures that are called *nomiotic* or bearers of significances. Four types of mental structures will be analysed: *nosemes*, *menemes*, *propagemes* and *noograms*. An in-depth analysis is devoted to different types of noograms that drive all mental processes: a) assertive-gnosic noograms; b) self-noograms; c) pathic noograms; d) axiological noograms; e) doxastic noograms; f) perspective noograms. Within the flowing mental

dynamics, the roles that nomiotic structures play within the mental processes that they direct and guide will be analyzed.

Chapter Five formulates the *inherent logic*; that is, the logic of the mind. In particular, the relationship between *brain waves* and *mental waves* is analyzed, and it is emphasized that mental processes are grounded in the transmission of waves that transfer significant information. The inherent logic works with *significant bonds* among mental or nomiotic structures which operate syntotically through the transmission of information waves among mental structures and cortical and noncortical parts of the brain. Different types of significant bonds and two processes of connectivity – the *wiring connectivity* and the *wave connectivity* – are introduced.

Chapter Six deals with the distinction between the aware and unaware mind. What is called *explicit awareness* will be defined and the fact that most mental processes are not aware will be underlined.

Chapter Seven is devoted to the analysis of the different relationships between the mind and the body, and between the mind and the brain. The word *bodyness* will be used to refer to the mental representation of the body.

Chapter Eight deals with time in relation to the mind and analyzes what is called *history of the mind*, which is one of the key factors of the way in which the mind operates.

Chapter Nine examines two issues related to the relationship between the mind and the world: from one side, the knowledge of other minds, and from the other, the influences of the onticity of the world on mental structures and on empirical knowledge.

Although the neurosciences have developed well in recent decades, the knowledge of the CNS and the mind does not allow us to clarify the way in which they operate, and in particular to understand how to develop the mental processes that generate very diversified activities such as thinking, reasoning, imagining and formulating feelings and emotional states.

The *nomiotic-wave model* presented is not empirical but theoretical, although its wording refers to recent neurophysiological and psychological research findings. Many theses and statements are based on scientific findings, while others have tentatively argued points that could be verified empirically. Only a few cases are quoted essays and papers; in the References, all the texts that were useful for the formulation of the nomiotic-wave theory of the mind are indicated.

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CHAPTER ONE

PHYLOGENY, FORMATION OF THE MIND AND DUAL MONISM

1.1. Phylogeny and Formation of the Mind

The encephalon of *Homo* (the modern *Homo sapiens sapiens*) and his mind are the outcome of genetic neuroevolutive processes which have been implemented over the course of millions of years and have generated the encephala of the *Homininae* and of the *Hominini* (*Australopithecus Afarensis*, *Australopithecus Robustus*, *Homo Habilis*, *Homo Erectus*, etc.) and, afterwards, of *Neanderthals* and *Homo sapiens sapiens*.

According to the theory of evolution, these processes have had an adaptive goal: the different encephala of the living species were modified to ensure them a better fit to an ecological niche. The theory of evolution – and particularly the notion of selective adaptation, even if nowadays they are the only plausible hypotheses – does not offer adequate and exhaustive explanations of the processes of genetic selection, which over millions of years have generated encephalic modifications that have given rise to the encephala of the living species, and particularly, those of mammals and primates.

The two more relevant aspects of this adaptive neuroevolutionary course are:

a) The process of encephalization: in other words, the increase of the size of the encephalon compared to the size of the body;

b) The organization of the cerebral matter: the formation of the different kinds of neural cells (neurons, glia, etc.), of neural structures (like the thalamus, hypothalamus, amygdala, cortex, etc.), of specialized cortical areas and of complex connections among neurons, populations of neurons and neuroanatomical structures (the so-called overall cabling or *connectome*).

These aspects have marked the neuroevolution of the CNS of mammals and primates (which, in its turn, is the result of the cerebral evolution of preceding species). This neuroevolution has operated within

the wider process of genetic evolution which involved the transformation of the entire bodies of living beings. The neuroevolution (the biological evolution of the various CNS) is a relevant aspect of the genetic evolution of living species, which has been characterized by deep transformations of species, the birth of new ones and the disappearance of others.

