

Role of Multiplicity for Emergence and Anticipation in Memory Evolutive Systems. An example in Art

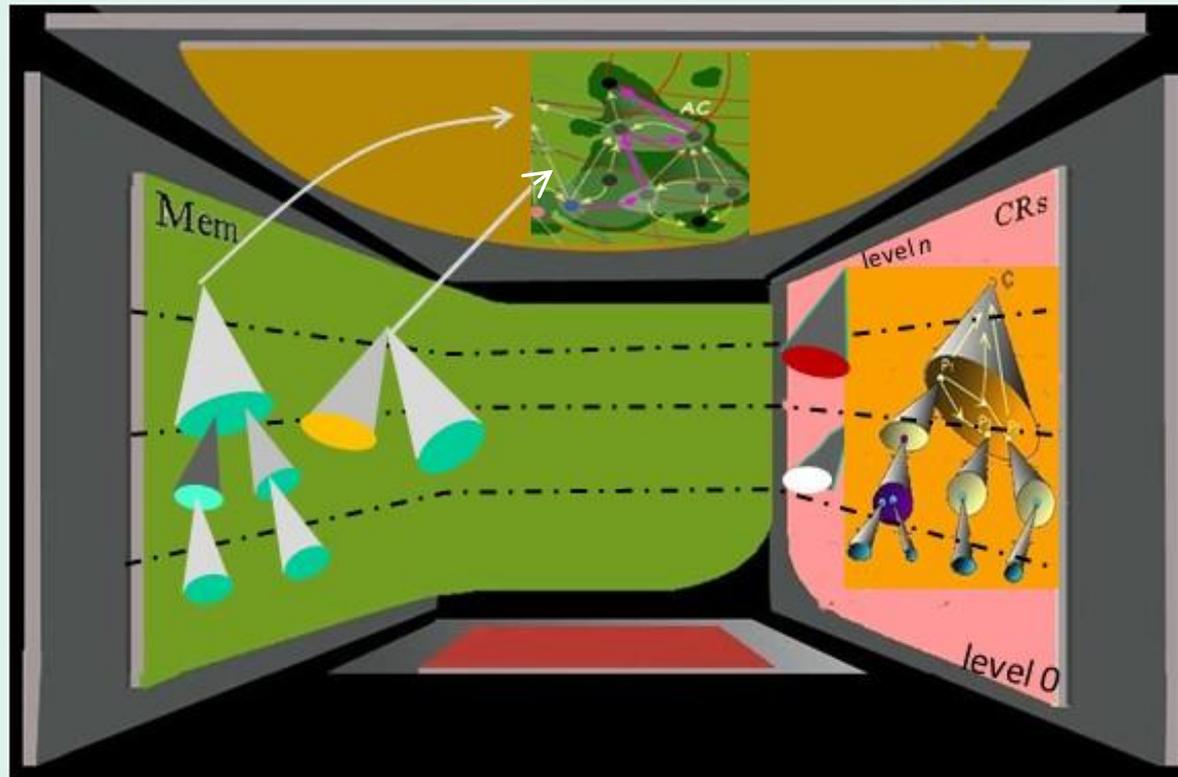
by

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A FRAME FOR EMERGENCE AND ANTICIPATION

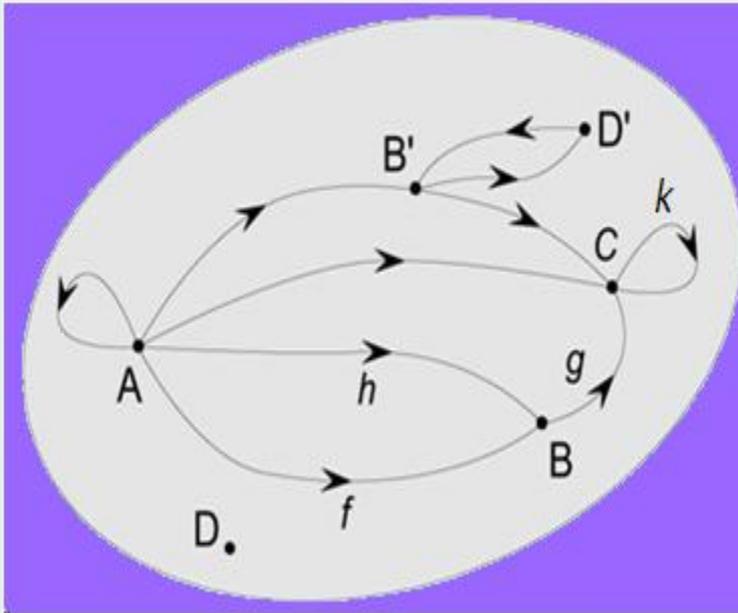


Evolutionary system with a hierarchy of components varying over time. Multi-scale self-organization, modulated by: a network of **Co-Regulators** (CRs) with different rhythms, function and logics; a flexible **memory** (Mem) storing knowledge and past events, with a subsystem AC acting as an internal model

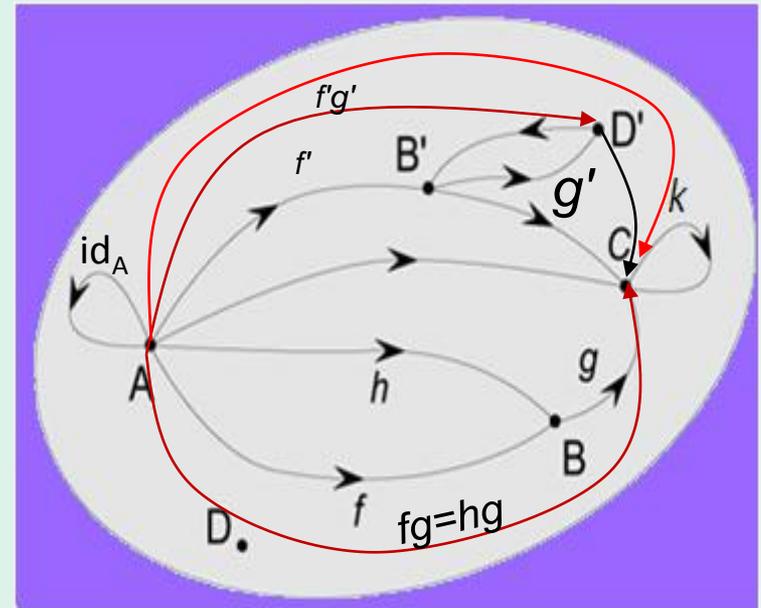
Modeled by a *Memory Evolutive System* (EV 1990, 2007).

