

COGNITIVE DEVELOPMENT: TOWARDS A PLURALISTIC AND COALITIONAL MODEL.

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ABSTRACT: Mainstream classical psychological theories have often favoured a conception of cognitive functioning and development based on uniformity and standardisation. This conception, as we will explain below in more detail, was proven to be fundamentally limited on almost every aspect of it. In contrast, this article adopts a pluralistic and a coalitional conception of cognitive functioning and development. It is pluralistic because we conceive cognitive development to take multiple and variable pathways, and to be operating through various forms of variability: i) intrapersonal, ii) interpersonal, iii) inter-contextual and iv) inter-cultural variability. It is coalitional too in that several processes and factors (indigenous and/or exogenous) combine together to form complementary networks which enable the individual to solve complicated tasks that require high cognitive efforts. This synergistic dynamism ensures the maintenance of networking among the different parts of our cognitive systems. Before addressing the theoretical foundations of the present pluralistic and coalitional approach, it is necessary to rethink some foundational principles of some of the most famous classical theories such as Piaget's unidirectional theory or "unitary theory". This review will pave the way for us to unfold the principles of the present approach at hand. We envisage that these principles are the key to the understanding of changes over the development and evolution at different time scales not only in the cognitive and conceptual systems but also in other juxtaposed systems of the humanities. In this regard and as an expansion of this model, we propose, a new line of research, for researchers to carry this model with the aspiration to find the same principles, and may be more, in other fields such as anthropology, sociology, educational sciences and psychopathology. The coherent elements between these disciplines are the cross-board recurrence of some systems (the cognitive, the conceptual, the linguisticetc.), cross-board nested time scales, and cross-board emergence of cultural phenomena.

KEYWORDS: cognitive development; pluralistic model; coalitional model

1. INTRODUCTION

Mainstream classical psychological theories have often favoured a conception of cognitive functioning and development based on uniformity and standardisation. This conception, as we will explain below in more detail, was proven to be fundamentally limited on almost every aspect of it. In contrast, this article adopts a pluralistic and a coalitional conception of cognitive functioning and development.

It is pluralistic because we conceive cognitive development to take multiple and variable pathways, and to be operating through various forms of variability: i) intrapersonal, ii) interpersonal, iii) inter-contextual and iv) inter-cultural variability.

It is coalitional too in that several processes and factors (indigenous and/or exogenous) combine together to form complementary networks which enable the individual to solve complicated tasks that require high cognitive efforts.

This synergistic dynamism ensures the maintenance of networking among the different parts of our cognitive systems. Before addressing the theoretical foundations of the present pluralistic and coalitional approach, it is necessary to rethink some foundational principles of some of the most famous classical theories such as Piaget's unidirectional theory or "unitary theory". This review will pave the way for us to unfold the principles of the present approach at hand.

2. SOME LIMITATIONS OF THE 'UNITARY' DEVELOPMENTAL THEORY

Undoubtedly, Piaget was one of the most faithful successors of the Aristotelian spirit in that he considered human intelligence to grow linearly and uniformly cross-individuals, i.e., it starts from a primitive phase named sensory-motor stage (from birth till two years old), through preoperational (2-7 years) and operational stages (7-8 years), to finally arrive at the logical thinking stages (Lautrey, 2001).

It is worth mentioning too that Piaget had tried to adopt the Darwinian conception of evolution by trying to forge symmetry between the biological and the intellectual traits of animals and humans. That is to say, the animal is governed during its biological development by the same mechanisms governing the human psychological development (adaptation, accommodation, assimilation, and equilibration), with a minor difference related to the rigidity of

the phenotypic program of animals which confines them to a primitive intellectual level (Piaget, 1977), as opposed to that of the human beings which remains open and flexible till they attain the logical stage. According to Piaget, all living beings, from plants, snails to human beings, obey the same processes of adaptation, accommodation, assimilation, and equilibration during their development (Mounoud, 2000). This means that Piaget had conceived all different species, including humans, through the same lenses of uniformity and reductionism. Piaget's linear pathway, attributed to cognitive development, is full of gains and bounces, with the objective of reaching a stage already foreseen in his theory of the logical-mathematic type. Note that according to Piaget this path is also discernible during the evolution of the history of science (Inhelder, 1989). Apparently, Piaget's obsession of the reductionist approach explains his hasty attempt to demonstrate the existence of common points between the primitive man and the motor sensory child on the one hand, and between Copernican physics and the child at the operational stage on the other hand (Piaget, 1973). In Gréco's words (Piaget, 1977), Piaget confused the epistemic subject, which is a collective, historical and a scientific production, with the psychological subject, which is a real space-temporal individual entity studied by the developmental psychologist.

