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On the early origins of consciousness, and all that

Through neurosciences towards computational psychoanalysis

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Abstract – On the basis of recent works made by Giampaolo Sasso (see [1], [2], [3] of the reference list), relying on the crucial crossroad between neurosciences and psychoanalysis, it will be possible to identify some hints for further formalization attempts turned toward a computational psychoanalysis outlook.

Keywords – Introjective and projective processes, resonance, oscillation, object relationship, consciousness, bundle, symmetry breaking.

I. INTRODUCTION

The recent work achieved by Giampaolo Sasso, and exposed in [1], [2], [3], has been centred on the critical relationships between neurosciences and psychoanalytic theories, taking into account the outcomes of the late *Infant Research*. From it, as well as following what has already been very briefly outlined in [4], some further brief discussions and suggestions concerning possible formalization attempts of certain main aspects of the Freudian psychoanalytic framework may be usefully worked out. In the meanwhile, throughout the paper, it will not be possible does not see clear and continuous recalls to the Husserlian phenomenology and its historical roots, until to reach a sort of phenomenological psychoanalysis¹.

II. BRIEF OUTLINES OF THE SASSO'S MODEL

A. A brief sketch of the model: first elements and basic notions

From his experience as psychoanalyst and psychotherapist, Sasso has casted the first bases for a new unitary framework of the object relationships in [1], trying to take into the right account the recent developments achieved by neurosciences. Following [1, Introduction], the functionality of the brain is mainly due to the dynamical action of a set of certain non-localized *mobile functions*, variously dislocated around all the general network of the nervous system which enact different perceptive-sensorial zones of it through *cerebral maps*, whose globally unitary dynamicity is the chief characteristic of the mind that, thanks to the running of distinct cerebral zones, allows to analyse different properties of an intended *object*.

These functions basically represent flows of information, along neural lines, given by the known psychic *introjective* and *projective* mechanisms. These latter neural pathways are called *s-o lines* (or *s-o pairs*) and locally connect two

elements, namely an element *s*, representing a mind element approximately located in the frontal, motor and premotor areas, and an element *o*, codifying a somatic-sensorial or a perceptive property of the object. Thus, neurophysiologically, a *s-o* line is a motor-perceptive path which connects a motor element *s*, aimed to reach the subject functions, with a perceptive element *o*, devoted to attain object functions. Along the human ontophylogenetic evolution, a very great amount of *s-o* lines arises, also with the support of the *neural redundancy* which neurobiologically characterizes the ontogenetic evolution of the human brain. The *s* elements (where *s* stands for subject), at first, explicate simple control and motor functions upon the perceptive *o* elements (where *o* stands for object), hence they locally couple for giving rise to a *s-o* pair, that is to say to an *object relationship*, which will move along *s-o* lines. This simple dynamics is the essence of the mobility's feature of the mind, roughly carried out by the dislocation ensuing from the double mobility given by both *s* and *o* elements that locally reconnect to produce *s-o* pairs which accomplish the basic role to locally represent, according to a general *vicariance principle*, a distal or global process just by means of multiple and structural integration process of various primary *s-o* lines. This last principle, which allows a flexible functional dislocation or mobility, formalizes the well-known Freudian processes of displacement and condensation (see [1, Chapter 2, Section 2.4]).

Therefore, an object representation, within this model, is mainly based on a structural assemblage of primary *s-o* lines, each of which establishes an inseparable constrain between the representational structure of the *o* elements and the subject function of the *s* elements. The system of the *s-o* relations is already present since prenatal phase and its potential strength to structurally organize is meaningful of the *intentionality* of the child to early establish object relationships. The structuration of this rich system of relations through suitable reorganization and reconnection of its elements, is a not easy task that will be at the basis of the general psychic development. In doing this, the mother will play a truly fundamental role, being her the first and closer human figure who child approaches, hence the first object. Such an interaction takes place, by resonance², between an autonomous projective-introjective (*P-I*) endogenous dynamics, connate with the child and continuously turned on by the reticular formation, and the action of the mother who alternatively

¹ This is, besides, historical not fully unfounded because, throughout the Freudian work, close parallelisms, meaningful comparisons and immediate analogies jump to the eyes if one points out what primary role has played the *object* and related notions (like object relationship or object cathexis, intentionality, and so on), in both contexts.

² Sasso, in [2, Introduction], considers the brain much similar, although in a simplistic manner, to a composite musical instrument which runs through a complex resonance which is made active from reciprocal interactions.

stimulates the functional properties of the s element and of the elements o , contributing to their reconnection into the $s-o$ lines.