Example: MES of the Art World of a society

GRAPHS AND CATEGORIES



A (multi-)graph G has vertices A, B, \dots , and arrows $f: A \rightarrow B$.
 Path of G = sequence of consecutive arrows.

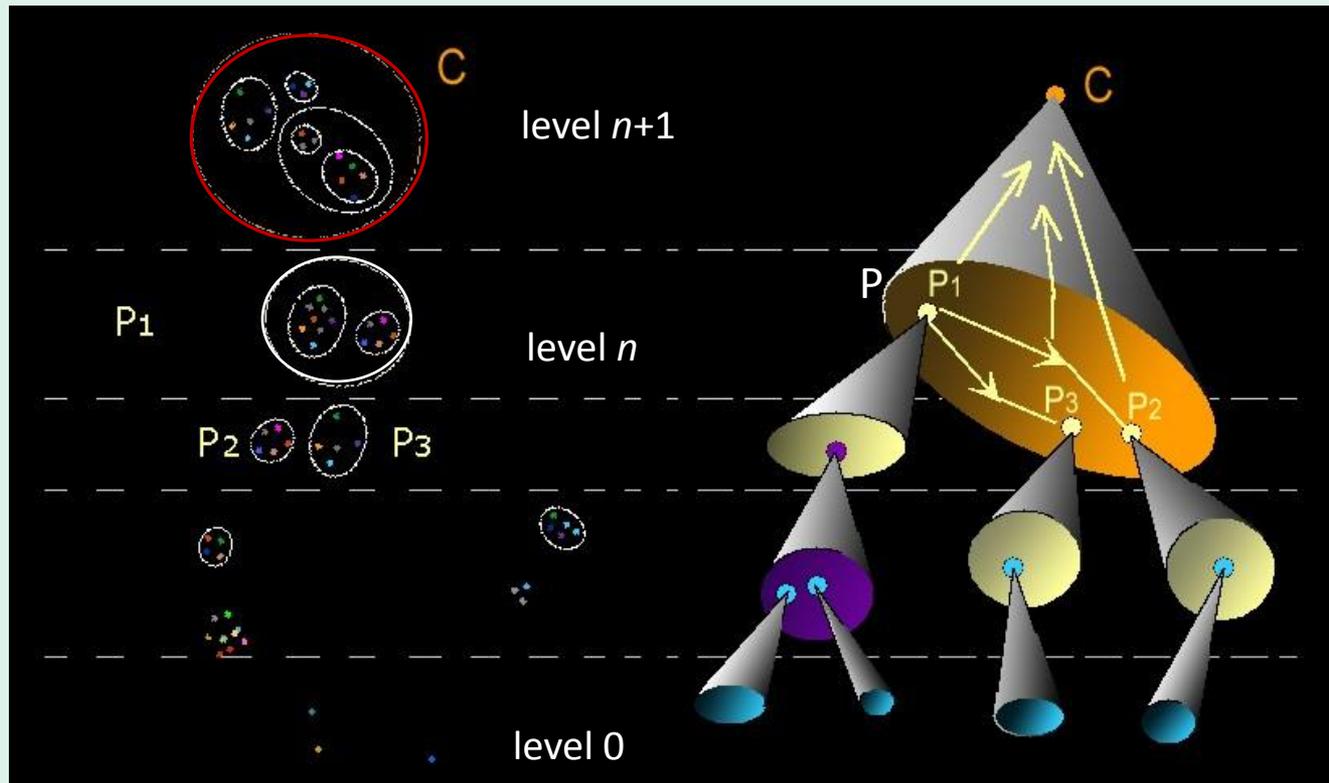


Category = graph in which each path (f, g) has a *composite* fg , the composition being associative and with identities.

Functionally equivalent paths
 \longleftrightarrow their composites are equal

Examples of categories: monoids, preordered sets, groups, groupoids, category of paths of a graph.

THE HIERARCHY OF COMPONENTS

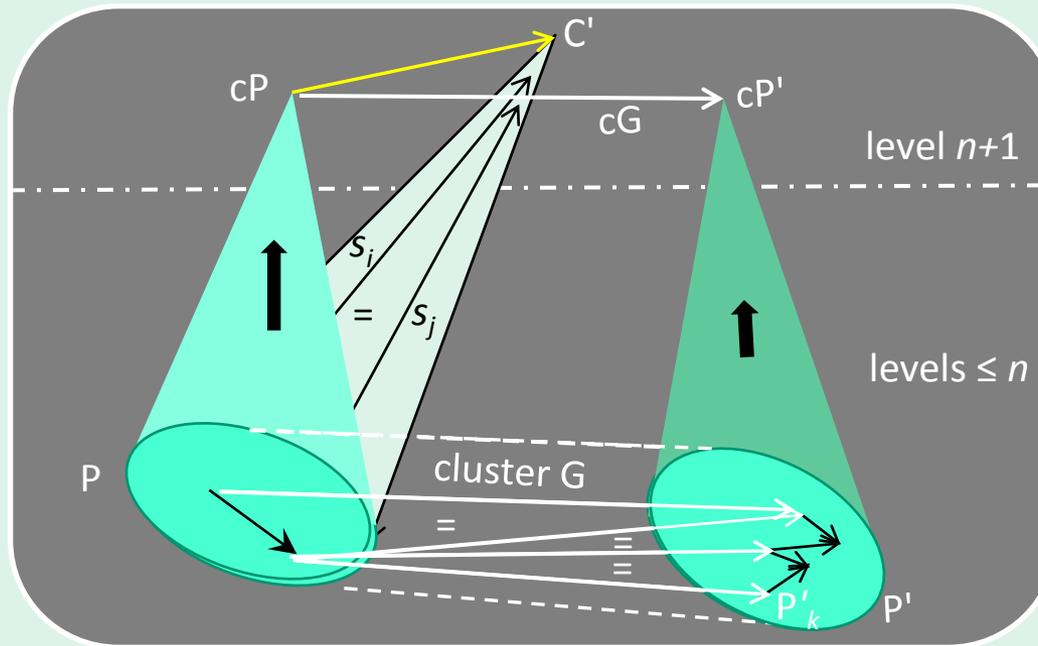


The system at t is represented by a category: objects = components at t , links = their interactions.

Objects divided into levels so that C of level $n+1$ has an internal organization into a pattern P of linked components of lower levels. which it 'binds', so that C and P have the same functional role .

---> C has a *ramification* down to level 0.