Thus, we can conclude that Piaget's theory involved at least two fallacious arguments: the hasty generalisation fallacy and the reduction fallacy. What is more remarkable about these two fallacies is the fact that they sit on two opposing poles of rationality, i.e., oversimplification versus over-generalisation. To put it bluntly, Piaget seems to lack the mastery of the zoom lens manipulation. Concerning the reduction fallacy, he reduced the entire history of collective human thought to the individual and psychological development. Regarding the hasty generalisation fallacy, he extrapolated the variant and individual psychological characters to the history of science and to the evolution of others species.

The general Piaget's project was to use psychogenesis to understand the epistemological problem of the emergence of new forms of thinking in the history of science (Mounoud, 1992). Thus far, it is important to turn now to the impact of Piaget's theory and epistemology on developmental psychology. It is well-known that Piaget has conceived and designed psychological development on the

basis of standard(ized) stages and mechanisms that govern all individuals and all cognitive domains (Mounoud, 2000). This reasoning led him to postulate that human intelligence passes during its evolution by a single linear pathway. Thus, for Piaget, the main mechanisms which are responsible for the unitary approach of development are:

the hierarchical integration mechanism: the stages of cognitive development emerge in a hierarchical and invariant order, in that, each stage succeeds, integrates and supersedes its antecedent;

the mechanism of subordination: the various forms of knowledge and cognitive skills are determined, during their development, by general structures such as the operational structure which itself is determined by – hence subordinated – the process of equilibration. This latter is in its turn subordinated to action, the forerunner of all the cognitive development;

the mechanism of the structure of the whole: the different domains involved in intelligence undertake the same rate of development in the form of a structural isomorphism named the general domain or the structure of the whole. It should be noted here that unitary theories describe the development of categorisation representations as a succession of hierarchical stages, that is to say, supplanting one less developed, i.e., more empirical categorisation modality by another more developed, i.e., more abstract.

Thus, for Piaget, rudimentary categorisation is, evolutionarily speaking, less developed than the abstract one. We can quote the example of the figurative collections by Piaget and Inhelder (1959). Indeed, the figurative collections – representing empirical categorisation – which develop in children between 2 and 4 years are replaced (between 4 and 6 years) by non-figurative collections. These, in turn, are replaced by logical classes.

Vygotsky (1934) in his turn maintained, in his treatment of the process of categorization, a unitary and linear approach. For him, the emergence of taxonomies is preceded by perceptual associations of the properties of objects (perceptual categorization) and by a chain of objects arranged by their functional relationship in everyday life. In the same way, Nelson (1985) also considered, based on the principle of supplanting/replacement, that the emergence of taxonomic categories as an abstract and logical form of categorization occurs through developmental processes from empirical categorization to more abstract

categorization.

Therefore, children aged 2 years old can produce schematic categories.

Accordingly, these schematic categories generate in its turn, slot-filler categories. So, the slot-filler categories by their substantial characteristics, allow the child to replace, in one script, an object with another which fulfils the same function. Later, at an advanced stage, the child focuses his/her attention, not only on the functional similarity of the two objects but also on their common properties of taxonomic genre, i.e., the child begins to master the classification of taxonomic features of objects. Similarly, Rosch (1975, 1983) adopted the same linear and unitary conception of development towards categorisation processes. According to Rosch, categorisation developed from more empirical and less abstract level named basic level (e.g. chairs) objects to a more abstract level (e.g. furniture), or to a more unfamiliar and specific category named subordinated level (kitchen chair). In contrast, some researchers, of the latest generation, specialised in categorisation demonstrated that children aged 3-4 years old are able to form various types of categorizations: taxonomic, schematic, perceptual and slot-filler ones (Bonthoux & Blaye, 1999; Berget, Bonthoux 2000; Cannard, Bonthoux, & Blaye, 2005; Blaye & Bonthoux, 2001). This proves that young children manage to process various categorical relationships, and to represent the same object by using alternative categorical relationships (Melot, 1997; Melot & Houdé, 1998).

