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An Ontic Conception of Chance in Monod's Non-Teleological Evolutionary Biological Theory

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Abstract

In *Le Hasard et La Nécessité*, one of the most influential books in the story of Biology, Jacques Monod presents his non-teleological evolutionary biological theory. Starting from the idea – which someone ascribes to Democritus – that everything existing in the Universe is the fruit of chance and necessity, Monod maintains that each alteration in the DNA happens by chance. Hence, chance – according to Monod – is the origin of every novelty happening in the biosphere, and then the driving force of the evolution.

But which conception of chance is at the core of Monod's non-teleological theory? According to Monod, chance events are the result of the intersection between different processes that belong to independent causal chains. These accidental events are called "absolute coincidences".

Despite its importance, this coincidental notion of chance is quite neglected in contemporary literature and it seems to eschew a precise definition. This study takes into proper consideration this conception of chance and tries to shed new light on it. More precisely, the main attempt of this survey is to endorse the idea that Monod's coincidental notion of chance is ontic, that is it does not depend only on our practical impossibility to have a complete knowledge about the phenomena observed.

A central role in the discussion will be given to the independence between the intersecting causal chains, which is at the centre of this conception of chance. As I will show, the typology of the independence plays an important part in providing a distinction between an ontic notion of coincidences and a methodological one.

Keywords: Chance, Absolute Coincidences, Ontic, Independence

Introduction

In philosophical tradition the word "chance", as for the French "*hasard*", is commonly used to indicate many different things. Sometimes, for example, it is employed to denote phenomena which are fortuitous in a fundamental way, sometimes to denote phenomena which are only methodologically fortuitous.

To make clearer the distinction between a fundamental notion of chance and a methodological one, let us consider the following Henri Poincaré's passage:

> Et alors si le mot *hasard* est tout simplement un synonyme d'ignorance, qu'est-ce que cela veut dire? [...] Il faut donc bien que le hasard soit autre chose que le nom que nous donnons à notre ignorance, que parmi les phénomènes dont nous ignorons les cause, nous devions distinguer les phénomènes fortuits, [...], et ceux qui ne sont pas fortuits et sur lesquels nous ne pouvons rien dire, tant que nous n'aurons pas déterminé le lois qui les régissent.[1]

Hence, according to Poincaré, fundamental chance is something which goes beyond our ignorance. Conversely, in the case of methodological chance, a phenomenon seems to be fortuitous only because we do not have a complete knowledge about what is observed.

In literature, and in standard dictionaries as well, many definitions of fundamental chance can be found, such as chance as lack of lawlike regularities, chance as ontic probability[2] and so on. Moreover, many definitions of non-fundamental chance can be found as well[3].

This enquiry considers only a restricted meaning for the word "chance", taking into consideration chance intended as *coincidences*. More precisely, the present enquiry will investigate Monod's notion of *absolute coincidences*.

According to the coincidental conception of chance, chance events are simply the effect of the fortuitous intersection between independent causal chains. This notion of chance seems to be very important, not only because it is closely related to the Principle of Causality, according to which whatever comes to exist has a cause, but also since it is the core of Monod's non-teleological evolutionary biological theory.

The main attempt of this survey is to endorse the idea that Monod's conception of coincidences is ontic, that is it does not depend only on our practical impossibility to have a complete knowledge about the phenomena observed. In order to show that, I will firstly present Monod's definition of coincidences, trying to investigate its origins especially in French literature. Then I will illustrate, not only that the independence between the intersecting causal lines is at the centre of this coincidental conception of chance, but also that the typology of the independence plays an important role in providing a

[1]Poincaré, p. 3.
[2]See, for example, probability according to standard interpretation of Quantum Mechanics.
[3]For an extended inquiry see I. Hacking, 1990.

distinction between fundamental coincidences and methodological ones. Finally, I will show that Monod's conception of coincidences, even though closely related to French literature, presents a kind of originality if compared to that tradition.