BINDING = COLIMIT. SIMPLE LINKS



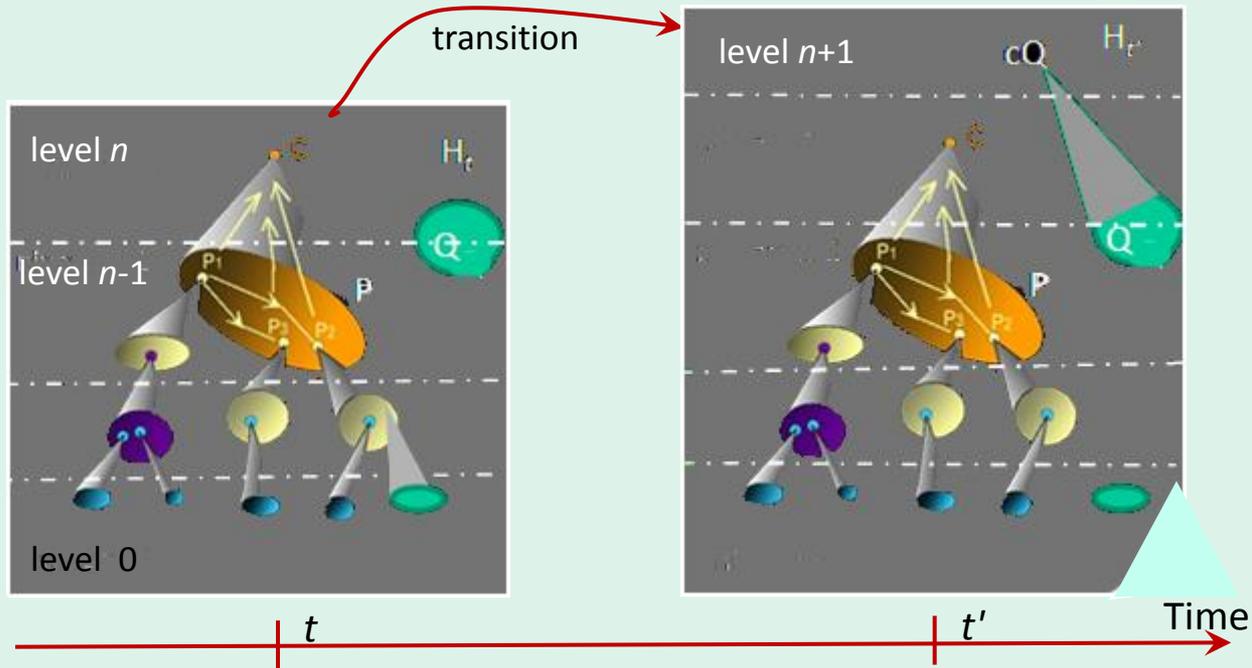
Pattern P = family of objects P_i and distinguished links between them.

Collective link = family of links $s_i: P_i \rightarrow C'$ correlated by P -distinguished links.

C = *colimit (or binding)* of P if there is a collective link from P to C through which any other collective link factors uniquely.

Cluster G from P to P' = maximal family of links from each P_i to at least one P'_k , correlated by the distinguished links of P and P' . If cP' exists, G binds into a (P, P') -*simple link* $cG: cP \rightarrow cP'$, or *n-simple link* if P and P' are in levels $\leq n$.

A HIERARCHICAL EVOLUTIVE SYSTEM

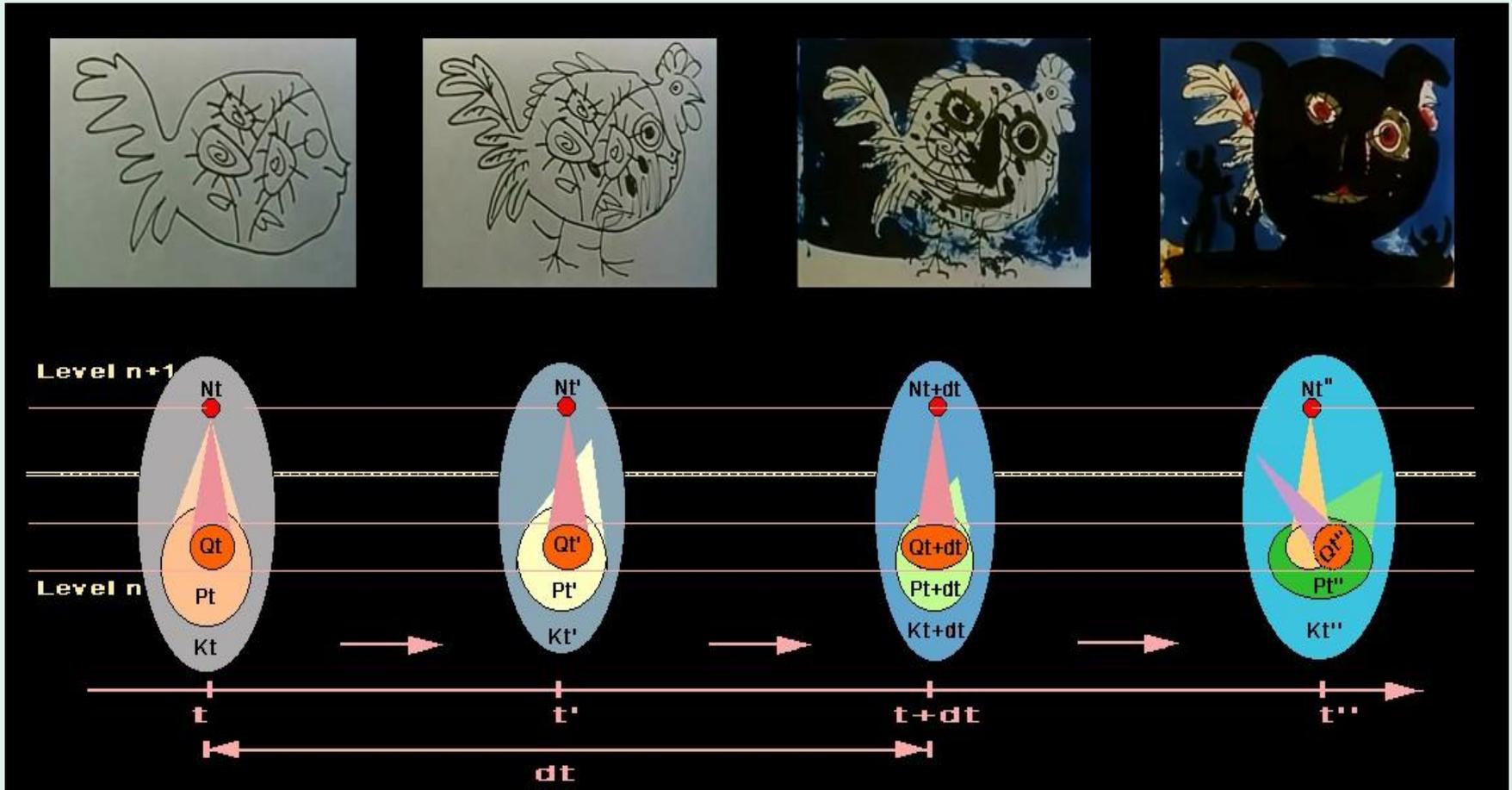


HES = family of hierarchical categories indexed by time, and partial transition functors between them satisfying a transitivity condition, so that a component is a maximal family of objects related by transitions.