Hence, children aged 3 years old, are polynomial, i.e., capable of attributing several names to the same object (Deák & Maratsos, 1998). In fact, a couple of researchers have demonstrated that even a baby has already an extended ability of categorisation that is not limited to empirical categories but attains also to more abstract forms of categorization. For instance, from his/her seventh month of birth, he/she can deal with some categories of taxonomy (McDonough, & Mandler, 1998). At the third month, using his/her gaze, the baby can show some taxonomic biases (Quinn, Eimas, Rosenkrantz, 1993). Similarly, at the same age, the baby can distinguish geometric shapes (Bomba & Siqueland, 1983; Lécuyer, 1991; Lécuyer, Streri & Pêcheux, 1996) from human faces (De Schonen & Deruelle, 1991; Lécuyer & Rovira, 1999). What is even more impressive is the preference of the new-born baby to keep his/her gaze fixed on the face of his/her mother rather than other faces (Walton & all., 1992). Also, it is remarkable that

the baby is able, starting from its ninth month, to identify the most accessible levels of taxonomic categorization such as the basic level, the level of typicality and the prototype (Mervis & Pani, 1980; Strauss, 1979). In the same respect, Younger (1993) claimed that the 7-month-old baby uses different properties to distinguish objects, but is still unable to coordinate between these object properties until his/her tenth month. In addition, a recent work has shown that even monkeys are capable of producing various forms of categories (schematic, taxonomic, perceptual) (Bovet, 2000). Given all these results, we think that the unitary assumption, which restricts the child's categorical knowledge to empirical categories only (basic level, figurative collection, complex object, and scene) that will be supplanted at an advanced stage by more abstract categories (logical, taxonomic, concept, super-ordinal level), is a limited approach. Ergo, the child is pluralistic in its categorical knowledge. Yet, in order to be able to discern this statement, it is necessary to have recourse to the principles of a Pluralistic and a Coalitional Model, the topic of our next section.

3. THE LANDSCAPE OF A PLURALISTIC AND A COALITIONAL MODEL

As its name suggest, the pluralistic and coalitional model, PCM for short, views the psychological developmental phenomenon as a complex, dynamic, nonlinear, and open system. Some of the terminology used by the PCM such as fractals, self-organisation, vicarious, and multi-variabilityetc. is adopted from chaos/complexity/dynamic systems theory (CCDST). However, we believe that our model is distinct from CCDST because it assumes agency intervention, i.e., interactions among various structures cross-time scales and level scales are subject, at least in some bottleneck cases, to some sort of conscious self-regulation. Thus, we presume that the system cannot be reduced to sheer automatic self-organisation as CCDST models propose.

To explain in more detail, researchers used one very famous example of a sand pile being steadily added from above by sand grains until an unpredictable avalanche happened (Bak, 1997). This example was used to make the point that systems' change and development cannot be predicted based on single factors (the grain of sand), and also self-organisation is attributed solely to the system as a whole, not to a single factor (one single grain of sand). In contrast, within PCM, we believe that change and development involve in addition to the emergent

structures based on self-organisation an X-factor related directly to the individual consciousness and will, i.e., in completely unexpected conditions the person may act differently than the system would have wanted/predicted him/her to behave.