The neural information so stimulated, goes through the $s-o$ lines in either directions $s \rightarrow o$ (roughly comparable with a *bottom-up* process) and $s \leftarrow o$ (roughly comparable with a *top-down* process) forming a net with capacity of rapid reconnection. Therefore, a $s-o$ line should be more properly written as follows³ $s \rightleftharpoons o$ being it the superposition of two unidirectional flows, namely $s \rightarrow o$ and $s \leftarrow o$, each of which provides a *proto-object relationship*. The flow $s \leftarrow o$ integrates, into the perceptive element o , the information coming from environment, and its codification as an internal information, is the basis of the introjective processes. The flow $s \rightarrow o$, instead, sprung out of the internal information already codified into the motor element s , is aimed to anticipate and to complete the external information, underlying a projective process. The continuous construction of the $s-o$ line network, which constitutes the basis of the $P-I$ endogenous dynamics⁴, at first starts from the stimulation of the own reticular formation of the cerebral trunk through the combinatorial action of basic elementary functions ψ (d'après Freud) which provide ancestral innate abilities of reconnection of the elements s and o , so giving rise to the first nuclei of the *Self* that will relate with objects. The mother is at first support for the set of elements o of the child's net, then she contributes to the various identificatory meanings to be assigned to the information conveyed by the $s-o$ lines through the directions $s \rightarrow o$ and $s \leftarrow o$, through an integrative modulation and coordination by maternal introjective information (Im). From a functional viewpoint, a link of the type $s \leftarrow o$ assigns an object property o to the subjective element s , so giving rise to an identificatory constrain of *introjective* type (I); instead, a link of the type $s \rightarrow o$ entails that a subjective function s is assigned to an object property o , so giving rise to an identificatory constrain of *projective* type (P). When these latter pathways undertake a preferential role, they provide stable introjective and projective properties. If the information given by maternal object (Im) is massively present, then introjective proto-object influences of the type $s \leftarrow o$ prevail, whereas, if Im lacks, then projective proto-object developments of the type $s \rightarrow o$ prevail.

The maternal introjective information Im greatly influences, above all through the procedural memory structures, the growing up of the representational network given by the articulating bundle of the $s-o$ lines, through a continuous re-organization of the endogenous and exogenous flows involved in the first autonomous $P-I$ endogenous dynamics, and that constitute the proto-object relationships from which derives the Freudian drive structure and that will take object nature just by means of the action of Im , so giving rise to the Freudian object relationship structure. The crucial point is the right interplay between the constructive endogenous $P-I$ dynamics and the exogenous object maternal influence Im , the

³ Already J. Piaget used a similar notation to mean the indissoluble active and dialectic relation between subject S and object O , from which the knowledge springs out of.

⁴ This $P-I$ endogenous dynamics should be meant as a sort of 'internal breath' of the cerebral system, almost analogous to a physiological one.

former having to projectively regulate, at the primary proto-object level, the introjective modulation by the latter, to give rise to advanced object relationships. The above mentioned basic interaction ($P-I$) – Im , will be re-enacted and restored, in the right terms, during the crucial transferral-countertransferral relation involved in a psychoanalytic setting, which operates through linguistic nets.

B. A brief sketch of the model: further developments

In [3], Sasso retakes what made in his previous works [1] and [2] to try to clarify a possible origin of consciousness⁵. Sasso again stresses the primary role played by the child's personal $P-I$ endogenous oscillatory dynamics $s \rightleftharpoons o$ which will drive the fundamental psychoanalytic identificatory development by means of the building of the representational system of the child which, in turn, will be greatly ruled and moulded, again through a periodic oscillatory dynamical mechanism, by the available introjective Im influences of the mother whose unconscious representations, already quite well-rooted in her, will converge into the incoming consciousness of the child just thanks to this endogenous dynamics with which the child naturally interacts and to whom is phylogenetically predisposed. So, the psychic development of the child begins at once with the institution of identificatory relations since her or his early stages, the mother greatly influencing this frail process with her own consciousness states. The primary psychic development is centred upon procedural (or implicit, hence unconscious) memories, which remain inaccessible to the next accrual of the declarative (or explicit) memories, hence with denied access to the psychoanalytic exploration that just makes use of declarative memory functions only. This implies a basic distinction between two chief types of repression mechanisms, namely a deeper *non-removed primary repression* (correlated with a *dynamical unconscious*) and a *removed repression* (correlated with a *removed unconscious*), a distinction, this, already sketched but left incomplete by Freud himself, which, instead, can now be quite clarified and formalized within the Sasso's model.

Into the $s-o$ line network, one should distinguish a particular subset of it, namely the one formed by those lines of the type s_i-o_i characterizing the internal psychic states related to the *representational* (or *perceptive*) *internal objects* o_i . The formation of the latter is need for giving a wider and even more articulated reticular formation by means of a continuous going inwards and onwards along the initial line $s-o$, due to the intermediary presence of an internal object, say o_1 , inside it, that is $s-o_1-o$, with the formation of another level line, $s-o_1$, but in a higher level than that of $s-o$, which, in turn, will require another element s , say s_1 , to settle the new higher level line s_1-o_1 , and so forth. This is the typical iterative process with which the $s-o$ line system grows up and develops, the appearance of the various intermediary internal elements o_i depending on the sensorial stimulation or excitation, whilst the consequent production of the elements s_i , needs to maintain the related stability of the system, greatly depends on the Im action. In such a fashion, the basic reticular formation evolves, with an even more complexification of its structure, from its lowest bases, placed into the most ancient cerebral structures,

⁵ In what follows, if not otherwise specified, we shall always refer to [3], which is the main reference of this paper.

through the sub-cortical and limbic structures toward the high cortical ones. The various elements o will concentrate into the posterior perceptive-sensorial cerebral zones to give rise to the *object function*, whilst the consequent control elements s will converge into the anterior control cerebral zones to give rise to the *subject function*, and to control the former ones.