Standard changes of configuration: addition/suppression of objects or links, binding of some patterns ("birth, death, scission, collision" Thom).

Modeled by the *complexification process* (EV 1987), explicitly constructed.

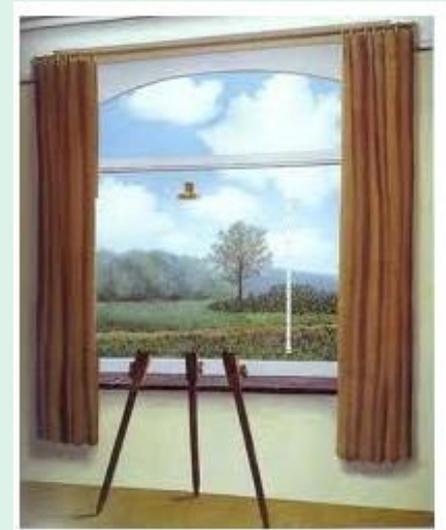
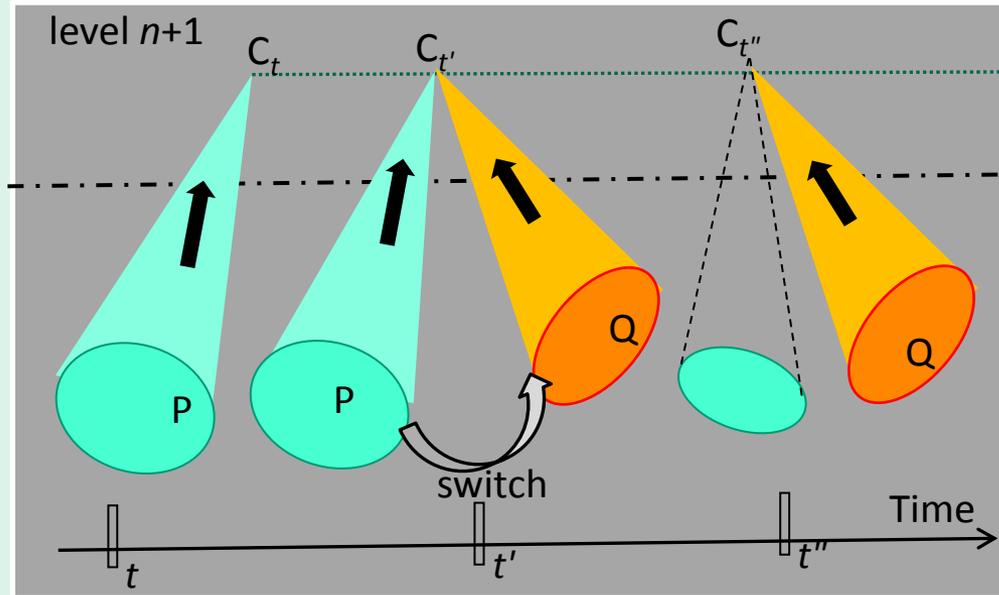
COMPLEX IDENTITY. STABILITY SPAN



Colimit 'unique', but different patterns may have the same colimit.

Stability span of a component N at t = longest period during which N preserves one of the decompositions it had at t .

MULTIFORM OBJECTS ---> FLEXIBILITY



Magritte

C is *n-multiform* if it has 2 lower levels decompositions P and Q not connected by a cluster. The passage from P to Q is called a *switch*.

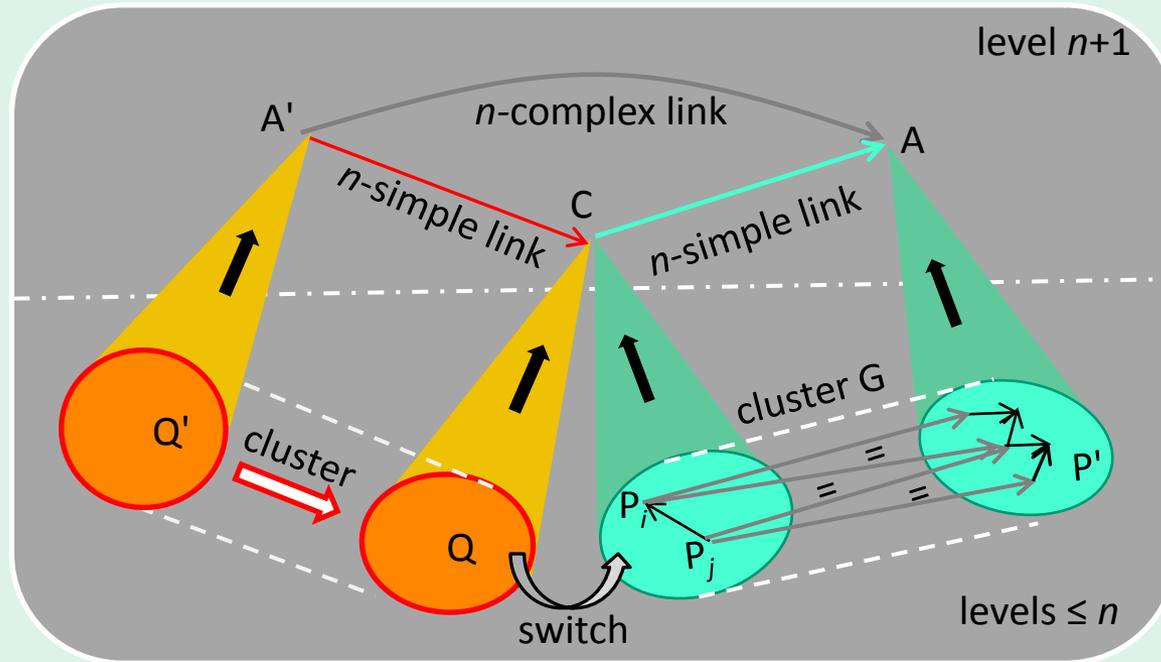
---> P and Q have the same functional role, though not well interconnected. Ubiquitous in biological systems (where Edelman speaks of "degeneracy").

Example: Ambiguous figure.

MULTIPLICITY PRINCIPLE (MP): In MES there are *n-multiform components*.

MP gives *robustness/flexibility* to the system via possibility of switches.