Monod's Conception Of Chance And Its Origins

According to Monod's conception of chance, intersections between different processes that belong to independent causal chains are the origin of accidental events, called "*absolute coincidences*":

> [...] C'est le cas, par exemple, de ce que l'on peut appeler les "coïncidences absolues", c'est-à-dire celles qui résultent de l'intersection de deux chaînes causales totalement indépendantes l'une de l'autre.[1]

This conception is illustrated in the following example:

> Supposons par exemple que le Dr. Dupont soit appelé d'urgence à visiter un nouveau malade, tandis que le plombier Dubois travaille à la réparation urgente de la toiture d'un immeuble voisin. Lorsque le Dr. Dupont passe au pied de l'immeuble, le plombier lâche par inadvertance son marteau, dont la trajectoire (déterministe) se trouve intercepter celle du médecin, qui en meurt le crâne fracassé.[2]

Almost the same view can be found in Henri Poincaré:

> Un homme passe dans la rue en allant à ses affaires; quelqu'un qui aurait été au courant de ces affaires pourrait dire pour quelle raison il est parti à telle heure, pourquoi il est passé par telle rue. Sur le toit travaille un couvreur; l'entrepreneur qui l'emploie pourra, dans une certaine mesure, prévoir ce qu'il va faire. Mais l'homme ne pense guère au couvreur, ni le couvreur à l'homme: ils semblent appartenir a deux mondes complètement étrangers l'un à l'autre. Et pourtant, le couvreur laisse tomber une tuile qui tue l'homme, et on n'hésitera pas à dire que c'est là un hasard.[3]

And before in Antoine Augustine Cournot, who says that chance events are not uncaused but they are simply the result of the intersection of independent causal chains:

[1]Monod, p. 128.
[2]Monod, p. 128.
[3]Poincaré, pp. 10-11.

Les événements amenés par la combinaison ou la rencontre d'autres événements qui appartiennent à des séries indépendantes les une des autres, sont ce qu'on nomme des événements fortuits, ou des résultats du hasard.[1]

A similar conception of chance can be also observed in Jean la Placette:

> Pour moi, je suis persuadé que le hasard renferme quelque chose de réel et de positif, savoir, un concours de deux ou de plusieurs événements contingents, chacun desquels a ses causes, mais en sorte que leur concours n'en a aucune que l'on connaisse. Je suis for trompé si ce n'est là ce qu'on entend lorsqu'on parle du hasard.[2]

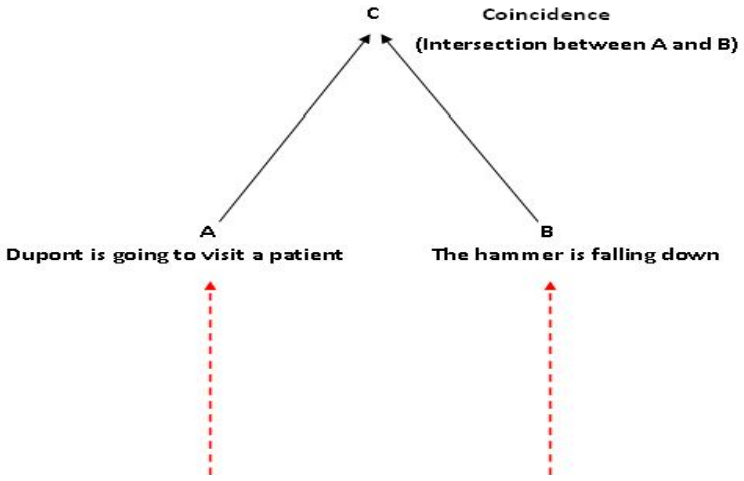
This coincidental idea of *hasard* goes probably back over Aristotle. In Metaphysics, indeed, Aristotle already maintains the fact that the existence of *per accidence* causes is an evidence of the existence of *per se* causes. In commenting on Aristotle's Metaphysics, Saint Thomas also says that if we treat accidental beings as things produced by *per se* causes, many things may be by accident, such us the meeting of independent causal lines[3].

