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## Structure and Dynamics

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Reasons vs. Causes: Emergence as experienced by the human agent

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## Causes and reasons

When talking of human beings, it is often overlooked that self-organization needs to be understood in the light of the purposeful organization characterizing their behavior. The physicist comes up with explanations in terms of “causes” of collective human behavior while human agents acting within this process see themselves as acting according to “reasons.” Explanations in terms of “causes” versus explanations in terms of “reasons” were according to C.P. Snow (1956) the source of a split between two divergent “cultures,” that of the scientist and that of the “humanist” intellectual.

Whenever laws (similar to those found in physics) are discovered that account for human behavior, these seem “external” to the motives that the agents active in the process assign themselves as the “reasons” why they are acting the way they do. Conversely, the view traditionally held by physicists is that if a “law” can be formulated that describes faithfully a variety of human behavior, then the agents’ sentiment to have determined their reasons for acting and having acted accordingly – their sentiment of freewill – must be illusory.

This shouldn’t be the case though. The agent’s “reason” is Aristotle’s *final cause*, a representation of a purpose to meet an objective: the “effect” which will then be attained. The physicist’s “cause” is Aristotle’s *efficient cause*: the one event that triggered a chain of other events, leading to the outcome seen as the “effect.” With the *efficient cause*, the emphasis is clearly set on the origin of the process, with the *final cause*, on its outcome.

To envision the *final cause* before the process has even begun implies of course a faculty for representing the end before it has been achieved. Hegel distinguished the realms of physics where elements are indifferent to each other and will collide if on the same course, the realm of chemistry where elements either attract or repel each other and finally the realm of biology where elements anticipate each other’s behavior and modify their own accordingly. The human species is endowed with such a faculty for *anticipation*: human beings make for themselves a representation of the outcome (a combination of Aristotle’s other two causes: the *material* and *formal causes*) and make it their goal (the *final cause*).

## Fields and particles

An emergent property arises as a distinctive shape in the statistical analysis of collective behavior. Where one would expect to see only the cloud of individual outcomes of the interaction of elementary components, a specific form has now emerged that can be described in its own right. The interaction of the underlying components has been channeled into what appears to be a specific attractor for the compounded effect of interactions; a “harmonization of behaviors” has taken place.

By this, a new dimension has been added, transcending the purely statistical description of compounded interactions. Conversely, this new dimension remains invisible when only the behavior of the elementary components is accounted for in their “individualistic” pursuits. The emergent process is a collective one and so is the “cause” that the law invokes; the agent’s interactions are on the contrary, individual. The *cause* acts at the “field” level while the *reason* is “particular”: it is a representation of what’s taking place from the point of view of the particle embedded in the field.

And the same applies to “structure” and “sentiment,” the contrast set that Rodney Needham introduced for characterizing the “structuralist” versus the “(British) functionalist” approaches to kinship studies in the 1960s (Needham 1962). “Structure” applies validly only at the field (collective) level while “sentiment” characterizes the particle (singular) within the field. The *structure* is the way that coordinated human behavior appears in its collective dimension to a bird’s eye view while sentiment is on the contrary the way individual agents experience the constraints that the collective behavior of other agents create (see also Homans and Schneider 1955; Paxton and Moody 2003).

“Sentiment,” the emotions experienced by the agent, means that human beings are not indifferent to the structures they’re part of and the way they respond may modify these structures in return. I gave an example of this in a recent publication (Jorion 2004) about fission of villages in Africa:

“Human populations are constrained just as any other living population by the carrying capacity of their environment. In the slash-and-burn type of agriculture, human dwellings encounter, at some point of their demographic evolution, the diminishing returns due to too remote fields having now

to be tilled. At such point in time, fission of villages occurs and part of the population emigrates to colonize more distant land. The fact remains that slash-and-burn agriculturists [do not utilize those] skills which would allow them, first, to become fully aware that they have exhausted the carrying capacity of their environment and second, to take the rational decision of splitting. What is observed in practice (see Jorion 1987) is that in the period that precedes village fission, witchcraft accusations flourish, more especially between chief sons: the most likely candidates for ultimately either conducting an emigrating party or taking the lead of that part of the population which will remain at the original dwelling” (Jorion 2004: 277).