The difference between the encephalon of anthropoid apes (chimpanzees, bonobos, gorillas and orangutans) and that of *Homo* is part of the wider genetic diversity of these living beings that have generated organisms with different bodies. The difference between the encephala of anthropoid apes and *Homo* concerns various anatomical and functional aspects, among which the more relevant, as far as our analysis is concerned, are those of the structure and functioning of the cortex with respect to the other parts of the encephalon and of the entire CNS. Among the many anatomical and neurophysiological characteristics that differentiate the cortex of *Homo* from that of anthropoid apes, we can underline the following: a) the size of the cortex and the related size of the brain (encephalization); b) the amount and the functional diversity of neurons and other neural cells; c) the neural organization of neurons and neurons' populations; d) the complex branching of its organization, in other words, its internal cabling and with other parts of the encephalon and the CNS; e) the functional specialization of neural structures and of the cortical areas with their interconnections; f) the simultaneous, parallel and compositional activation of various processes which involve different cortical areas and noncortical structures. These characteristics are fundamental for the formulation of the model of the mind that will be outlined in the following chapters (particularly Two, Three, Four and Five).

These characteristics are due to the structure of the human genome which is not so different from that of anthropoid apes, but such difference has caused enormous diversities in the respective organisms and, particularly, in their brains that are similar but at the same time deeply different with regard to the level of encephalization and the diversity of the cerebral mass and its organization: the human brain acquires in time those characteristics previously outlined.

The size of the encephalon is a fundamental factor, although not the only one, that has generated great differences in the activities that the encephala of anthropoid apes and man can perform. Indeed, as we well know, there is a relevant difference in size between the human brain and that of the anthropoid apes: the size of the brain of the anthropoid apes is ~400-600 cm^3 while that of *Homo* is ~1200-1300 cm^3 (sizes refer to the volume of the brain skull). The bigger the encephalon, the larger the number of neurons and more branched and complex the connections

among them could be. This is particularly true for the structure of the cortex of the primates and of the neocortex in *Homo*. Just to emphasize how this brain size difference is relevant, let's remember that starting from the *Australopithecus Afarensis*, which had an encephalon size (the volume of the skull) of ~400 cm^3, more or less equal to that of present-day anthropoid apes, it has taken roughly more than 3-4 million of years, passing through *Homo Habilis* and *Homo Erectus*, to generate the brain of *Homo sapiens*.

Compared with the species genetically closest to *Homo sapiens sapiens*, humans have an encephalon with a higher degree of encephalization and a much larger number of neurons, specialized structures and cortical areas and a great complexity of connections which allow one to elaborate contemporaneously different information and to transmit them to different part of the encephalon. An even more relevant characteristic of the human cortex rests in the presence of cortical neurons (particularly the pyramidal ones) which have very long dendrites that connect many cortical, subcortical and noncortical areas so that any cortical process is the result of the activation of many cortical and sometime noncortical areas. The very complex cortical cabling is capable of simultaneously elaborating (also by means of parallel neuronal processes) a large quantity of information coming from the world and from different parts of the CNS, the PNS (peripheral nervous system) and the body. This cortical cabling, together with the specialization of the various areas, allows those cerebral processes that we call mental or noetic, which characterize the activity of the human mind, to happen (in this book, the word *noetic* is used as a synonym of mental, referring to any activity of the brain which directly involves the neocortex).

With the current state of research, we are not able to explain why neuroevolution (increasing of the brain's size and that of the cortex with its complexity) has had such a great impact on *Hominini* and not on anthropoid apes (chimpanzees, bonobos, gorillas and orangutans) and within the *Hominini*, not on the different species of *Australopithecines*, but on *Homo Habilis* and *Homo erectus* and afterwards on *Neanderthals* and *Homo sapiens sapiens*.

We could hold that neuroevolution would not be guided by adaptation but by randomness; nevertheless, it allowed the generation of the encephalon of the modern *Homo* with all those characteristics which have made it so complex, so that it is able to perform those neuronal activities that are missing in the anthropoid monkeys: those that allow the use of a natural language and those that generated science, technology, art, literature, religion, ethics and politics; broadly speaking, the culture and

social organization of the human groups, starting from the beginning of the Paleolithic era.

The fundamental characteristic of the encephalon of *Homo*, which is different from that of other living species, concerns the structure and the organization of the neocortex that generates what is usually indicated with the term *mind*, which is the prominent and perspicuous characteristic of the brain of the human species.

Each mind self-constitutes and self-organizes over time, generating its own informational contents, its own ways of operating, its informational or noetic structures, more or less complex, and its identity (the mental identity which is part of the identity of the self). These processes are realized with parallel neurophysiological and neuroanatomical processes that give rise to a given brain and make it work in a way similar and different from any other. Hence, generating a given mind means generating a given brain. The mind is placed within the CNS (see Chapter Two), therefore so are the neurophysiological processes which generate it and elaborate its information. Nevertheless, the mind is not formed only as a result of the strictly internal processes of the CNS, but on the grounds of four types of relations: a) with different parts of the CNS; b) with the body of the subject which embodies it; c) with the individual psychical and existential dynamics; d) with the world in which the subject and its body are placed: the phenomenic world, the socio-cultural one and the inter-mental relations (see Sections 3.9, *Locality, Nonlocality and N-Localities of the mind: Expressed Mind and Extended Mind*, and Section 9.1, *Other Minds and the Intermental Dialogue*).