In parallel, sociology has also recently tried to move away from certain classical unitary positions (such as Marx's and Bourdieu's) which hastily generalized some social variables observed in particular contexts on other forms of social structures. Conversely, sociology has recently begun to adopt a pluralistic conception that believes that the social phenomenon is a dynamic, extremely complex, and variable phenomenon that does not lend itself to be modelled by the classical linear models. Thereof, recently a remarkable interest of sociologists was in discovering the chaotic aspects of some social phenomena such as "heterogamete". This latter is evidence that each individual is unique and distinctive even if he/she is socially constituted. In order to explain this aforementioned concept, Lahire (1998) used the following metaphor «the crumpled paper sheet», i.e., the paper sheet symbolizes the social world, its structures, its different domains, etc. Then, when the paper sheet is crumpled and folded several times, it can give us an interesting picture of what each individual case represents. Two similar papers never take the same shape once they are crumpled. Additionally, what makes our PCM model unique are its distinctive features to deal with developmental psychology.

We presume that the system of developmental psychology is based on five pillars:

1. psychological subject;
2. poly-variability;
3. multi-pathways of cognitive development;
4. poly-mechanisms of cognitive functioning; and
5. cognitive flexibility and self-organization due to the dynamics of coordination between several processes and sub-cognitive system.

Concerning the Psychological Subject, in straightforward terms, the pluralistic cognitive approach calls to get rid of the rather epistemic and theory-constructed subject and to opt instead for the psychological real subject.

Interestingly, this pragmatic shift is in line with the new and recent paradigm shift adopted by the Geneva School, founded by Piaget.

Inhelder (1989) – one of the famous collaborators and successors of Piaget –

made an explicit and unequivocal statement about this shift: “In Geneva too, we would like to join this adventure [turning to the psychological subject]”. Inhelder (1989) proposed a different definition of the psychological subject based on analysing the variable idiosyncrasies of the individual behaviour in particular situations to extrapolate and identify *ad hoc* cognitive patterns specific to the type of contexts faced by the individual. In other words, the study of the psychological subject implies that we are dealing with micro-developmental variability that cannot be generalised to the entire population of the system. Thus, the human’s cognitive system is flexible because it is shaped by functional and contextual conditions which allow the child to improvise creative strategies, tools, techniques, and solutions to unpredictable problems. That is to say, this concept of "the psychological subject" proves that each child develops "Debugging Strategies", that allow him/her to a great extent to resolve cognitive breakdowns when he/she is faced with some complicated problem situations (Siegler, 2003). In the same vein, Fischer & Immordino-Yang (2002) claim that recent studies in cognitive psychology have failed to prove the existence of invariant formal structures common to all subjects, governing all cognitive domains, such as Piaget's overall structures or Chomsky's universal grammar structures. Among the contradictions that questioned the overall structure hypothesis there is the gap between the performance of children of the same age group *vis-à-vis* certain challenging situations.

4. POLY-VARIABILITY

According to Lautrey & Caroff (1999), the traditional mainstream conception of cognitive development envisioned a unique itinerary, punctuated by phases and stages; a course for the child psychological development along which the speed of its progression is the only form of variance between individuals. More precisely, that conception assumed a single form of variability, named vertical inter-individual variability, i.e., cognitive structures take the same forms among the children of the same age group, but differentiate among different age groups. Indeed, the unitary approach – though appearing in different models – of developmental psychology dominated most famous theories of the last century, such as Piaget's, Freud's, Wallon's and Vygotski's theories (Troadec & Martinot, 2001). On the other hand, the pluralistic model tries to get rid of this pre-

established vertical inter-individual variability and opts for a principle of poly-variability. This latter includes the following forms of variability:

horizontal intra-personal variability: it reveals that different cognitive domains grow neither in the same way nor at the same speed (Khabbache, 2003). Bonthoux and Blaye (1999) concluded that the child can change the type of his categorisation processes according to the kind of tasks, or sometimes according only to a simple modification of instructions (Bonthoux & Blaye, 1999);

inter-individual variability: Barsalou (1982) and Bastien (1997) managed to illustrate the same latter point by using the categorisation domain. They claimed that the magnitude and scale of cognitive plasticity of the categorisation processes vary from one person to another;