As Cournot highlights, the core of this conception consists in the independence of the intersecting causal chains:

> Il faut, pour bien s'entendre, s'attacher exclusivement à ce qu'il y a de fondamental et de catégorique dans la notion du hasard, savoir, à l'idée de l'*indépendance* ou de la non-solidarité entre diverses séries de causes [...].[4]

To clarify this point, let us represent the already quoted Monod's example.

Figure 1. *Monod's Example of a Coincidence*



[1]Cournot, p. 52.
[2]La Placette, p. 7, end of the preface.
[3]For an extended enquiry see M. Julienne Junkersfeld, 1945.
[4]Cournot, p. 56. The italic is mine.

In Figure 1, Dr Dupont is going to visit a patient for the first time. In the meanwhile, Mr Dubois is fixing a roof in the same area. When Dr Dupont comes across Mr Dubois' work site, Mr Dubois' hammer falls inadvertently down and the trajectory of the hammer intersects the trajectory of Dr Dupont, who dies. The two red lines in the figure represent the two independent causal histories of *A* and *B*.

To sum up, coincidences are events that can be divided into components *independently* produced by some causal factor.

Global Independence *Versus* Local Independence

At this stage of the discussion, it would be worthwhile saying something more about the meaning of the independence of the intersecting causal lines, which is - as we have seen - at the centre of the coincidental notion of chance.

When we think on the *independence* we deal with two main options:

- The independence is *global*: there is not any direct, or indirect, causal link between the causal lines we are taking in consideration, and the causal lines involved do not share any direct, or indirect, common cause in their past[1].
- The independence is *local*: there is some indirect, but not direct, causal link between the causal lines we are taking in consideration, or the causal lines involved share some indirect common cause in their past[2].

In order to specify the meaning of the word "direct", it could be useful to employ the definition of what Patrick Suppes calls "direct causes":

> *[…] An event $B_{t'}$ is a direct cause of A_t if and only if $B_{t'}$ is a prima facie cause*[3] *of A_t and there is no t'' and no partition $\pi_{t''}$ such that for every $C_{t''}$ in $\pi_{t''}$*
> *(i)* $t' < t'' < t$,
> *(ii)* $P(B_{t'} C_{t''}) > 0$,
> (iii) $P(A_t|C_{t''} B_{t'}) = P(A_t|C_{t''})$.[4]

[1]Of course, a direct or indirect common cause of the causal lines involved could always be found if we trivially consider as common causes the range of all the physical laws. What is required here is holding the physical laws fixed, and then excluding the existence of extra common causes.

[2]Moreover, there could be a third kind of independence, that is something like a *partial* independence. In such cases, we can talk about "partial coincidences", that is events whose components share some, but not all, of their causal ancestors. For a more extended discussion see D. Owens, 1992, p. 8.

[3]For a definition of "*prima facie* cause" see P. Suppes, 1970, p. 12.

[4]Suppes, p. 28.

So that a direct causal link between, for example, *A* and *B* is a link which is not intercepted by any intermediary *I*, and a direct common cause *C* of *A* and *B* is a common cause which is not intercepted by any intermediary *A′* between A and C, and by any intermediary B′ between B and C.

Now, we can explicate the *global* independence between two processes, *A* and *B*, that belong to different causal chains in the following terms.

A and *B* are *globally* independent if they are probabilistically independent, so that:

$P(A/B) = P(A)$
and
$P(B/A) = P(B)$

The probabilistic independence between *A* and *B* is not due to any intermediary *I* of *A* and *B*. Hence, the following is not true:

$P(A/B \wedge I) = P(A/I)$
and
$P(B/A \wedge I) = P(B/I)$

Moreover, the probabilistic independence is not due to any screening-off common cause in the past of *A* and *B*. In fact, given a screening-off common cause, *A* and *B* are probabilistically independent of each other[1].

Therefore, in this case, the probabilistic independence is not *conditional*, but it is an *absolute* independence.