On the grounds of these relations, each mind is generated with specific characteristics and with continuous dynamics of transformation. Therefore, for the formation of the mind, at least four factors are necessary: a) a CNS with a big and complex cortex; b) a subject; c) a body; and d) a world. From the various relations which are set up amongst these factors is generated the mind, and a given mind in a specific period of time.

Up to now, we have made reference to the CNS as a whole, but it is necessary to remember that the CNS includes, besides the encephalon with its cortex, the brain stem and the spinal cord and medulla. In the following, in many cases we will refer to the CNS as a whole, leaving out the distinction between the encephalon and its other parts, and we will analyze some of the many activities of the encephalon, quite often, but not always, involving the activation of the spinal cord which elaborates information carried by the PNS.

In this chapter and in the following one, the attention will be focused on the modalities with which the mind forms inside a CNS. In order to analyze such modalities, first of all, you must answer the following question: *given a CNS, genetically formed, is it possible to generate one and only one mind or one of the many which might have been generated?* In anthropological terms, this means to wonder if the mind of every man is the outcome of only the processes internal to the structure of his CNS.

This question must be answered articulately in order to avoid two forms of reductivism: the *biological-genetic* one and the *mentalist* one. *Biological-genetic reductivism* holds that: a) the mind is the result of cerebral processes which can be explained only using neurophysiological analysis; from this claim, a kind of eliminativism can be derived according to which the mind can be reduced to the brain so that the mentalistic terms have no semantic reference to the phenomenic world; b) given one brain, only a given mind will be formed; therefore a given mind is what it is, since it was the only chance that a CNS had to generate it.

On the contrary, *mentalist reductivism* holds that the mind has a deep autonomy from the CNS so that, given a brain, it does not necessarily mean that it derives one and only one predetermined mind.

The theses of both reductivisms, as we shall see, contribute to clarifying how a mind forms and determines itself as it is in a given period of time.

According to biological reductivism, the mind is the result of only cerebral processes, even if wide and complex, and therefore it can be so only if the CNS is able to generate it. This claim is only partly true since the presence of the mind is concomitant with the presence of the subject/body and of the world, and both heavily affect the formation and the functioning of the mind. A strong biological reductivism holds that given a brain, only a specific mind can be formed and therefore every subject can have only that one mind which could have been generated by his CNS or, more generally, by his genome.

From a subjective point of view we can wonder if the mind, which is currently owned and used to perform a task – for example, writing this book – is the only one which could have been generated by a person's CNS even if it can modify itself over time.

Is my mind what it is just because my CNS allows and has allowed its formation? If it is only the CNS which allows its generation, then it would be necessary to infer that the mind I have could have been only this and not any other; is this claim plausible and acceptable? In a superficial way, it would be possible to answer affirmatively and this answer seems to be not only plausible but also acceptable. But it is necessary, as we shall see,

that this answer must considered in a more articulated and complex way: in Section 3.8 (*Encephalic and Mental Multiversity and Symptotic Processes*), it will be held that given a brain, not only one mind but many minds can be generated, even if they all have a determined cerebral structure which undergoes continuous dynamics of self-organization and transformation.

If, on the contrary, mentalist reductivism is accepted (grounded in a complete autonomy of the mind), then it should hold that considering a given CNS, any mind can be generated since it forms autonomously from the structure of the CNS and therefore from the related genome. Even if this thesis is partly acceptable, as is that of biological reductivism, it does not correspond to the empirical evidence according to which the neurophysiological characteristics of any CNS, derived from the related genome, influence and in a certain way determine the formation of a specific mind.

If the theses of the two reductivisms are partly acceptable, then, or they do not contradict each other, while this happens, or while they are both sustainable because of the constitution of the mind, starting from a given CNS, it must be considered as an outcome of dynamic processes in which different roles are played: both the structure of the CNS and the related genome, and what it has generated; that is, the mind which has formed in a given period of time inside a subject as a result of various relations with the world, including human beings and groups.

There is a strict and necessary interlacing between mind processes and configurations and the other brain processes; so, the mind is influenced by the entire brain and the nonmental brain is influenced by the mind. They are part of a unique system; the mind must be considered a part of the brain and particularly as a subset of all the cerebral configurations and processes (see Chapter Two): *the mind is the brain, but the entire brain is not the mind*. Therefore, we can claim that there is not a CNS formed once and for all and only on the grounds of the information of the genetic code, but it is also the result of what it has generated; that is, the mind, with its activities, modifies not only the working of the CNS but also some part of its neuroanatomical structure and matter: as the CNS influences the mind, so the mind influences the CNS. Therefore, the formation and the development of the mind are part of the formation and the development of the entire CNS.