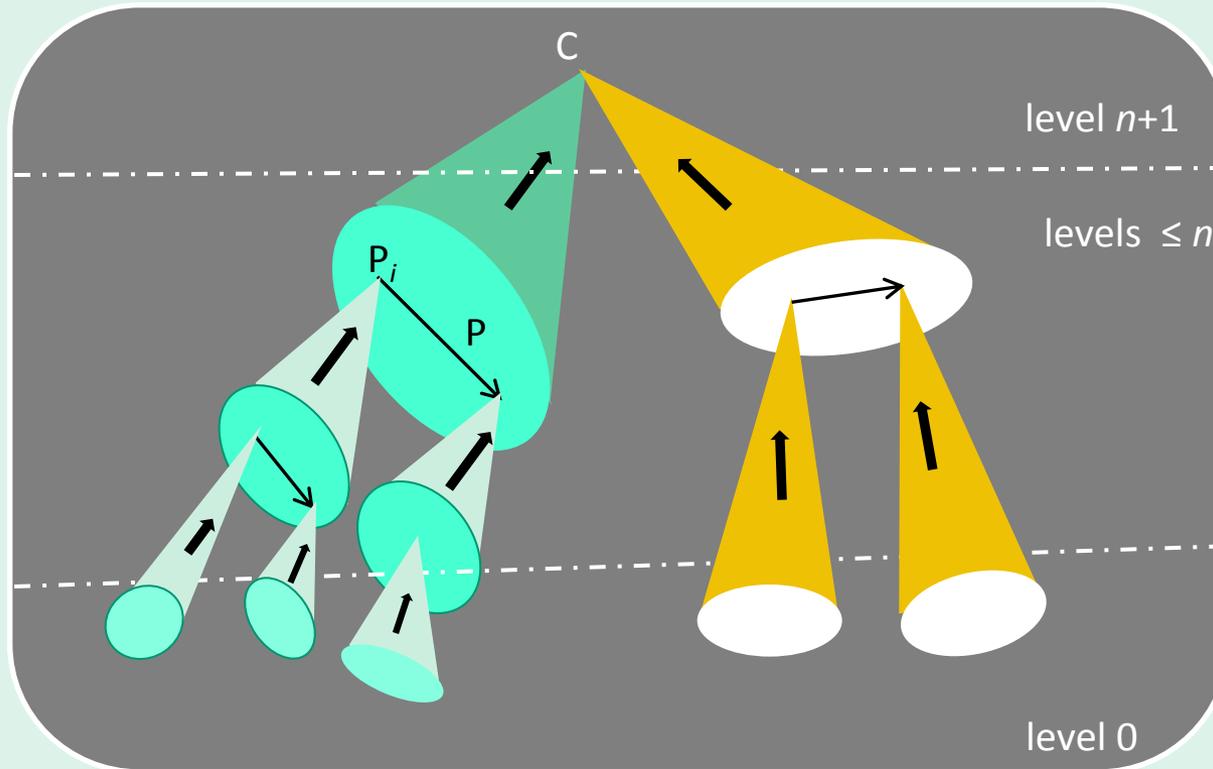
MP ---> EMERGENCE OF COMPLEX LINKS



The composite of n -simple links binding clusters separated by a switch is generally not n -simple. It is called an *n -complex link*.

n -complex links represent properties *emerging at level $n+1$* , not observable locally at lower levels, though they depend of the global structure of these lower levels.

COMPLEXITY ORDER

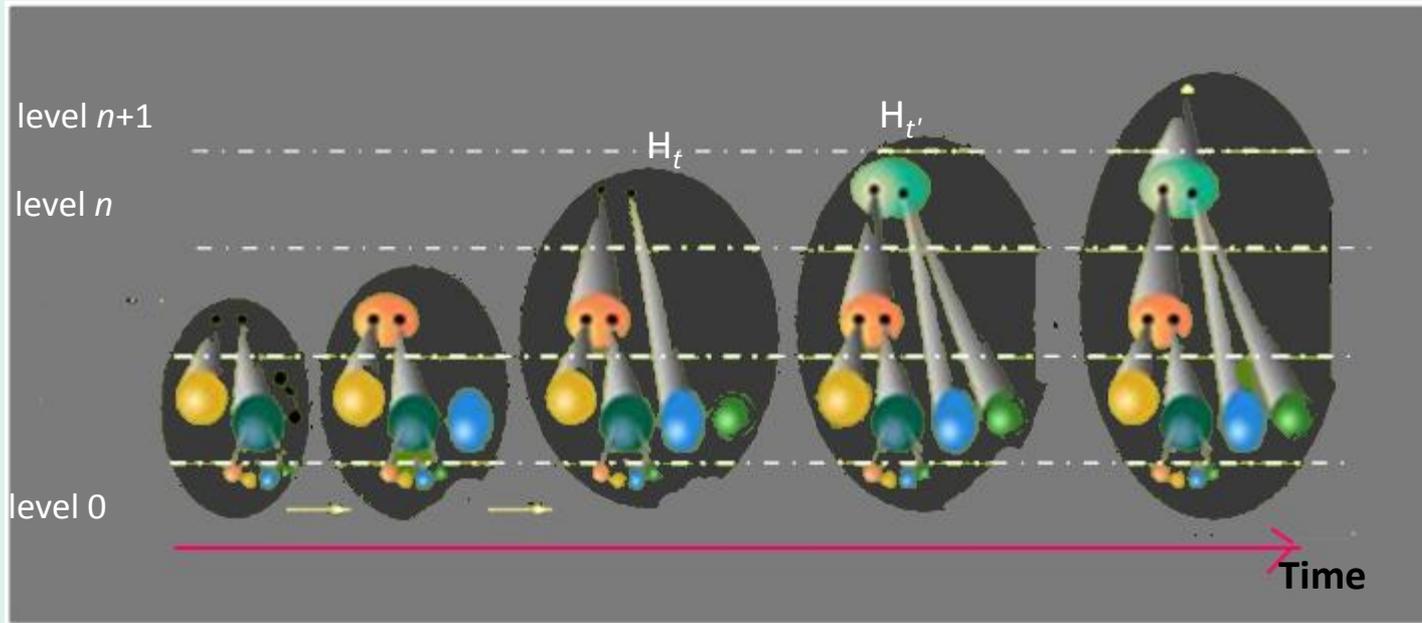


Complexity order of C = smallest length of a ramification down to level 0.

COMPLEXITY THEOREM (EV 1996). *MP is a necessary condition for the existence of components of complexity order strictly more than 1.*

Without MP, any component is the colimit a pattern of level 0.