The *local* independence admits the existence of ancient common causes, and indirect causal links between the processes involved. So that, given any intermediary *I* of *A* and *B*:

$P(A/B \wedge I) = P(A/I)$
and
$P(B/A \wedge I) = P(B/I)$

Moreover, given any indirect common cause *C* of *A* and *B*, any intermediary *A′* between *A* and *C*, and any intermediary *B′* between *B* and *C*:

$P(A/B \wedge B' \wedge A' \wedge C) = P(A/B' \wedge A' \wedge C)$[2] $= P(A/A' \wedge C)$[3] $= P(A/A')$
and
9

In this case, the independence is not *absolute*, but it is *conditional*.

[1] See H. Reichenbach, 1956.
[2] This is due to the fact that *B′* is an intermediary of *B* and *C*, in a way that it screens off *B* from *C*.
[3] This is due to the fact that *C* screens off *A′* from *B′*.

In fact, *A* and *B* are independent given any intermediary between *A* and *B*, or any intermediary between a common cause *C* and *A*, and a common cause *C* and *B*.

Otherwise, the following is true:

$P(A/B) \neq P(A)$
and
$P(B/A) \neq P(B)$

Concerning the *local* independence, a good question could be the following: would we say that a particular event happens by coincidence if we knew that the probabilistic independence between the causal lines involved is not *absolute* and it is only due to the fact the intersecting causal lines involved share the same causal history?

Most probably we would say that such events are fortuitous only because we are unable to trace all of the causal histories. If we had something like a Laplacian God's-eye view, we could probably trace all of the causal sequences, and then we would be able to see that the phenomenon observed does not happen by chance. In situations like that our ignorance seems to be the sole and the primary reason we say that the event in point is coincidental.

This means that a conception of coincidence that comes from a *local* independence between the causal lines involved is not fundamental, but it is still methodological, since it depends solely on our ignorance about what is observed.

Conversely, a conception of coincidence that comes from a *global* independence between the causal lines involved seems to be fundamental. In fact, in such cases, if we had something like a God's-eye view, coincidences would not disappear, showing their independence from our degree of knowledge[1].

The independence from our degree of knowledge is, indeed, well explicated by the *absolute* probabilistic independence between the causal lines involved, which is entailed by the notion of *global* independence.

Monod's Absolute Coincidences: an Ontic Notion of Chance

At this point of the discussion, it seems easier to show whether Monod's conception of coincidence is ontic or not.

As we have already seen, Monod talks about "*coïncidences absolues*".

Where the use of the word "*absolues*" is not fortuitous. More precisely, such a word means that there are coincidental events which would still be coincidental even though we had something like a God's-eye view, that is independently from our degree of knowledge.

[1]It is important to point out that what has been said has value if we consider the causal chains that produce coincidental events as physical chains, that is as something of very similar to real processes in the world.

As already pointed out, the independence from our degree of knowledge is explicated by the *absolute* probabilistic independence between the causal lines involved, which is entailed by the notion of *global* independence.

Hence, it seems that Monod is thinking about the first type of independence, that is the *global* one.

This is made evident even by the following already quoted Monod's passage:

> [...] C'est le cas, par exemple, de ce que l'on peut appeler les "coïncidences absolues", c'est-à-dire celles qui résultent de l'intersection de deux chaînes causales *totalement*[1] indépendantes l'une de l'autre.[2]

Where the word "*totalement*" stays for what can be called "globally".

According to what I have already said, a *global* independence between the causal chains involved means that:

> *There is not any direct, or indirect, causal link between the causal lines we are taking in consideration and the causal lines involved do not share any direct or indirect common cause in their past*.

So that, for Monod's example (Figure 1):

P(A/B) = P(A)
and
P(B/A) = P(B)

That is, the fact that Dr Dupont goes to visit his patient is probabilistically independent of the fact that the hammer falls down, and the fact that the hammer falls down is probabilistically independent of the fact that Dr Dupont goes to visit his patient. Of course, the probabilistic independence is *absolute*.

As already shown, a conception of coincidences that comes from a *global* independence between the causal lines involved seems to remind a fundamental kind of coincidental events, in a way that Monod's notion of coincidences seems to be clearly ontic.

To enforce the idea according to which Monod's notion of absolute coincidences is a fundamental conception, let us consider the following passage:

> Le contenu de la notion de hasard n'est pas simple et le mot même est employé dans des situations très différentes. Le mieux est d'en prendre quelques exemples.