Initially, the various internal representational elements o_i are distributed amongst many different cerebral zones, just this variegation standing at the basis of the human capability to identify and to represent the various distinct properties of an external object o whose phenomenological individuation is therefore characterized by the series of such representational objects $o_1, o_2, \dots, o_i, \dots$ which are the codified perceptive information originated (or is the trace left) by o , hence from the external environment. But the control of these internal objects must be ruled by the representational system given by the (frontal) elements s , so that, for instance, when an external object o , which had already given rise to a perceptive internal object, say o_i , tries to recover the initial line $s-o$ to be re-evoked, now it first meets o_i along this pathway, but the new intermediary line $o_i \leftarrow o$ is a non-phenomenological elaboration since it does not provide any phenomenological consciousness content due to the absence of any s element. To this end, therefore, a new element s is needed to restore a consciousness constrain of the type $s-o$, so giving rise to a phenomenological consciousness content or intentional act through the following new elaboration $s_i \leftarrow (o_i \leftarrow o)$. Often, the external information is firstly worked out by those many cerebral zones devoted to the codification of the various possible perceptive elements o_i , amongst which, nevertheless, homologous bonds of the type $o-o$ are possible, which however remain unconscious because their elaboration takes place mainly into procedural memories. But little by little such homologous links arise, they stimulate the representational system of the elements s (which, in any case, starts from albeit minimal innate equipment of unitary representational patterns), choosing one of its elements, say s_i , that will control and regulate the sensory-motor-perceptive element⁶ o_i through a one-way re-entering projective line $s_i \rightarrow o_i$ (providing a *representational access*⁷, with which the sensorial-perceptive flows enter into the brain) codifying the

⁶ Which takes place in the perceptive-sensorial cerebral zones.

⁷ Which takes place in the frontal, motor and premotor cerebral zones and allows to access to the representational information content given by o_i . These lines $s \rightarrow o$ have always running in the brain, also without perceptive inputs, otherwise the cerebral activity would turn out, this also explaining why the child has normally needed for a right counterbalanced supply of introjective feedbacks. A kind of limbic switchboard is assumed to be mainly responsible for the continuous activation of the various peripheral cortex zones to catch information. This might be considered as the neurophysiological counterpart of the *human intentionality*. The restoring of a constrain of the type $s-o$ implies the different (topological) *localization* given both by a frontal element s and a parietal-occipital element o : the former approaches the latter, revealing a consciousness element which is not localized in the element s but *elsewhere* (this recalling the Lacanian *Other*), that is, in the element o , which is need for its phenomenological occurrence. According to the original Freudian thought, the various *object relationships* arose by relationships amongst different mental s_i-s representations of the objects o , that otherwise might not have phenomenological content.

information of o_i by means of the internal restoring of the one-way introjective line $s_i \leftarrow o_i$ (providing a *representational restoring*, with which the frontal zones of the brain drive and control the sensorial-perceptive information), just promoted by $s_i \rightarrow o_i$, which reproduces, although in a less sensitive fashion with respect to the original or initial way⁸ $s \leftarrow o$, the environmental information and that is need for an enough normal psychic development to prevent a projective excess of investment not adequately counterbalanced by introjective responses; hence, once that such an introjective re-entries $s_i \leftarrow o_i$ assumes a stable asset, then o_i institutes a constrain on the frontal zone that therefore acquires a property of the object o , codified by the set of internal objects o_i , so determining an introjective effect. The mother action always operates through introjective lines of the type $s_i \leftarrow o_i$, so that her influence superposes with the other introjections.

In any way, the elements involved in any line $s \rightleftharpoons o$ are inseparable of each other, this to highlight the indissoluble intertwining between the object's properties o and the subject's intentions s , this unitary coupling giving rise to an irreducible and primitive elementary nucleus of consciousness, i.e. a *qualia*. The indivisibility of the constrain $s \rightleftharpoons o$, allows to introduce the fundamental property of *binding* of the phenomenological constrain $s-o$, which comprises different functionalities, like the *conjunction binding* of projection's signals coming from distinct cerebral zones and the *dynamical binding* of synchronous signals activated in the same zone or in the bordering one; furthermore, a distinction between *spatial* and *temporal binding* is considered as well. A chief theoretical problem of the binding is the possible synchronization of oscillatory responses with regard to spatially separated regions of the cerebral cortex, issue which requires the presupposition of a stimulating intrinsic cerebral dynamical switchboard to build up the oscillatory fibre of the $s \rightleftharpoons o$ lines, and upon which the bending relies. From what has been just said above, we may state a general principle⁹ of the *joined elaboration* concerning the two main elements s and o of any primary phenomenological constraining line $s \rightleftharpoons o$, according to which any phenomenological consciousness content exclusively springs out from the joined elaboration of an element o with an element s . Nevertheless, as we have seen above, there may exist as well links between homologous elements, for instance of the type $o-o$ or $s-s$, but without giving a consciousness phenomenological content.

Therefore, together to the formation of the representational internal objects o_i , a related set of representational elements s_i is also available little by little that representational accesses $s_i \leftarrow o_i$ arise, where each element s_i is into correspondence with the original (frontal) representational element s through a non-phenomenological homologous (frontal) bond of the type $s-s$,

⁸ Because every internal object o_i codifies, in general, only partial properties with respect to the ones codified by the original perceptive elaboration $s \leftarrow o$. It is very difficult to succeed to reach the first original perceptive element o , because the various perceptive internal objects o_i are 'incapsuled' amongst them according to J. Fodor. The psychic mechanism that tries to pursue this, is findable, for instance, in the hallucinatory and dreaming phenomena, in the vivid imagination of the child, and in the artistic skills (in which the so-called 'eidetic' memory plays a very fundamental role).