MP AT THE ROOT OF HIGHER COMPLEXITY



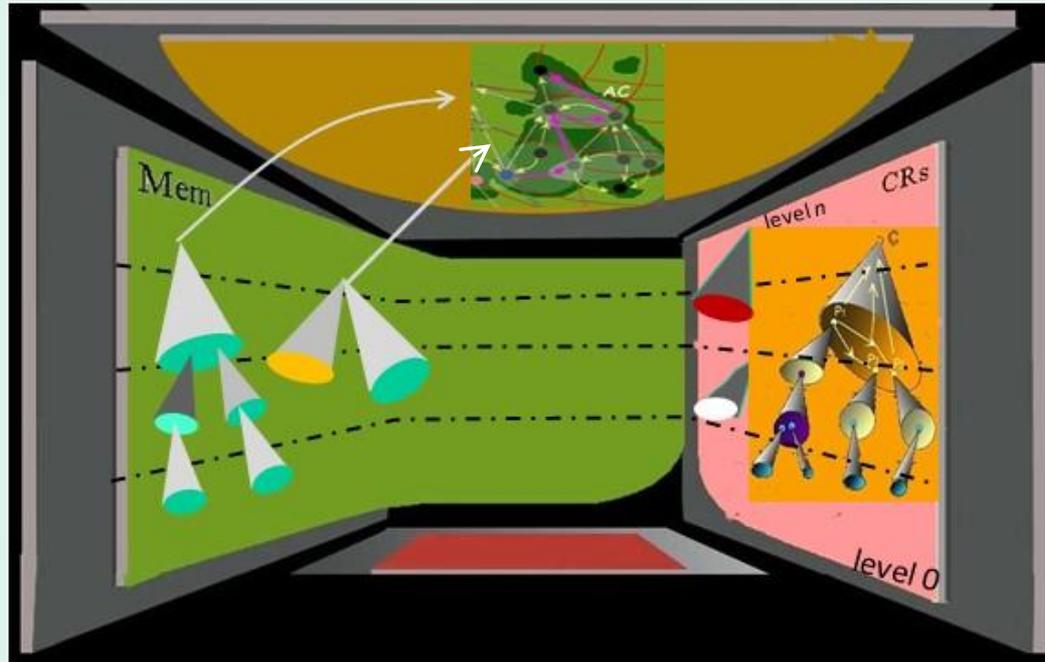
EMERGENCE THEOREM. *In a HES, MP is a necessary condition for the emergence over time of components of strictly increasing complexity order, and it intermingles the material, formal and efficient causes (---> organism in the sense of Rosen).*

MP not satisfied ---> 'pure' reductionism.

MP ---> emergentist reductionism (in the sense of Mario Bunge).

In MES, MP is always satisfied, allowing the emergence of higher complexity.

MULTI-SCALE SELF-ORGANIZATION



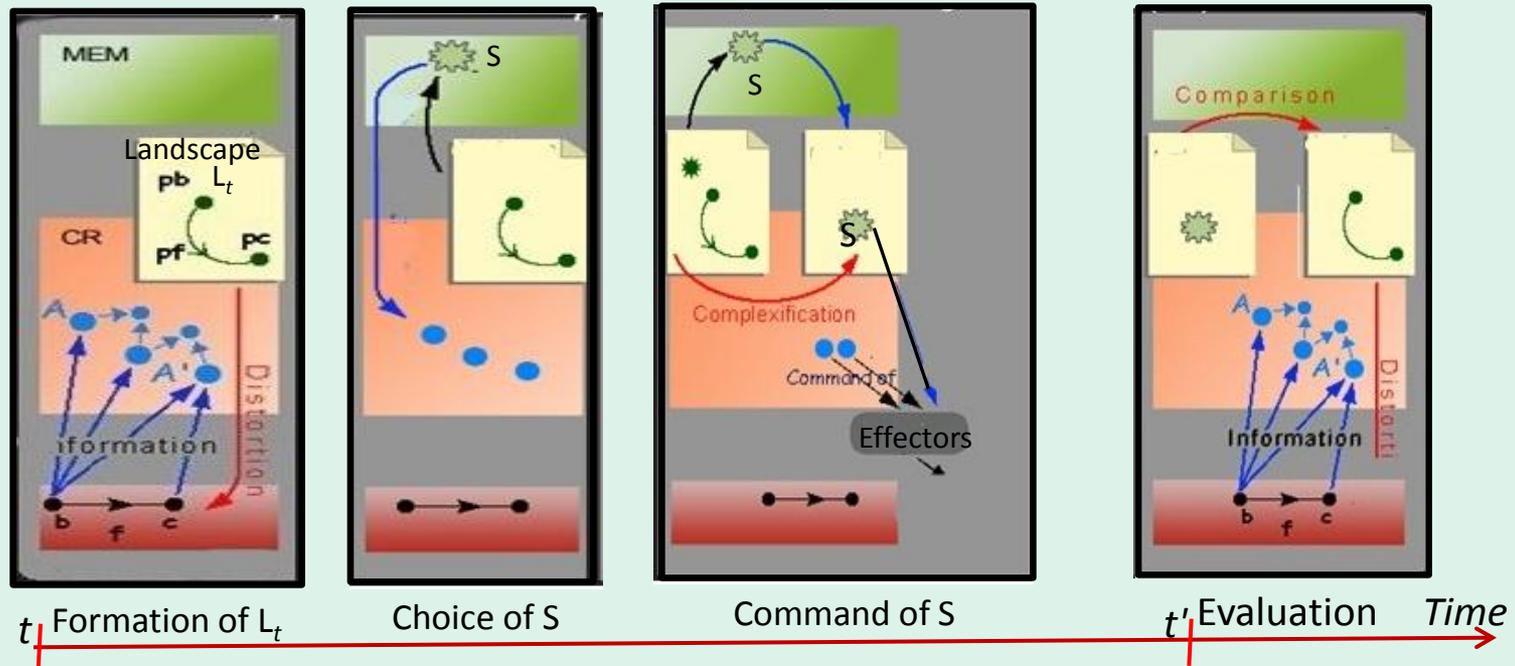
Dynamic of a MES modulated by:

A *net of co-regulators* (CRs). A co-regulator is an evolutive subsystem with its own function, complexity, operating at its own temporality.

A flexible long-term *memory* storing knowledge and past events, developing through CRs. It contains a higher order subsystem, the *Archetypal Core* (AC).

Each link between components has a *propagation delay* and a *strength*. At an instant t , It can be active or passive.