As we will better clarify in Chapters Two and Three, the mind must be considered as part of the brain (the mind is brain) and as the outcome of particular cerebral processes that take care of all relations that a brain could have with the world.

More generally, the formation of the mind is affected by the following factors: *a) the genetic code; b) the relations with the external world, particularly with other minds and the cultural-social environment; c) the relations with the body; and d) the processes which are generated inside it on the grounds of internal information and of those which are formed autonomously and have a strong impact on its dynamics.*

On the grounds of these considerations, it is possible to formulate an analysis in order to describe a general conception of the mind, of which many characteristics and aspects will be taken into consideration in this book. An analysis based on the thesis of *dual monism* will be presented in the following section.

1.2. Dual Monism: Structural Monism and Operational Dualism

The *mind is embodied* in the brain, is a part of it and is correlated with many structures of the CNS; therefore, there is no mind if there is no brain.

Thesis: *If there is a mind, there must also be a brain and if there is a brain, there could be also a mind, but if there is no brain, there will not be a mind* ('no matter, never mind').

Nevertheless, not all brains generate a mind and to make it possible, it is necessary, first of all, for them to be alive since a dead brain cannot generate a mind. Only if a brain is biologically functional, then can it generate a mind, even if the mind is not completely generated by the brain because, as we have claimed, is also the result of its formation and of the relations between the brain and the world.

Even if there are some brains which could generate a mind, not all of them are capable of doing it and this depends on their matter and structure. The mind of humans is as it is because in *Homo*, there is a very complex brain made of ~90 (someone says 86) billions neurons, glial tissues, neuroanatomical and neurophysiological organization and structures, enormous numbers of connections (perhaps many trillions) among neurons and neuron populations, adequate energies (like brainwaves) and neurochemical processes which work jointly and simultaneously and which allow the parallel co-elaboration of a large quantity of information. So, the human brain can give rise to the formation of the mind to which we assign many activities and states like thinking, imagining, feeling pleasure or pain, feeling happy or sad, formulating theories, and planning the activities not only of the following day but also of one's entire life.

What in everyday thought we call the mind, which each man believes himself to possess like all other human beings, is such only thanks to the presence of the brain, which characterizes the species *Homo sapiens sapiens* and which is the result of a long process of evolution and neuroevolution.

Maybe other living beings could possess a mind, but this would certainly be different from that of humans, and at this time, neither mental activities similar or analogous to those of the humans in their large variety have been ascertained, nor have works or artifacts comparable to those of humans been found in groups of other living beings (including nonhuman primates and anthropoid apes), which could been considered as the result of their possession of a mind.

If it is ascertained that humans have a mind because they possess a specific brain with its complex structure, then we must suppose that many relations between the mind (which is embedded in the brain) and other parts of the brain must exist: between parts of the brain that generate the mind and mental processes and those others that do not generate mental processes.

Descartes's thesis on the mind-body relation was not the first in the history of philosophy and science, and many others followed, leading up to the present ones, influenced by the progress of the neurosciences and cognitive psychology. These disciplines have clearly pointed out the strict relations between the mind (or mental processes) and other parts of the brain, although they have brought many researchers to uphold materialist and eliminative theses according to which it is possible to investigate only the brain and not the mind; or else reductivist theses that aim to reduce the mental activities only to neurophysiological processes without considering the influences of the world on these activities. In this book, we do not accept any reductionist or eliminative theses. However, it is crucial to underline, as we have already stated, that from a naturalistic point of view, we cannot think of a disembodied mind; that is, a mind that does not need to have (or does not have) a brain to exist and to operate.

With the current state of scientific and philosophical research, it is not possible to hold any form of strong ontological dualism such as that formulated by Descartes, but this does not bring us to accept either a monism grounded in only the existence of the brain or a monism even more drastic and eliminative, or a mentalist monism according to which the mind is completely separated from the brain. To refuse the eliminative monism and the naturalistic reductivism does not bring us to hold any form of strong ontological dualism. On the contrary, we are allowed to accept a monist perspective which stresses the difference between the

nonmental brain and the mental brain; that is, the mind; a monism grounded in the necessary ontic presence of the brain, and it does not reduce the mind to neurophysiological processes and assign to it an ontic state different from that of the brain.