⁹ Which has deep roots into the Husserlian phenomenology.

that is to say $s_i \rightarrow s$, recalling that s_i and o_i are memory stored elements¹⁰. Thereafter, once that a frontal element s_i is primed, an attempt of restoring the original frontal representation s takes place, this being possible, due to the above principle of the joined elaboration, only re-evoking the corresponding perceptive object o , hence one of its partial internal objects o_i , so restoring a phenomenological constrain of the type $s-o$, to be precise s_i-o_i , until up to complete this process with the frontal non-phenomenological elaboration $s_i \leftarrow s$ in such a manner to have a phenomenological perceptive elaboration of the type $(s_i \leftarrow s) \leftarrow (o_i \leftarrow o)$; and all this, of course, requires a non-zero temporal interval to be realized, in this case being a fundamental prerequisite to ascertain what type of time notion we are using (see [4] for a very brief mention about physical and psychic time distinction¹¹). Thus, to summarize, the original perceptive object o will be re-evoked by means of a series of partial internal objects o_i each of which, in turn, pushing on the original representation s of the original perceptive object o , gives rise to a series of (frontal) representational elements s_i such that a relation of the type $s_i \leftarrow s$ holds, each of these last homologous bonds not having any phenomenological content if it is considered without to the homologous bond $o_i \leftarrow o$.

Notwithstanding they are void of any consciousness content, both the above mentioned frontal homologous elaborations $s_i \rightarrow s$ and $s_i \leftarrow s$ play a very fundamental role for the human psychic development. Indeed, as a main characteristic, they may run either with partial consciousness states or even with absence of phenomenological consciousness, that is to say, in an unconsciously manner. Therefore, it is clear too what fundamental role they may play for understanding the possible mechanisms with which unconscious does work. Thus, the elaboration of elements of the type s , notwithstanding takes place for a main object-environmental control purpose, may be phenomenological present either in a partial manner or even wholly absent. Furthermore, ideal, intuitive, attentive, self-reflexive and early states of consciousness may be brought back to the action of the homologous bonds of the type $s-s$ with respect to the set of representational objects o , the former undergoing to certain basic meaning producing¹² *hierarchical ordering* operations, coming from the personal live experience with the environment¹³, which will allow to structurally build up the representational system of the $s-o$ constrains, having the primary property to identify unitary patterns. This latter ordering processes will play a very fundamental role for human consciousness, being them also related with the

possible orders coming from the dynamics and topology of the cerebral maps.

C. A brief sketch of the model: advanced notions

The above mentioned system of double representations $s-s$ and $o-o$, is able to explain as well in what consists the main distinction between a primary non-removed unconscious and a secondary removed unconscious. The former mainly concerns deregulations of the representational system of the frontal lines $s-s$, with damages, in general due to a basic lacking of an adequately and enough maternal interaction child-mother in forming homologous bonds between elements s_i and s , hence with a basic impossibility to have phenomenological contents provided by relations of the type $(s_i \leftarrow s) \leftarrow (o_i \leftarrow o)$, in this case, generally writing $s \leftarrow$ to denote the simple fact that there exist persistent and consistent inhibitory representational frontal elements s hindering hierarchical orderings into the $s-s$ system with gaps in the abstract representational *mental states* s_i-s . The latter, instead, mainly relies on the inability to establish stable $s-o$ phenomenological relationships due to the fact that frontal elements s , with the occurrence of suitable re-entering mental processes $s-s$, hinder the reaching of sensor-perceptive occipital-parietal objects o_i , so not allowing the formation of a consciousness content; in this case, we simply write $s \leftarrow \hat{o}$ to mean the general fact that the representational frontal element s hinders the approaching of consciousness by the perceptive element \hat{o} .

Now, after having outlined the fundamental role played by the endogenous dynamics $s-o$ (with its functional correlate in the $P-I$ dynamics) in resonant periodic interaction with the mother, we can consider the next two main stages of the psychic development of the child, that is to say, the basic *identificatory system* and the next *mentalization*¹⁴ process. The latter has mainly due to the structuration of the $s-s$ line system, whereas the former requires something more. Indeed, along the primary psychodynamic development of the child, roughly codified by the well-known oral-anal-genital sequence, we attend to a convergence of identificatory traits due to both familial figures (i.e., mother and father), at first that of the mother then the one of the father, so giving rise to all that complex series of *identificatory constellations* but which, in general, turns out to be quite unstable. According to E.Z. Tronick, the first consciousness states are the outcome of the running of an *asymmetric*¹⁵ *dyadic system* centred on the early interrelation between the child and the mother, from which

¹⁰ Both elements s and o have representational nature into the human brain, so we might speak of a *double representational* nature of the system of basic constrains $s-o$.

¹¹ In turn, just this issue might be puts at the basis of a clarifying inquiring examination or of a deepening study, about one of the crucial problem of psychology, just that concerning nature and properties of the *physical* and *psychic* time, which might turn out to be of some usefulness also from a computational cognitive science standpoint.

¹² That is to say, having semantic functions.

¹³ In this basic interaction, a truly fundamental role being played by *mirror neuron* systems, which allow the incoming of the primary resonance interaction mother-child, hence it is the first basis for the human intentionality.