inter-contextual variability: this type of variability is illustrated by the fact that some cognitive processes may vary according to the type of context faced by the individual. To better explain this concept, we mean that the level of familiarity of the individual with a given task, or the degree of ambiguity of a problem situation to be solved affect the type and strength of processes activated. For example, categorisation behaviour, in its turn, can vary in respect to its contextual variability (Yeh & Barsalou, 2006). In other words, categorisation activities change according to every day contexts (Vallee-Tourangeau, Anthony & Austin, 1998). Furthermore, inter-contextual variability may be witnessed in the participants' behaviour depending on the nature of the task faced by the individual, including the type of equipment, instructions used in the task, and the type of experimental paradigm adopted by the researcher;

intercultural variability: children from different cultures show different cognitive behaviours. For instance, children from Polynesia (Troade, 1999) or Morocco (Khabbache, 2003) performed the task of inclusion in a different cognitive style from the European ones. Some researchers observed an increase in taxonomic categorisation in the western culture – a culture that is dominated by the Aristotelian logical thinking – at the expense of other forms of categorisation (Lautrey, 1998). In contrast, in the African contexts, as it is the case in the Kpelle tribe, people are inclined to use functional categories more than taxonomic categories (Schliemann, Carraher, & Ceci, 1997).

4. MULTI-PATHWAYS OF COGNITIVE DEVELOPMENT/A MULTI-PATHWAYS' COGNITIVE DEVELOPMENT

According to the pluralistic model, linear cognitive development trajectory is one possibility among others. Thus, in agreement with non-linear dynamic complex systems and chaos theory, we opt for a multi-pathways development assumption (Lautrey, 2003). This latter claims that cognitive development tracks are, in several occasions, non-linear and obscure trajectories; sometimes take the form of a spider's web (Troadec, 1998; Fischer & Yan, 2002), or follow zigzag lines (Houdé, 1999), and other times parabolic concave or convex lines (Pacteau, 1995; Khabbache, 2003), and even display a U shape (Siegler, 2004).

More interestingly, a pluralistic development allows reversibility and regressivity of some skills' and competences' development (Mounoud, 1999). To mention, Reuchlin had warned scientists since 1985 that the unitary paradigm of psychological development was erroneous and that a pluralistic approach must be adopted. The development of categorical processes, according to Piaget & Inhelder (1959), was linear and progressive, starting from the concrete operations to the abstract ones. With respect to this unitary assumption, we can expect that empirical categories (perceptual and functional categories) will decrease gradually with age in favour of the emergence of the abstract categories (logical and taxonomic categories). In contrast, this seems not to be the case.

5. POLY-MECHANISMS OF COGNITIVE FUNCTIONING

Piaget and his followers considered that knowledge enrichment, hence, development, is attained exclusively by two mechanisms, namely assimilation and accommodation, which join the new knowledge with the old one. However, it was not until the advent of neuroscience that the idea that cognitive development is managed not only by enrichment but also by the impoverishment and inhibition of some cognitive structures (Leray & Young; quoted by Mounoud, 1990).

Consequently, many researchers began to adopt this new conception (impoverishment/inhibition) in their handling of cognitive development and functioning as it is the case with Houdé & Guichart (2001) in their concept of effective/ineffective inhibition, Karmiloff-Smith's (1997) in his theory of loss and profit of knowledge, and also in his conception of negative and positive feedback

of cognitive processes and strategies.

It is important to mention that the recent conception of cognitive development as it is the case with the process of impoverishment is an enhancement of the abduction theory which was developed in 1974 by Mehler. This latter indicates that some cognitive abilities, which lean towards specificity, must be specified by eliminating some structural constraints and vague knowledge. We think that Mehler's original idea of abduction had been reformulated by Karmiloff and Smith in their concept of "modularization". Modularization is, according to Karmiloff & Smith (1998), a mechanism that is responsible for reconfiguring the fuzzy structures of cognitive domains whose epistemological boundaries are still confused, by specialising them and making them more distinct (Karmiloff-Smith, 1998).