Furthermore, on the grounds of what has been said up to now, we must claim that from a naturalistic point of view, there are not any mental activities when there is not a cerebral activity at the same time, as there is not any behavior if there is not a body that behaves, or a body that supports it: there is not a limb movement if there are no limbs; there is not a smile if there are not lips that allow it; in the same way, there is not any mental activity if there is not a brain that supports and generates it, even if, as we will underline later on, the mind is generated not only by the brain but also by the information coming from the body, other minds and the world, and in any case, this information is elaborated by brain processes.

It is necessary to state again that even if this thesis is acceptable, from it, one cannot derive that mental activities are reducible to neurophysiological states or processes, in the same way that a behavior expressed by a body is not reducible only to the movements of the body and to the physiological laws which regulate them. For the mind, too, the necessary *ontic co-presence* of the brain does not mean that only its neural processes determine the mental contents, even if these are cerebral configurations.

The history of philosophy and the more recent history of psychology and of the neurosciences have been focused on different kinds of relations between the mind and the body, which very often have been brought to a strong ontological Cartesian dualism. According to such a dualism, no form of reductionism in which the mind is reducible to the brain (thesis of materialist identity) is acceptable; for this reason, the mind is considered as an 'entity' (often thought of as immaterial and identified with the meaning of the term soul) which has no relation with the brain other than that of being embodied in it (we will leave out mentioning the thesis of the immateriality of the mind, since from the scientific and philosophical points of view, it is not acceptable).

It is difficult to accept this form of dualism, but it is also difficult to deny it and to hold a strong reductionist (eliminative) conception according to which something like the mind does not exist; it is nothing else but the brain, intended in a strict physical sense.

This reductionism is not acceptable because there is no doubt that it is possible to refer, at least from one side, to the neurophysiological processes, and from the other side, to what they generate, like, for instance, thoughts, which can be transcribed in language in order to be communicated and as such 'to get out of the brain'. Moreover, it is not

possible to deny that the neurophysiological activities influence, in different ways, the same thinking and acting so that it seems acceptable to hold at least one difference between *what the brain does and what the brain generates* when some process has been performed. Therefore, it is plausible to hold a difference between the mind and the brain in this minimal sense, but this thesis neither necessarily brings a strong ontological dualism, nor does it support a reductionist monism.

Therefore, these remarks let us to support what we call *dual monism* which proposes a *structural monism* and an *operational dualism*.

In its structural aspect (*structural monism*), *dual monism* holds that: a) there is only one phenomenic (or natural) structure, which is the brain (encephalon) or more widely the CNS; b) in the CNS, there are only neurophysiological processes; c) the neurophysiological processes are informational processes; that is, they elaborate different types of information; d) there are no mental processes which are not cerebral processes; e) the mental processes and the mental configurations are a subset of the cerebral processes and configurations.

According to structural monism, which is not reductionist, it is possible to distinguish one part of the brain from the entire brain: the mind is that part of the brain which is mainly formed by the neocortex and results from cerebral processes that involve it, besides the noncortical areas. As we shall see in Chapter Two, the mind gives rise to those results that, in ordinary language, we indicate with mentalist or psychological terms like thinking, reasoning, having emotions, feelings and so on.

Operational dualism, which is the second aspect of dual monism, instead, holds that:

A) The mind and brain are two different entities: 1) the brain is a phenomenic entity; 2) the mind is a phenomenic entity because it is embodied in the brain (a subset of cerebral processes and configurations), and at the same time it is a *nomiotic/semiotic entity* which elaborates and spreads nomiotic/semiotic information. In other words, *information with significances* also expressed with a system of signs, like those of natural language or others, like designs. Here and in the following, we use the term *significance* and not *meaning* which will be used only to refer to the connotation or the denotation of a linguistic sign.

B) The mind is neurophysiologically embodied in the brain so that: 1) there is no mind if there is not a brain which supports it; 2) if there is a mind, then there must also be a brain; 3) if there is a brain, there could also be a mind; 4) without a brain, there is not a mind (the Thesis that has been previously formulated); and 5) the mind is brain, but the whole brain is not the mind.

C) The mind is functionally different from other parts of the brain, since it elaborates nomiotic/semiotic information, it involves specific cerebral areas, mainly cortical ones, and is the result of: 1) mental processes; 2) inter-mental processes; 3) interactions with the body; and 4) interactions with the phenomenic world, the socio-cultural environment included therein. These characteristics of the mind will be analyzed in Chapters Two and Three.