¹⁴ That is to say, the comprehension of the mental states of other people's, which ensues from the suitable regularization between the two main systems of the maternal introjective flows $s \leftarrow o$ (*maternal intention*) and of the projective re-entries $s \rightarrow o$ controlling the representational grid (*child intentionality*) of the elements o . This intentionality comparison is of primary interest because, otherwise, the child would not be able to distinguish between the own intentionality and any another one if, at least, the intentionality of the mother made no its appearance. Also this last fact refers to Husserl's phenomenology. The child intentionality increases as the interactions coming from mother and environment enhance, but the first founding nucleus is given by the recursive oscillatory-dynamical interactions with the mother.

¹⁵ This asymmetry implicitly implies the presence of a first form of a hierarchical structure into the dyadic consciousness states.

starts a *dyadic expansion* of consciousness states which spring out from a projective-introjective (*P-I*) oscillatory dynamics, having a basic periodic recursive character¹⁶, through which a remarkable transfer of consciousness states may take place, from mother to child, just thanks to an innate *intentional need* by the child due to the childhood attachment models. Therefore, the child intentionality is inherent with the *P-I* endogenous dynamics, directly oriented to maintain and to control the object relation, gradually engaging either the primary and secondary associative nets involving the elements *s*. With different action and running in dependence on the involved cerebral lobe, the introjective *I* and projective *P* flows oscillatory revolve around the elements *o_i* upon which engrave with a dynamics of the general type $P \rightarrow o_i \leftarrow I$, where the introjective flows *I*, in normality conditions, excite bodily or somatic zones¹⁷ in such a manner that is locally regulated and counterbalanced (as a kind of a restraining ‘protective shield’) by the re-entering projective flows *P*, so giving rise to a Freudian energetic cathexis which ‘engrave’ the stimulation (or excitement) into a certain element of the psychic apparatus, so giving rise, in turn, to that rich and variegated frontal representational grid of human mind given by the elements *s*. Steady imbalances of such a two-flow dynamics give rise to pathological psychic illnesses. On the other hand, the above mentioned asymmetric aspect of the basic intentional function involved into the crucial dyadic system mother-child of above, gives rise to a kind of implicit hierarchical structure into the consciousness dyadic state. Furthermore, all the discussions of above, should be made for both the right and left cerebral lobes, for instance making use of a double sign \pm to appoint one of these to the *s* and *o* elements, with related homologous and heterogeneous combination lines, for distinguishing these two zones.

A very important issue concerns the *topology* of an object relationship. The repression should not be understood as a kind of *area transfer* from one psychic place to another one but rather as a non-topological *local dynamical change* of the cathexis itself in such a manner it may be under the action of different psychic agencies. According to the Sasso’s model, this may be explained as the *access* of an element *s* upon an element *o* through a *s-o* lines that modify its *local elaboration*. Therefore, the Freudian unconscious should not be meant as a set of topic agencies but rather as dynamically characterized by a continuous distribution of the various accesses *s-o*. Already Freud himself, in his work *The Unconscious* of the 1915, considered the question whether the repression is characterized by *topical displacement* and condensation mechanisms (*topical hypothesis*) or rather it is characterized by a kind of *local state* or *phase transition* which takes place in the same locality, regarding the same material (*functional hypothesis*). Initially, Freud chose the first hypothesis, but next he decided upon the second one, considering as a basic repression mechanism, the one consisting in a sort of *cathexis subtraction* of either the unconscious mnestic *vestiges* (d’après Murtagh – see [5]) or conscious mnestic traces, hence as a

¹⁶ And the mirror neuron systems as a primary neurophysiological support.

¹⁷ That is to say, the *source* of an object cathexis of the general type $\text{source} \xrightarrow{\text{object}} \text{drive destination}$.

local state change of the cathexis: in other words, a certain subtraction of energy weakens the cathexis itself, with a consequent changing or transformation of it. Nevertheless, thought within the Sasso’s *s-o* model, these two Freudian hypotheses are not in contradiction of each other, because both should be seen as mainly due to changes of networks, in which either the object cathexis and counter-cathexis differently acts, distributing itself amongst the primary and the secondary nets; in turn, a different situation takes place in dependence on the cerebral lobe under consideration. Therefore, this multiplicity of phase (or state) changes, differently distributed amongst many distinct cerebral levels, basically characterizes the crucial link unconscious-conscious within the *s-o* model.

The very early interactions of the child with the mother and the related environment, essentially take place for innate physiological reasons, whilst the fundamental *identificatory development* takes place only later, thanks to a disaggregative condition of the previous stages of the child psychic development (mainly ruled by the mother action) which entails an *instability of identity* that will promote and will drive all the next psychic development comprising four main sequential steps: the first one given by the primary child-mother tuning in; the second one given by the identificatory development (studied by psychoanalysis); the third one converging into the various attachment models, and fourth and last one given by the mentalization process, which takes place when the primary cerebral net starts to differentiate into other higher levels. This last process provides distinct secondary networks, from the primary one which was mainly ruled by the primary relation maternal object, departing from this with the acceptance of new object relationships extending the initial introjective-projective dynamics of the *dual* type to the more complex one having of *group* type, with the occurrence of a paternal figure. This incoming group development, even due to the above mentioned dynamical instability, naturally characterizes that multiple dynamics of the cerebral mind, ever undergoing to continuous transformations and re-organization procedures all featured by hierarchy-producing associative-dissociative coordination processes, providing a differentiated set of various object relationships. The associative character regards the convergence integration of the primary cerebral net, moulded by the mother one and having a fundamental sensory-motor nature, during the initial basic child-mother interaction, whereas the dissociation feature has to do with the divergence proliferation of the secondary cerebral nets, which underlies any psychic splitting (like the *disavowal* mechanism) process¹⁸, and that, therefore, need of a re-organization for a basic psychic unity, although an essentially dissociated nature characterizes the psyche of every human being. In this latter step, the (mind-producing) mentalization will operate to coordinate the introjective-projective flows within the secondary cerebral net framework, in such a manner to regulate the identity nuclei which spring out from the primary net (having sensory-motor source) of the *dual* relation