Equally important, the emergence of the neurocognitive approach and the advancement of constructivist neurology both contributed to the idea of cerebral polymorphism, that is to say, the synaptic connections of the brain are highly variable and complex. This variability and complexity depend, among other things, on the peculiarities of tasks performed by the individual. Accordingly, believing that a single mechanism is the source of all cognitive development and functioning is completely unsound (Oliver & all, 2000). Conversely, it is assumed that behind any new cognitive achievement, a new neural network of micro-connections – and probably a loss of other micro-connections – emerges. In other words, we are talking about synaptic pruning or/and synaptic elimination. In this sense, we should admit the plurality of cognitive development mechanisms that match with the polymorphism of the neurological connections. So we can cite:

the mechanism of vicariance: sparked by the particularities of the task to be processed, an evocation call gets initiated in order to replace a less efficient process by another more efficient. Thus the mechanism is intended to supplement a deficiency (De Ribaupierre, 2005);

the mechanism of integration: two cognitive systems might be integrated and blended with each other to give rise to a new structural system that is capable of processing and solving new problem situations;

the mechanism of complementarity: it takes place in situations where a process accomplishes the function of another process, and yet it preserves its own identity (Lautrey, 2003);

inhibition/modularisation mechanism: as we have already pointed out, inhibition does not only take on the meaning proposed by Houdé, i.e., subtracting the processes and causing cognitive confusion during a task-resolution operation, but also the meaning of modularisation (Karmiloff-smith, 1992) or differentiation (Carey, 1985, Carey & Spelke, 1994), i.e., eliminating some general and vague knowledge, permits to a cognitive domain to become more specific;

coalition mechanism: this process is responsible, on the one hand, for bridging different cognitive domains by establishing new neuronal connections, and, on the other hand, developing new hybrid domains by combining certain components and principles of two different cognitive domains. For instance, theoretical physics is the result of a fusion of mathematics with physics (Carey, 1985; Carey & Spelke, 1994). In this regard, among the criteria to assess the development of a skill there is the level of its complexity which is the production of the dynamism of fusion and/or interweaving of several skills that belong to various cognitive domains (Demetriou & Nazi, 2001);

re-description of representations mechanism: it is a metacognitive mechanism that describes in a declarative and conscious way the components of each domain, and specifies the possible links that may exist between different cognitive domains. The interest of this re-description is to create a meta-domain or a hyper-cognitive domain that has the role, on the one hand, of controlling and managing the information of different domains, and on the other hand, of coordinating between these domains, and planning strategies that may allow the individual to cope with new problem situations. Moreover, given its descriptive aspect, this above-mentioned mechanism allows the individual to generalise and map a competence belonging to a particular field on other areas. It is important to mention that this kind of dynamism contributes to developing a skill by making it more complicated, sophisticated and refined. We mean by a complicated skill a skill which attained a kind of flexibility, permitting it to be transferred to other domains (Schwartz & Fischer, 2005).

6. COGNITIVE FLEXIBILITY AND SELF-ORGANIZATION OF THE COGNITIVE SYSTEM

In his theory, Piaget reduced the infant's diverse skills to the motor sensory actions

in the first phase of cognitive development, and to operational action in the second phase. However, many contemporary researchers have shown experimentally that the child is able to conceptualize his actions and to produce abstract knowledge at an early age. As early as the fourth month, the baby shows some numerical skills in dealing with objects as it succeeds in solving tasks about the permanence of objects. Additionally, by its ninth month, the baby arrives to categorize objects with taxonomical biases (Houdé, 2004). Thereby, we believe, in line with (Mounoud, 1999), that the human cognitive system, at a very early age, is divided into two cognitive sub-systems; one is practical/procedural, and the other is conceptual/abstract, or using Lautrey's terminology, one is analogical, and the other is propositional (Lautrey, 1987).

The procedural subsystem is contextual, intrinsic and directly linked to the external environment. Its fundamental role is to process empirical data and information collected from the external environment. It is characterized too by its pseudo-controlled aspect, and by being more probabilistic and automatic *vis-à-vis* information processing. However the conceptual subsystem is distinguished by its propositional and formal aspect, and also by its ability to decontextualize information. These features allow this subsystem to produce an abstract and conceptual knowledge, and in the meantime to control and regulate the activities of the procedural subsystem. Thus, in this way, the conceptual subsystem is similar to the reflective abstraction process of Piaget, the metacognitive functions of Flavell, or the hyper-cognitive domain of Demetriou. It is well known that Reuchlin (1973), Pylyshyn (1981) and recently Mandler (2000) envisaged certain degrees of separation between the two subsystems (conceptual *versus* procedural). However, according to the Pluralistic and the Coalitional Model, we maintain, in line with Lautrey (2003), the interaction hypothesis which claims the existence of a mutual interface between the two subsystems. The dynamism brought about by the interaction between these two subsystems sparks the development of some self-organizing competences which allow the cognitive system to be partially autonomic and independent from external support, and more reflexive about its insight which support a metacognitive development and the growing of some self-functioning skills such as:

- self-representation,
- self-concept,
- self-regulation,

self-modification and
self-initiative.

Furthermore, it should be noted that Mounoud (1993) in his turn admits a kind of complementarity and an interdependence relationship between the two sub-systems. Rittle-Johnson, Siegler, & Alibali (2001) also defend the presence of an alternating relationship between the conceptual and the operational aspects of the cognitive system. That is to say, the conceptual subsystem will direct the operational subsystem to detect the essential properties of a problem situation, and to arrange them as an internal representation of the problem. After that, the propositional subsystem will compare this representation with other forms of representations (of other problems) which are stored in the long-term memory. The aim of this comparison is to abstract and to generalize that representation to new situation problems, and also to transfer some techniques and mechanisms, experienced and admitted to be helpful in resolving a category of problems, to other forthcoming contexts and situations.

That means that the propositional system plays a major role in elaborating preventive and pre-emptive strategies which permit us to deal accurately and efficiently with unexpected situations. The role of the operational subsystem is to lead the conceptual subsystem to comprehend the situation problem at hand and grasp its important features. That, in its turn, allows the conceptual system to abstract and elaborate representations of the problem in the form of models of representation to problem situations.

The models of representation are stored in the long-term memory for future retrieval and treatment for new upcoming tasks. It is important to mention too that the cooperation between the two subsystems (the operational and the conceptual) permits the perceiver to select and manage the appropriate strategies and techniques that have been stored in the long-term memory, in the form of mental representations, to the current and exigent situation problem at hand. In parallel, in certain cases, the new information update, coming from the perceiver's environment, and which is made available by the operational subsystem leads the former system (conceptual system) to adjust itself with the peculiarities of the task processed. In other words, the operational subsystem, functioning as a receptor of varied information from the external environment, contributes in guiding the attention processes to focus on updating the

propositional content and operational processes of the conceptual subsystem in order to cope properly and efficiently with new contingencies.

Imagine that without this kind of updating ensured by the operational subsystem, the conceptual subsystem would generalize its strategies and knowledge to other situations without taking into consideration what is happening in the current situation, which leads, in its turn, to hasty generalisations, misconceptions, or misrepresentations of the situation problem at hand (Diesendruk & Gelman, 1999).

7. CONCLUSION AND FUTURE DIRECTIONS

Generally speaking, there is a growing consensus among researchers of different trends that the development and function of both the perceptual and the conceptual systems are administered and governed by the principles of the PCM; namely:

- (i) the centrality of the psychological subject in favour of the epistemic one,
- (ii) the acknowledgement of the existence of poly-variability (interpersonal, intrapersonal, inter-situational, and intercultural variability),
- (iii) the principle of multi-pathways of cognitive development,
- (iv) the principle of poly-mechanisms of cognitive functioning, and
- (v) the principle of cognitive flexibility/plasticity and self-organization.

These principles together collaborate to deal with a dynamic complex system, i.e., the mind system, to explain how the infant who is born with so little knowledge can come to develop so many insights of the surrounding environment. We envisage that the principles of the PCM are the key to the understanding of changes over the development and evolution at different time scales not only in the cognitive and conceptual systems but also in other juxtaposed systems of the humanities.

In this regard and as an expansion of this model, we propose, a new line of research, for researchers to carry this model with the aspiration to find the same principles, and may be more, in other fields such as anthropology, sociology, educational sciences and psychopathology. The coherent elements between these disciplines are the cross-board recurrence of some systems (the cognitive, the

conceptual, the linguistic . . . etc.), cross-board nested time scales, and cross-board emergence of cultural phenomena.

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