The carrying capacity is here the structure, the witchcraft accusations, the sentiment. Snow’s “two cultures” split can then be reformulated in these terms: the scientist takes the standpoint of the field and speaks of “structures” while the humanist, takes the standpoint of the sentient particle and speaks of “sentiment.”

### **A trajectory in phase space**

In the terms used in physics when describing mechanical systems, the *phase space* of an emergent property possesses one or more additional dimensions to that of the individual components whose interactions constitute the system displaying the emergent property. Indeed, a full definition of the component, listing all its essential properties and nothing more, fails to mention the emergent property itself. A full definition of the emergent property mentions jointly the definition of the elementary components of the system as well as the features in the interaction of the individual components that generate the emergent property. The emergent process gains a permanence as a dynamical path in time or, in Waddington’s terms: a “chreod,” a channeling that is more than a simple collapse of individual attempts: the “chreod” is a becoming, “a change of form (that is, of space) in time.” In the case of cause and reason there is a gradient in the phase space containing this additional dimension and the descent along the gradient amounts to a “relaxation” in the phase space. The *cause* is the point where the descent is initiated while the *reason* is its point of arrival, the final state as it was represented in the agent’s mind as a goal before the descent even began.

We have shown therefore why there is no justification for not considering both “causes” and “reasons” in our explanations of human behavior as together they uniquely determine the path in phase space that human agents purposely adhere to. What is left to understand is how *efficient causes* and *final causes* work complementarily.

### **Awakening**

Catastrophes typically derive from positive feedbacks where a process, amplifies and snowballs, until it reaches a critical state where it collapses into one of the seven elementary catastrophes that René Thom first catalogued. Catastrophic processes that human beings endure translate into their suffering, leading to awareness and analysis of what happened (*awakening*); this drives them to modify their behavior so as to avoid the return of the disaster that was at the origin of that suffering.

Human beings’ awakening typically materializes into a negative feedback which stops the chain reaction and restores a situation where divergence from the equilibrium is absorbed (*homeostasis*). Human agents do modify their behavior and the way this transpires within the physical law describing that behavior is that a negative feedback has intervened where there was thus far only a positive one, creating a *bifurcation* in the process. Because they trigger a negative feedback within a positive one, “reasons” explain the critical points that the physicist observes as being part of the “lawful” behavior (like in a crowd dousing a fire).

Awakening has a role to play when individual behavior can be harmonized, made “coherent” as when it is said of a laser beam that it is a “coherent” stream of photons. “Harmonized” does not mean however “identical,” it just means “coordinated.” Identical behavior from all agents may actually lead to a catastrophe: the stock market, for instance, crashes when every agent seeks to sell while it evolves harmoniously when about half the agents want to sell and the other half wish to buy (see Jorion forthcoming). Awakening has a role to play when human behavior is semi-coherent and shows therefore a potential towards harmonization.

Awareness may be of the actual mechanism at work, just as when a Ponzi scheme falters because current participants pull out while potential participants hesitate and finally refrain from joining. This may

derive from the so-called “USA Today effect”: becoming aware of a process because it is now explicitly described in journalistic accounts.

Awakening is able to make a difference when a consensus to coordinate behavior ensures success more surely than chance encounters. To have any structuring power it needs therefore to occur when the process has already reached a stage of “semi-coherence”; this is Marx’s notion that for the revolutionary to have any impact, the period needs to be itself “pre-revolutionary.”

### **Following a rule**

A way to ensure a harmonization of behavior that prevents lethal snowballing is to create a “rule” that introduces forceful harmonization when individuals comply with it. Rules can only be created within a dialogue framework between human agents. Philosophers like Hobbes and Rousseau characterized the foundation of this dialogue framework as the *Social Contract*, when *Man* traded some of his freedom to enhance his safety and security.