¹⁸ The recent *theories of the multiple structure of the Self* claim attention on the dissociated states of the human psyche, on a basically inhomogeneity of the processes which concur to form consciousness. Freud himself always pointed out the fundamental *disunity of the Ego*, in either normal and pathological cases. All that confirms many points exposed in [6] and [7].

child-mother to the secondary nets due to the action of the *group* function upon the first dual nucleus. Thus, as a crucial point of the mature psychic development, the so-called *Œdipus situation* arises, forcing the child to come out from the initial *dual* relationship with the mother, pushing the child to find a her or his own identity. All this is quite similar to the symmetry breaking like phenomena, outlined in [4] and mainly due to a paternal figure action, regarding the famous child-mother *double bind*, which includes many aspects and notions similar to either the optimal and pathogen mother influences provided by the primary child-mother *P-I* dynamical relation. Also belonging to this class of relations, characterized by symmetry breakdown like phenomena, might be considered the so-called Otto Rank *double* (1914) and the related transformational function which gives rise to the *identificatory* function by means of the main passages from primary to secondary nets, with consequent intentionality diversifications.

In the Sasso's *s-o* model, the psychoanalytic identificatory process, which implies a consciousness growing up, might be formalized as a *bundle of identificatory traits* each of which is the coordination of a finite sequence of elements¹⁹ of the type $\langle s_i-s-o \rangle_1, \dots, \langle s_i-s-o \rangle_n$, whose every element is formed by an *intentional nucleus* s_i-s that acts upon an object o to give rise to a consciousness content s_i-s-o on the basis of the reciprocal and perpetual child's comparative interrogation between what the mother has firstly implemented into her or him by primary interaction child-mother with the related environments, the above mentioned instability of this dual link leading to be opened to new identifications (corresponding to the passage from the primary to secondary cerebral nets). The various non-phenomenological identitary nuclei $\langle s_i-s \rangle_j$ will be organized, by the mind, into the secondary cerebral nets according to a certain hierarchical order of them which starts from the original founding nucleus of the primary cerebral net to develop into the secondary ones. Therefore, the mind is not the identity in itself but rather is the hierarchical ordering of the various intentional nuclei $\langle s_i-s \rangle_i$ distributed amongst the primary and secondary cerebral nets; the consciousness, in turn, is not the mind but rather is the phenomenological representational contents $\langle s-o \rangle$ from time to time available to the non-phenomenological nuclei $\langle s_i-s \rangle_j$ which form the mind coordination. The main feature of this process is the fact that we really do not perceive the *pattern* but its unitary (Gestalt) *hierarchical categorical configuration* that emerges from the action of a non-decreasing *temporal function* (to account for the basic and unavoidable consciousness temporal dimension) that regulates and controls the integrative processes of the ever evolving multilevel cerebral networks mainly according to a combinatorial dynamics. Therefore, we again highlight the fact that the temporal dimension plays a very fundamental role for consciousness and its integration, as already pointed out in [4], giving a unitary and cohesive character to consciousness

¹⁹ This sequence may also give an explanation to the *psychic group* nature of the psychoanalytic setting studied by René Kaës, who has also stressed, starting from the previous work made by Kurt Lewin, Émile Durkheim and Freud himself (about the mass psychology), on the unavoidable role played by the psychic group feature for the human inter-subjectivity which has an irreducible basic group structure meant in a precise manner.

due to the primary founding nuclei of the *Self* (primary consciousness). We once again stress the truly unavoidable fundamental hypothesis on the consciousness origin and structure, according to which it is centred on the constrains *s-o* meant as a founding *ontological unity* of the consciousness itself, through which a sensorial elaboration o is liable to be linked with a motor elaboration s (in this, a preminent role being played by mirror neuron systems – see also [8]) to give rise to an elementary consciousness content *s-o* (a *qualia*) whose dynamics is promoted and ruled through the primary interaction child-mother given by the *P-I* oscillatory dynamics $s \rightleftharpoons o$ which is need for the development and integration of the composite cerebral network. The consciousness then evolves trying to integrate and coordinate the manifold of the various constrains *s-o* along the parallel evolution of the manifold of the various cerebral networks whose instability is mainly due to the phylogenetic *neural redundancy* that pushes to produce high level cerebral networks (amongst which the one related to the language).