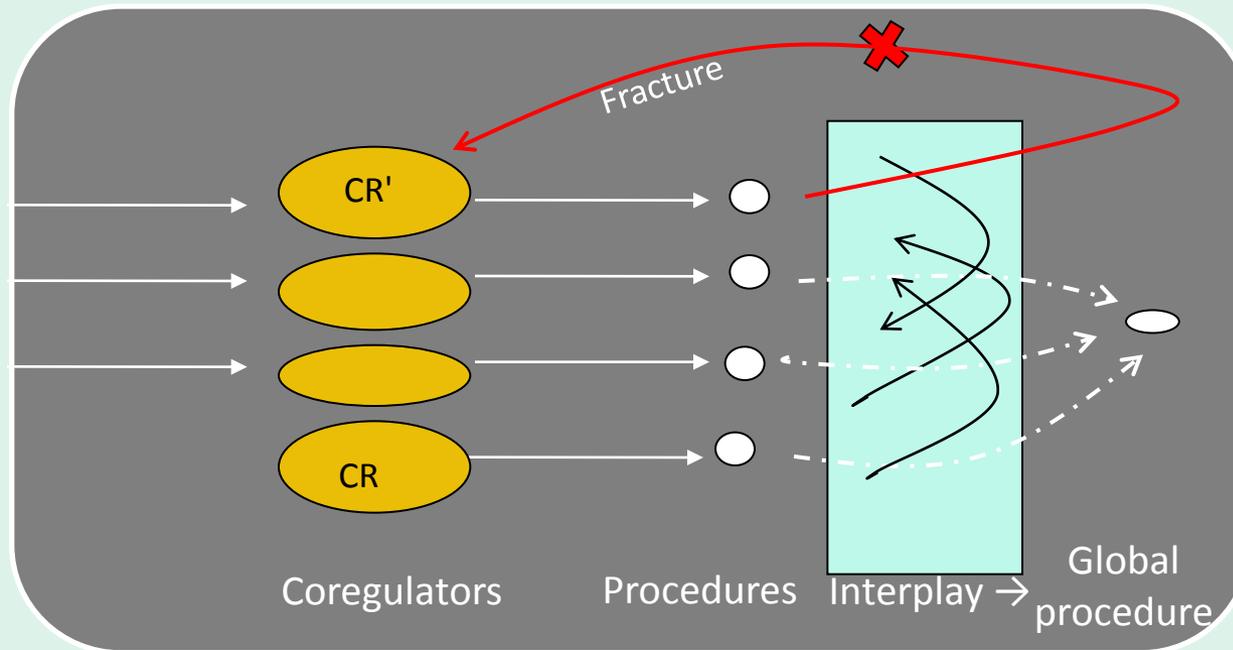
A CO-REGULATOR CR AS A HYBRID SYSTEM



CR acts stepwise at its own rhythm. At each step from t to t' :

- (i) Collect of the information accessible in its *landscape* L_t
- (ii) Choice of a procedure S to respond
- (iii) Sending commands of S to effectors ---> dynamic process from t to t' (computable via differential equations)
- (iv) Evaluation and storage of the result at t' ---> *Fracture* if objectives of S not attained.

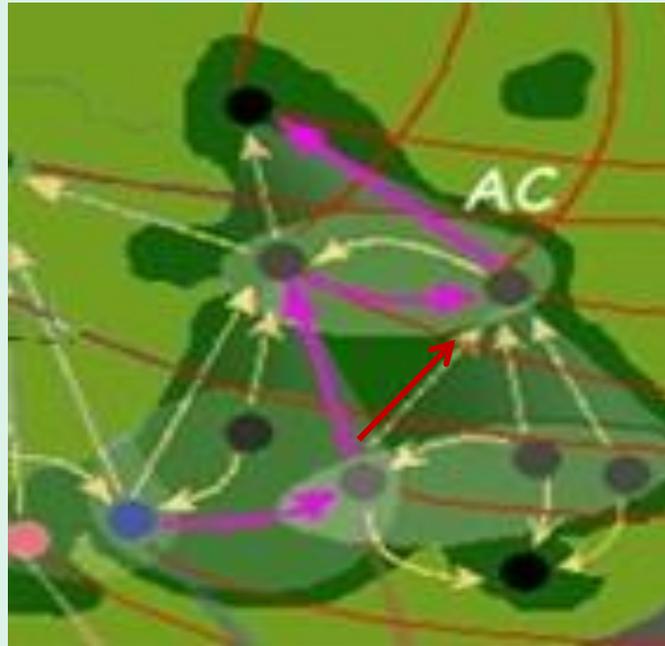
FROM LOCAL TO GLOBAL: INTERPLAY AMONG CRs



The local logics of the co-regulators being different, their procedures at a given time may not fit together.

- > *Interplay among the co-regulators* to obtain a global procedure. MP gives it more freedom degrees via the possibility of switches.
- > *Fracture* and, if it persists, *dyschrony* for some co-regulators. It can be repaired by a change of their period (*re-synchronization*).