The rule followed becomes the *reason* for the behavior observed while it is at the same time the *cause* for that behavior. The existence of the rule drives the process; there is conflation here of *reason* and *cause*: John Searle once noted that the meaning of the rule plays an *efficient cause* role in the behavior that follows it (Searle 1984: 47).

Rules may become intuitively followed in the process that Émile Durkheim had in mind when he introduced that notion of the “internalized social,” when following the rule has become a “second nature” and agents follow it unaware. In fact, with the “internalized social,” there isn’t anymore any proper “following” of a rule as there is no “final cause,” no anticipation by means of a representation of the outcome: the process has become properly *physical*: it is no “second” nature at work but properly “first” nature.

It derives from this that the description of the collective behavior of human agents following a rule (whether it is consciously followed or has been “internalized”) can be accounted for by “laws” akin to those of physics (Jorion 2004). Besides, this is in fact the intuitive motive why the laws of physics were called “laws” in the first place: because they account for a process similar to that of agents following a rule.

### **The “invisible hand”**

The “invisible hand” refers most often to processes where the following of a rule has been internalized (like in high-speed traffic on a freeway: “keep away from other vehicles”) but it refers also to processes where there’s no following of a rule at all and the harmonization has in fact been spontaneous, that is, internalized from time immemorial (like queuing up): pre-human maybe (like in mutual grooming: “you scratch my back and I’ll scratch yours”).

Sometimes, as with the stock market, it is erroneously said that an “invisible hand” is at work, on the simple assumption that there is an ongoing dynamical process. However when a process is likely to have a catastrophic outcome – which is typically the case with the stock market as it sometimes crashes – it is unwarranted to invoke the “invisible hand.” If stock markets persist most of the time, it is in fact because the complexity of the price’s past history makes it just as likely for an agent to believe that it is now on the way up or down and the stability of the market derives only from the mean-reverting quality of the *law of averages* (see Jorion forthcoming).

But the “invisible hand” may result also from the encounter of individual strategies within a context of mutual goodwill. It is then of the nature of what Aristotle called “*philia*”: solidarity (reciprocity), the “philanthropic” goodwill uniting the members of the same community towards the realisation of the common welfare. It is a direct (although sometimes *unconscious*) contribution towards making the social system *work*. One speaks then of an “invisible hand;” there is no need here for a dialogue between the agents involved but the reason is simply that “*philia*” has come into play.

“*Philia*” is sometimes referred to as “fair-play.” Fair play works against the agent’s self-interest as it distracts him from winning at all costs, but it implements unspoken rules ensuring the maintenance of the game. Talking of economic exchange, one speaks of the “invisible hand” as deriving from the agents on the market “selfishly pursuing their sole interest.” But traders need to cooperate towards the preservation of the benefits deriving from their trading relationship: sellers seek to ensure therefore the existence of buyers,

and buyers that of sellers. Trying to win is one thing, making sure that the game goes on is another one that requires equally effort and dedication. There is therefore in these competitive situations, out of necessity, both antagonism AND solidarity; striving to the common good amounts to self-interest AND solidarity, not self-interest INSTEAD of solidarity. Effectively thus, traders never follow their "sole interest": they follow both their own interest and the interest of the game as such; they collaborate with their adversaries for the superior cause of the pursuit of the game.

### **Conclusion**

Consciousness has endowed human beings with a capacity for representing to themselves the outcome of dynamical processes. This allows them to be *particles* able to modify the behavior of the *field* they are part of. It allows them in particular to prevent catastrophes deriving from the processes they're engulfed in to reach a critical point. A powerful means they discovered to such ends is in stating rules and following them: these rules then become at the same time, the *cause* for their behavior and its *reason*. By generating rules (even if these are one day forgotten for having become *second nature*), human beings introduce a harmony, a "coherence" in behavior that was lacking until then. *Self-regulating mechanisms* were offered to human beings as a gift, *rules* are a gift they made themselves by assigning *reasons* to their actions, or said differently, through the exercise of Reason.

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