III. TOWARD SOME FIRST FORMALIZATION ATTEMPTS

In the previous sections, we have seen what fundamental role may play the sensory-motor *bundle* \mathfrak{F}_{s-o} of all the possible phenomenological constrains $s \rightleftharpoons o$, each of which may be considered as a kind of algebraic maps of the type $s \rightarrow o$ and $s \leftarrow o$, together its main properties, amongst which the *locality* one and the *vicariance principle*. All that plays a crucial role in the dawning and in the development of the human psyche, through the interplay between the child *P-I* endogenous dynamics and the introjective maternal influence *Im*. Thus, we may surely state that the bundle \mathfrak{F}_{s-o} in the child is, above all, the outcome of the decisive two-way dynamical interaction of periodic oscillatory type $P-I \rightleftharpoons Im$, respectively between the *P-I* endogenous dynamics – ruling the primary identificatory processes of the child – and the so-called *mother-child tuning in*, so that the following pair $\mathcal{P}_c = \{\mathfrak{F}_{s-o}, P-I \rightleftharpoons Im\}$, made by the bundle of functions \mathfrak{F}_{s-o} and by the oscillatory dynamical system $P-I \rightleftharpoons Im$ structuring \mathfrak{F}_{s-o} , gives rise to a formal basis, say \mathcal{P}_c , for the psychic development of the child. These latter simple claims may imply, from a general history of science standpoint, some possible brief elementary formal remarks as the following ones.

A. On bundles, logic and dynamical systems

In mathematics and theoretical physics, a very notable role is played by the wide class of the so-called *fibred structures*, amongst which there are *bundles*, *fibre bundles* and *fibre spaces* (see [9] and [10]), whose notions first arose out of questions posed in the 1930s about issues on the topology and geometry of manifolds, and whose first rigorous formulations date back to the 1950s. We shall refer to a very simpler basic notion, that of bundle of functions, from which some of the other ones may be built up. Following [11, Section 1.1] (see [13, Section 3.1], [14, Chapter I, Section II.3] and [15] as well), given two abstract sets²⁰ X and Y , a *bundle* $\mathfrak{F}(X, Y)$ of *functions* from X to Y , is a class of sets of functions, say $\mathfrak{F}(U, Y)$, of the type $f: U \subseteq X \rightarrow Y$ for each $U \subseteq X$, such that, for every covering $\{U_i\}_{i \in J}$ of U , we have $f|_{U_i} \in \mathfrak{F}(U_i, Y) \quad \forall i \in J$,

²⁰ In general, X is, at least, a topological space.

this last property expressing a *locality condition*. Moreover, following [15], the basic idea underlying the notion of bundle is just that of *locality*, that is, the existence of elements locally defined and having enough properties of gluing and restriction. But, what is important is the fact that a bundle defined between topological spaces, besides to have local elements, has too a *local logic* through which one may establish the truth values of every local property by means of the construction of an appropriate *Heyting algebra* on it, recalling that every Boole algebra is a Heyting algebra as well. Therefore, if properly contextualized, it would not be fully out of place to consider what has just been said above referred to \mathfrak{F}_{s-o} , the fact that the consciousness is mainly the result of the integration, into unitary and temporal-hierarchically ordered patterns called *qualia* (or primitive *psychic qualities*), of the various emerging phenomenological outcomes at most unconsciously coming out from a multiple system of centres placed into different cerebral networks, together with the various *binding* and *hierarchical ordering* operations basically ruled by a primary temporal dimension, which might be suitably formalized within this context or framework.

Following [16, Chapter VII, Section 7.3.A-C], within the general dynamical system framework (above all, catastrophe theory), between two dynamical systems presenting recurrence (like metabolic ones), resonances will always appear, the stability of the corresponding dynamical system resulting from the topological product of the two given systems depending on the ratio of the corresponding resonances. In particular, between two metabolic systems in a free interaction promoted by a weak perturbation with stochastic direction, an exchange of information always takes place. In general, the topological product of two dynamical systems put into free interaction between them (like two oscillators that enter into resonance), is structurally unstable and has a wide and variable range of possible resonances in competition amongst them, the related stability depending on the nature of the initial perturbation. In the topological product-system, each factor-system loses its individuality, converging into a new unstable and mixed dynamical system (*resonance system*) whose initial instability gradually goes towards a more stable regime through the reaching of a resonance state chose amongst the possible ones. By the way, we notice that the mathematical framework suitable for the treatment of this last issue involves a fibration of the product topological space; finally, we also notice that René Thom, in [16, Chapter XIII, Appendix 1], provides a very interesting formal model of the a memory from a dynamical system point of view, which might have as many interesting applications from a computational psychoanalysis standpoint.

In [17, Chapter X, Section 10.2], a lucky formal geometrical model, centred around the dynamical notion of resonance, is proposed to try to formalize the notion of *signification*. The *resonance* is one of the key notions of modern dynamical system theory and, from what has already been said above, it may be put at the basis of the first most elementary attempts to formalize communication transmission phenomena. On the other hand, already E.C. Zeeman, in his celebrated 1965 paper *Topology of the Brain*, considered the totality of our own cerebral activities as forming a topological dynamical system, amongst other things predicting and foreshadowed many

results which will be later confirmed by the next mirror neuron researches. Later works of Zeeman confirmed the usefulness of general topological dynamics in modelling the brain, whose chief dynamical feature seems just be that oscillatory nature of its phenomena (see [18] and references therein). The above mentioned basic interaction between the *P-I* endogenous dynamics and the maternal introjective influence *Im*, might be laid out within the above sketchily described framework of the theory of dynamical systems, for instance formally identifying, in the activation promoted by the cerebral reticular formation of the cerebral trunk, the dynamical action of an *attractor*. Obviously, the dynamical system approach to cognitive systems is by now well-stated but, following the brief lines outlined in this note, it might deserve interesting further perspectives on the computational psychoanalytic side. Furthermore, also in the early history of neural computation, after the pioneering works by J.J. Hopfield, several formal architectures were set up between the 1970s and the 1980s, considering some dynamical system notions and concepts, like that of resonance and self-organization: to be precise, the *adaptive resonance theory*, mainly developed by S. Grossberg and G. Carmeking, considers the hypothesis that the brain autonomously runs in such a manner to organize it according to certain recognition codes, whilst T. Kohonen developed the idea according to which neurons self-organize themselves to variable adaptive purposes through the institution of *self-organizing maps*.