The thesis of the *not reductionist dual monism*, in its two aspects structural and operational, is based on the following assumptions:

a) There are not two types of material entities (mind/brain) but only one material entity: the brain or encephalon (or more widely the CNS);

b) In the CNS, there are only material entities like neurons, axons, glia, neural nets, energy, etc. and in it, only neurophysiological processes of different kinds are implemented;

c) Tissues, structures, electrochemical energy and cerebral processes organize themselves during the cerebral dynamic in different ways which generate different results;

d) The involvement of different areas of the encephalon and particularly of the neocortex generates different processes and results;

e) The cerebral processes allow the formulation of those cerebral activities which are called mental;

f) The cerebral/mental processes (or neuromental) are processes which involve the neocortex and elaborate nomiotic/semiotic information which carries significances and can be expressed with a system of signs and related meanings;

g) The structures and the cerebral-mental processes are determined by: 1) the genetic code of each individual and of the species which generates the CNS and influences, in different ways, the modalities in which the mental processes develop; 2) the constitution, dynamics and internal history of the CNS and of the mind; 3) the manifold complex connections among the different parts of the CNS; 4) the relations, through mental and inter-mental processes, between the CNS, the body, the other minds, the phenomenic world and the socio-cultural environment.

On the grounds of these assumptions and particularly points b, c, d and e, it is evident that the mind, or better, the set of the mental configurations and processes, is a result of specific cerebral processes which involve different areas of the CNS and particularly those of the neocortex.

However, it might seem strange to consider different types of activities in one class, even if the informational contents and cerebral processes are very wide and complex, like those which regulate the heartbeat and those which have allowed me to write this book, or those which allow me to

reason, or those which bring an emotional or sentimental condition to awareness. Even if it is true that all of these contents and activities are formed by neurophysiological processes, particularly neurochemical ones, it seems, for example, that my conceptions of the ontology of the mind is something different from the regulation of my blood flow. Yet they are both the result of neurochemical processes, but no one could state that they are of the same type and also that my ontology of the mind can be explained only on the grounds of neurophysiological processes.

Therefore, it is useful to make a distinction between *nonmental processes and configurations* and *mental processes and configurations* which are a subset of the much larger set of all the cerebral configurations and processes; both, although different, are cerebral processes and configurations. This distinction conforms to operational dualism and structural non-reductionist monism (dual monism). This distinction, that we will analyse deeply in the following chapter, is grounded in the complex structure of the CNS in which some of its structures, as we know, are not only neuro-anatomically different, but play very different tasks.

CHAPTER TWO

MENTAL AND NONMENTAL PROCESSES AND CONFIGURATIONS

In this chapter, the distinction between *nonmental processes and configurations* and *mental processes and configurations* is analysed, which has already been introduced in Chapter One and is the theoretical kernel of the nomiotic theory of the mind that will be analysed deeply in Chapters Three, Four and Five.

2.1. Mental and Nonmental Processes and Configurations

The encephalon is the fundamental part of the CNS which includes the brainstem and the spinal cord. In the following analysis, as we have already underlined in Chapter One, in many cases we will refer to the CNS as a whole, leaving out the distinction between the encephalon and its other parts. We will analyse the activities of the CNS which many times, but not always, involve the activation of the spinal medulla, with elaborate information coming from the PNS.

The encephalon of *Homo* is different from that of any other living species, particularly of primates, mammals and anthropoid apes, because it possesses a functional and structural diversity and a neocortex much more complex, subdivided in specialized areas, with an enormous number of neurons and of connections among them which allow one to elaborate different information contemporaneously and to transmit them to many parts of the encephalon and to the Peripheral Nervous System (PNS), and so to the body: *the neocortex makes the difference and lets one perform those cerebral activities typical of Homo* (the mental ones).

The encephalon is a unitary, complex and dynamic system in which some of its cerebral and functional structures, that are the result of phylogenetic neuroevolutive processes, are particularly concerned in performing various tasks not autonomously, but with the involvement of many of them.

Although, with the current state of research, it is difficult to strictly subdivide the CNS into different anatomic and functional broad parts, since we know that it works in a complex interconnected modality, we can refer approximately to the following ones. A more ancient neuroevolutive, that can be called *spinal-medullar*, in which are included the medulla oblongata and the spinal medulla, controls the body's vital functions. A more recent one, sometimes called *paleoencephalon* (reticular formation, hypothalamus, and limbic system, which includes the amygdala), is involved in the appetitive, competitive, maternal and social functions including emotions and feelings. The most recent one, called *neoencephalon*, typical of *Homo*, is formed by the neocortex with its structures and its very complex connections among them. It generates those mental activities which have allowed the social behavior of the first groups of *Homo sapiens sapiens* and the onset and development of human culture: science, technology, religion, philosophy, the arts and the social, economic and political organization of human groups and collectivities.