THE ARCHETYPAL CORE

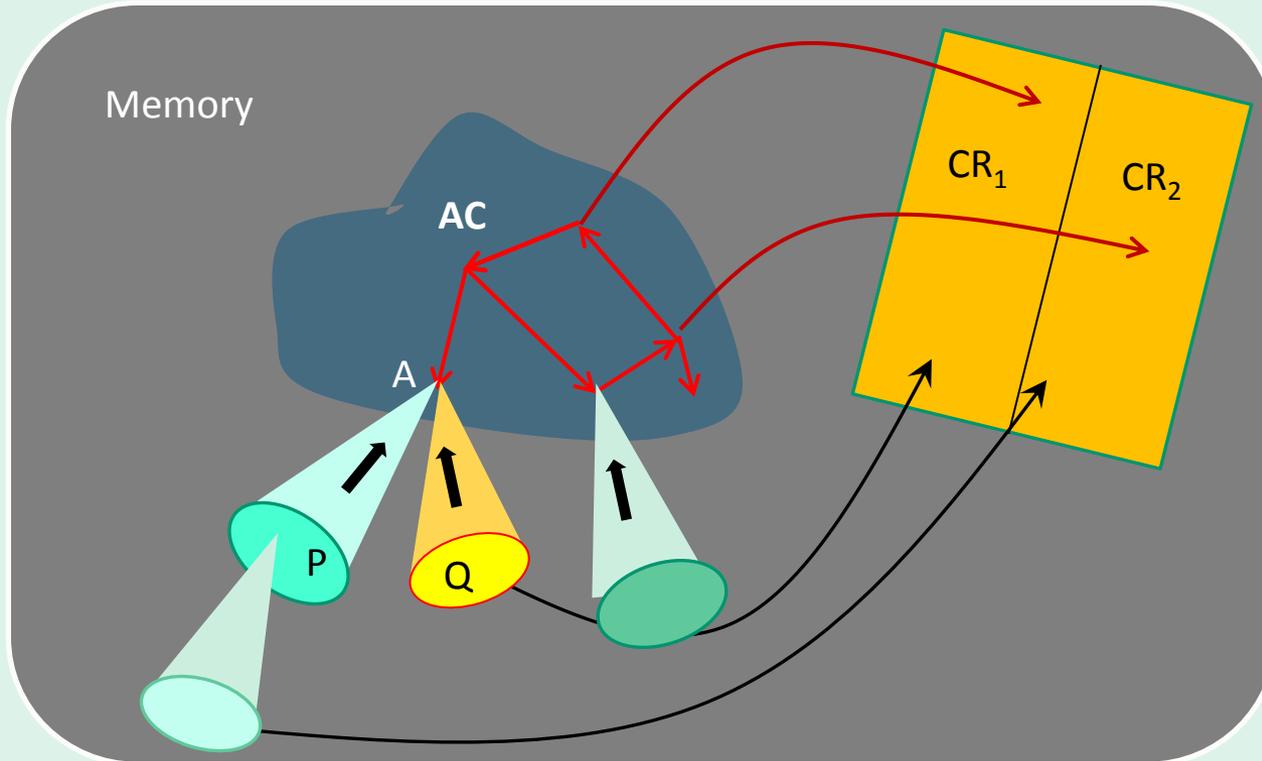


MP allows for the development over time of the *Archetypal Core* AC.

AC = subsystem of the memory formed by higher order components integrating significant memories, with many ramifications and possibility of switches between them. Their strong and fast links form *archetypal loops* self-maintaining their activation.

AC embodies the complex identity of the system ('Self'), acting as a *flexible internal model*.

INTENTIONAL CRs AND THEIR GLOBAL LANDSCAPE



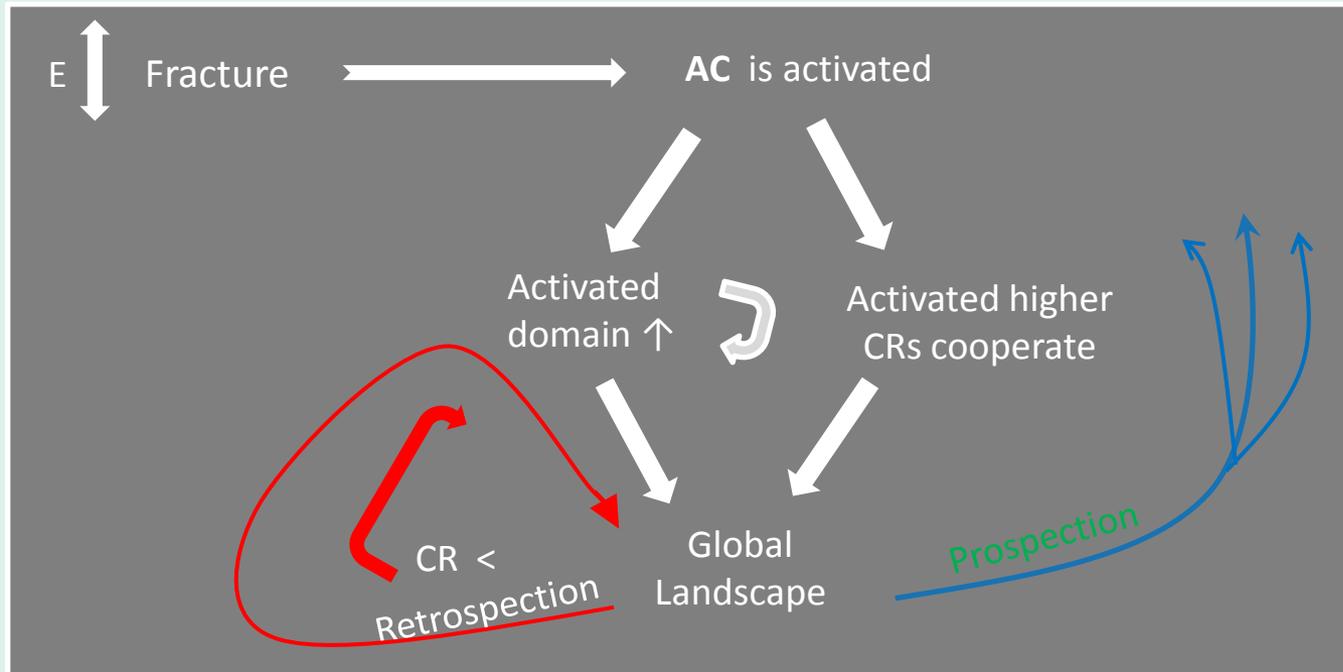
Intentional CR = higher CR directly linked to AC.

Activation of part of AC diffuses through self-maintained archetypal loops.

It propagates to a decomposition P of some A, then, via a switch, to another one, to a ramification.

Transmitted back to intentional CRs, it allows the formation of a *global landscape GL* uniting and extending their landscapes.

ANTICIPATORY INTENTIONAL PROCESSES



MES is an *anticipatory system* in the sense:

"a system with multiple potential future states for which the actualisation of one of these potential futures is determined by the events at each current time." (Dubois, 1998)

An 'intentional' anticipatory process consists in:

---> *Retrospection* for analyzing an event E and finding its possible causes (by 'aduction').

---> *Prospection* to try sequences of possible strategies and select one.

EXAMPLE: EMERGENCE OF CUBISM IN FRANCE



Braque,
Houses at l'Estaque
1908



Picasso
Guitar Player
1910

1. Picasso and Braque like the same things (Cézanne, primitive art,...). They collaborate to invent new perspectives (interactions of 2 landscapes)
2. Other artists like their work and join with them, forming a new group of artists which emerges in the Art world.
3. Critics and painters are divided. The word "cubism" is introduced as a joke (by Matisse), but it makes the trend more visible. (Fracture/Repair)
4. Some art dealers like their work and materially help them, anticipating their works will be bought ---> the group may progress.
5. Over the years the current is more and more recognized.

CONCLUSION

MP at the basis of emergence, flexibility and anticipation:

- > Emergence of objects of increasing complexity order
- > Flexibility of the co-regulators interplay through switches between decompositions of multiform objects
- > Global logic unpredictable from the CRs local logics
- > Development of the Archetypal Core, making intentional and anticipatory processes possible.

FOR MORE INFORMATION

1. *Memory Evolutive Systems: Hierarchy, Emergence, Cogni-ion*, Elsevier, 2007.
2. MENS, a mathematical model for cognitive systems, *Journal of Mind Theory* 0-2, 2009.
3. The following sites contain most of our papers:

<http://ehres.pagesperso-orange.fr>
<http://vbm-ehr.pagesperso-orange.fr>

THANKS