B. On symmetry breakdown and generative structures

On the other hand, modern differential geometry techniques have allowed to work out symmetry breaking formalism in the most general fashion through fibre bundle tools within gauge theory framework: in this regards see [19, Chapter 10, Section 10.3], [20, Chapter 4, Section 4.4] and [21, Chapter 11]. Moreover, the real essence of symmetry breaking relies on functional analysis of operator spaces, like Hilbert spaces. Indeed, following [22], [23] and references therein, roughly we may say that, from a formal viewpoint, the spontaneous symmetry breaking mechanism for infinite dimensional classical systems involves maps between Hilbert space sectors in relation to actions of certain related symmetry groups (e.g., the group of internal symmetries of a certain mathematical entity – like an equation – and the related stability group). All these formal considerations might be suitably reworked out in relation to \mathfrak{F}_{s-o} , where a crucial point is the comparison between different representations of non-phenomenological intentional nuclei $\langle s_i-s \rangle_i$ to give rise to phenomenological contents when approach an object *o*. On the other hand, in [16, Chapter 10, Section 10.3, Remark 10.3.11], the author stresses which formal analogies, similarities and common points may exist between symmetry breaking phenomena – via Higgs mechanism – and catastrophe theory of dynamical systems, this last theory being the most suitably formal framework in which possibly put \mathcal{P}_c . Furthermore, in [24, Section II.1], R. Thom provides a very interesting discussion of the possible formal relationships existing between (macroscopic) broken symmetry phenomena and the resonance ones, bearing, as a main example, the case of two periodic linear oscillators in interaction between them whose structural instability may be

overcome by means of a (macroscopic) symmetry breaking phenomenon with the consequent appearance of a resonance²¹. In conclusion, from these very simple remarks, we would want to put forward possible and plausible useful comparisons and transpositions between the symmetry breaking phenomena theory, as taking place within the general framework of dynamical systems (d'après the pioneering works of R. Thom, I. Prigogine and others), and the formal system \mathcal{P}_c where some main its features have been identified, amongst which the fibre structure of its elements, the basically resonant oscillatory nature of its dynamics, some main topological aspects (amongst which the locality and the functional hypothesis of the object relationships) and the hierarchical ordering character provided by an innate temporal dimension.

The latter should be meant as a primitive psychic function rooted into the primary and most ancient structures of the *Self*, which regulates and controls all the running of \mathcal{P}_c . The temporal dimension belongs to the set of *generative structures* which are considered, from a more properly structuralistic viewpoint, as those early, primitive (structural) archetypical bases of the human psyche upon which to build up the next psychic development of every human being. In fact, following Yuri I. Manin, as early as the human individual has takes consciousness of the own Ego in front of a world that changes, the notion of time has gradually undertaken even more a prominent role along the course of the history of culture. Since primitive epoch, human being has always had some method to measure time, usually by means of recurrent phenomena. The time originally makes its phenomenological appearance as a consciousness' flow characterized by the awareness both of the transiency of the present and of the content of the various thought entities. Furthermore, following too [25, Chapter 1], since the known pioneering Piaget's works on child psychic development, the psychological bases of the mathematical thinking have been studied from a structuralistic point of view. Precisely, certain primary biological mechanisms have been ascertained to be at the basis of certain elementary formal structures, called *generative structures* (so named by N. Bourbaki), from which all the other ones constructively follow according to a well-defined *architecture des mathématiques*. These generative structures are classified into three main classes, respectively containing the *algebraic*, the *topological* and the *ordered* structures. According to this view, the psychological bases for the ordered generative structures is the primitive idea of *time*, both discrete and continuous, while the topological generative structures have their psychological bases in the idea of *closeness* which, in turn, find their roots into the biological mechanisms of the organization of the perceptive space around a privileged centre, namely the human body. In concluding this brief note, we would want to further stress the following fact that, according to us, plays a very fundamental role in the psychic development of human psyche, namely, the truly founding and primary role played by the triadic familial structure in structuring and developing the human psyche of the child.

²¹ With the change of the two periods in such a way to get a rational ratio, the choosing of the phase of the periodic composite process obtained in this way being a further symmetry breaking phenomenon.

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The *computational psychoanalysis* officially was born with the works of the Special Session (A5) kindly hosted by the 13th IEEE ICCI*CC-2014 *International Conference on Cognitive Informatics & Cognitive Computing* held in London, UK, on August 18-20, 2014 (see the related Proceedings quoted in [4]). As a truly new discipline, it started, on the basis of the previous primary work made by Ignacio Matte Blanco in working out a formal ground to the Freudian psychoanalysis, with the early basic works due to Rosapia Lauro Grotto, Fionn Murtagh and Andrei Khrennikov (see the preprint [4] and references therein). It basically has, as one of the main purposes, try to understand what are the primary formal structures and running mechanisms of the unconscious, with the ambitious aim to possibly implement them into the wide computer science framework.

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