It is worthwhile to underline that the phylogenetic processes that gave rise to the CNS of *Homo sapiens sapiens* are *replicated* in the ontogenetic process of each CNS: at the beginning, the structures related to the vital functions are formed in each CNS; afterwards, the noncortical ones, and later on, those of the neocortex are formed; in the final result, all these structures are, more or less, interconnected and integrated, giving rise to a system in which each structure is more or less specialized and its specific function is implemented involving many others.

Although a strict anatomic and functional subdivision is not broadly accepted by all scientists, it is useful to distinguish different kinds of functions played by the CNS which correspond to some of the activities of each human organism: to fulfill the needs of the body, and so of survival; to express emotions, feelings and moods; and to perform mental activities, such as thinking, imaging, reasoning and so on. Nevertheless, the specific cerebral structures of the different parts (for example, the limbic system) usually do not work in an isolated way, but jointly and in an integrated way with many others. For instance, although the amygdala is particularly involved in elaborating emotional functions, these are not performed only by it but with the involvement, besides the structures of the so-called paleoencephalon, of others regions belonging to the neocortex. All the cerebral functions are performed in an integrated way; thus, in general, it cannot be held that there is a strict correspondence between functions and anatomic structures, although some structure, in respect of others, are more involved in performing a specific task. Thus, only on the grounds of this perspective and just for the goal of this book, we will use this

subdivision in a broad way, so we will refer to these parts of the CNS and the relative cerebral structures, and the term *paleoencephalon* will be used only to include those structures of the CNS which do not belong to the neocortex: from one side, the neocortex, and from the other, all the cerebral structures of the encephalon and of the entire CNS (noncortical structures).

In the following, we will refer to the CNS as a whole, but the analysis will concern mainly the encephalon, with its neural structures, and particularly the areas of the neocortex. Mainly, we will analyze two kinds of configurations: NMC = {nonmental configurations}; MC = {mental configurations}. Both of them belong to the set of all the cerebral configurations (<CC>) elaborated by a CNS.

Definition: *The cerebral configurations <CC> are informational structures generated in a certain instant of cerebral time, can be maintained for a period of time and can be stored in memory. These structures are the result of articulated neurophysiological processes which operate inside the CNS and, more widely, inside the entire body (including the PNS)*.

The *cerebral configurations* are neurophysiological structures which contain information, neurochemically codified, and are mutually connected and influenced; the interconnected processes could generate structures more complex than those involved. From an ontic point of view the cerebral configurations are natural entities that can be investigated as any other phenomenic entity.

From a systemic perspective, the cerebral configurations can be considered as simple or very complex states of the CNS, which can be 'observed' in an instant *t'*. The CNS is not a discrete system (or automaton) in which states are separated and follow one after the other; the processes of the CNS are at the same time *continuous*, since any of its states are part of continuous dynamics and so are correlated to many others, and *discrete* because states, embedding specific information, are more or less defined, identifiable and different from one to another. For instance, a neural process that gives rise to a perception is a continuous process starting from the sensorial organs until the activation of cortical areas, while each step gives rise to identifiable separate states, until a state is reached in which the final perception of a stimulus is embedded. Any cerebral process generates a configuration, or state, which is maintained for a determined period of neurophysiological time (the topic of discreteness versus continuity of cerebral/mental processes will be taken

into account in Section 5.2.3 – *Linearity, Nonlinearity, Predictability, Temporal Reversibility,Enumerability, Discreteness and Continuity*).

The cerebral configurations <CC> are neurophysiological structures derived from cerebral processes, including brainwaves and glial cells, and formed by a large number of neurons and neuron populations, by the connections amongst them and other parts of CNS and by the information which has been neurochemically codified in them.

The cerebral configurations are the result of all the neurophysiological processes which occur inside the CNS, with or without connections with the PNS and with other parts of the body, which are realized in a given interval of time.

Each mental and nonmental cerebral process generates a configuration that can be considered as a state, simple or complex, of the CNS, and theoretically it can be *observed by an external subject, as we observe entities and objects of the world*; for example, with tools like the EEC, fMRI or PET, or more complex ones that will be built in the future.

The set <CC> includes all the cerebral configurations which are formulated by a given CNS and they are therefore in very large number. Many are active for a short period of time, while others are saved in the long term memory and can be reactivated even if not all at the awareness level. Only those preserved in memory that are reactivable, even if they are not presently aware, can play an active role in mental activities.

The broad set of cerebral configurations <CC> is subdivided in two subsets: the *nonmental configurations* (NMC) and the *mental configurations* (MC). The NMC are the result of neurophysiological processes which concern vital functions of the organism and involve noncortical areas and can sometimes influence cortical processes. On the contrary, the MC are the outcome of processes that involve the neocortex directly, although they can also elaborate information coming from noncortical areas. The mental configurations possess specific characteristics, which will be analysed afterwards (see Section 2.2), that differ from all the other cerebral configurations which are formed by different cerebral processes.

Hence, within the CNS there are two main kinds of processes: those involving the neocortex that give rise to mental activities and configurations, and those that involve noncortical areas which give rise to nonmental configurations concerning the organic functions of the body.

The cerebral processes are the only ones which happen inside the CNS and, as it has been outlined previously, are divided in *nonmental* and *mental ones.*

The *(cerebral) nonmental processes* are those which regulate the various functions of the body, including the control of primary emotions.

These processes involve different cerebral structures such as the brainstem (diencephalon, midbrain, pons, and brain bulb), the paleoencephalon and many connections between the CNS and PNS. These processes in many cases activate elaborations of information coming from the cortex, but do not activate, or do not directly activate, the areas of the cortex, even if they can influence cortical (mental) processes (the brain's influence on the mind). Because they do not activate directly, cortical areas *don't carry nomiotic (significant) information and do not involve the awareness* even if their results may be aware.

The *(cerebral) mental processes*, instead, *directly* involve the cortical areas and other noncortical ones, and generate all the cerebral activities that we call mental, cognitive and not cognitive or pathic: thinking, language, attention, intelligence, concept formation, memory, problem solving, formulation of decisions, global psychic state, moods, feelings and emotions (excluding the primary ones).

The mental processes generate and carry significant or nomiotic information and some of their resulting configurations, but not all, could reach the state of awareness.

The activation of different areas of the neocortex generate processes and elaborate information that we call *nomiotic* or *significant processes and configurations* that will be analysed deeply in Chapter Three – *A Nomiotic Theory of the Mind*.

The mind, formed by nomiotic processes and configurations, is the result of the neuroevolutive conformation of the CNS and it is placed within it. It is the result of a deep and large involvement of the neocortex which is placed in the hemispheres, left and right, connected by the *corpus callosum* that allows the transmission of information from one hemisphere to the other. Each hemisphere performs specialized functions which could be integrated in different ways with those of the other, thereby generating complex integrated processes such as the formation of a perception of a phenomenic object.

The cerebral lateralization – that is, the functional difference between the two hemispheres – lets each hemisphere perform different operations, but this does not mean that some of them are realized only by one of the two hemispheres. Although, for instance, the cortical areas of language are placed only in the left hemisphere, linguistic activities, such as the reading and comprehension of a written text, involve many processes, some of which are placed in different cerebral areas of the right hemisphere.

The cerebral lateralization and the relative specialization of the hemispheres indicate that in some mental activities, some areas of one or

of the other hemisphere are more active. Therefore, each hemisphere can have a more relevant (or dominant) role in some mental activities carrying out specialized operations. The left hemisphere plays a relevant role in different activities such as linguistic, logical, significant and generally cognitive ones. Particularly in right-handed people, the left hemisphere is more involved, while the production of language is more bi-lateral (requiring both hemispheres) in left-handed people and in many cases is done by the right hemisphere. Linguistic functions like intonation and accentuation are done by the right hemisphere. In the left hemisphere, information relative to rational decisions, problem solving and self-reflection is elaborated. The right hemisphere, instead, is specialized in the elaboration of pathic (emotional and affective) information, information related to spatial manipulation and to artistic activities. This hemisphere is more involved in the depressive states and in the elaboration of pessimistic thoughts.

In this book, we do not analyse the structural and functional differences between the two hemispheres, but it is useful to underline that some functions are realized in only one hemisphere while others are worked out with the involvement of both hemispheres: they are bilateral processes. For instance, rational operations of the left hemisphere not infrequently involve information in the right hemisphere.

Mental processes are usually the integrated (or compositional) outcome of the activities of both hemispheres, but depending on each process, could be dominant one or the other hemisphere; for instance, the left hemisphere in the case of mental processes which involve language, or the right hemisphere in the case of elaboration of not verbal information that could activate the limbic system.

Although one or the other hemisphere would be dominant in some processes, a great part of mental activities are the outcome of integrated processes that involve both the hemispheres, and so are the different elaborations of specialized information; for instance, the reading of a literary text involves the left hemisphere in dominant way (the cortical areas of language, areas 17, 19), but also the right hemisphere that allows information referring to space to be processed in order to generate an overall perception of a written text, like the page of a book.

In the following, even though not directly and explicitly, we will refer to both hemispheres and to the specific functions of the different cortical areas according to the architectonic subdivision indicated for the first time by K.Brodmann and confirmed, even if with some differences, by the present research on lateralization and on the specific functions of the different cortical areas.