[1]With the use of the word "*totalement*", Monod is even excluding the possibility that absolute coincidences can be partial coincidences, that is events whose components share some, but not all, of their causal ancestors.

[2]Monod, p. 128. The Italic is mine.

> Ainsi on emploie ce mot à propos du jeu de dés, ou de la roulette, et on utilise le calcul des probabilités pour prévoir l'issue d'une partie. Mais ces jeux purement mécaniques, et macroscopiques, ne sont «de hasard» qu'en raison de l'impossibilité pratique de gouverner avec une précision suffisante le jet du dé ou celui de la boule. Il est évident qu'une mécanique de lancement de très haute précision est concevable, qui permettrait d'éliminer en grande partie d'incertitude du résultat. Disons qu'à la roulette, l'incertitude est purement *opérationnelle*, mais non *essentielle*. Il en est de même, comme on le verra aisément, pour la théorie de nombreux phénomènes où on emploie la notion de hasard et le calcul des probabilités pour des raisons purement méthodologiques.
>
> Mais dans d'autres situations, la notion de hasard prend une signification *essentielle* et non plus simplement *opérationnelle*. C'est le cas, par exemple, de ce que l'on peut appeler les "coïncidences absolues" [...].[1]

Where the word "*essentielle*" stays for "fundamental" and the word "*opérationnelle*" stays for "methodological".

It seems that Monod, when he talks about "absolute coincidences", is thinking on some kind of fundamental phenomena[2].

Monod's Absolute Coincidences: a New Kind of Coincidental Events

Monod's conception of coincidences, even though closely related to French literature, presents a kind of originality when compared to that tradition.

As we have already seen, even according to Cournot, chance events are not uncaused but they are simply the result of the intersection between independent causal chains. To make clearer this point, let us consider the following example from Cournot[3].

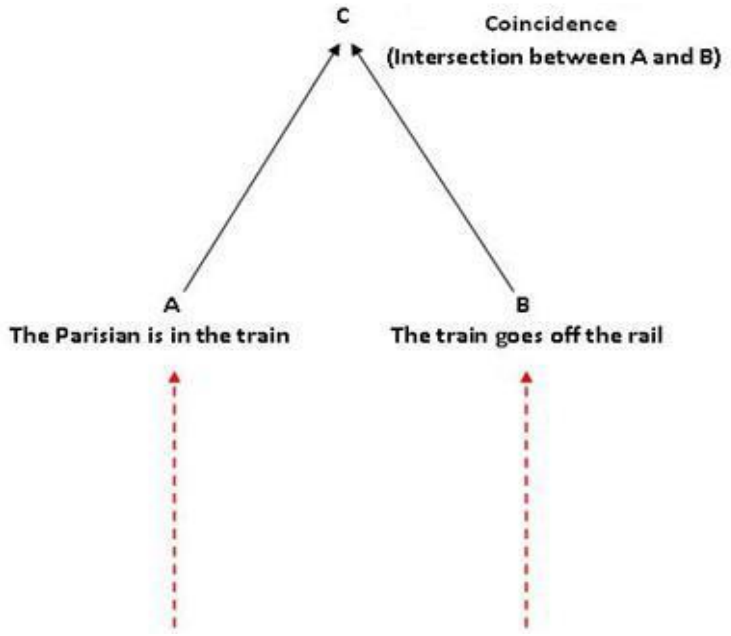
A Parisian decides to go for an outing and takes a train to reach the desired location. The train goes off the rail and the Parisian is the poor victim. In this case we have an intersection between two independent causal lines: the Parisian in the train and the train which goes off the rail.

[1]Monod, p. 128. The italics are mine.

[2]It is important to point out that what has been said has value since Monod considers the causal chains that produce coincidental events as something of very similar to real processes in the world. According to Monod, indeed, chance (absolute coincidences) is the origin of every novelty happening in the biosphere and then, in some sense, in the physical world.

[3]Cournot, p. 52.

Figure 2. *Cournot's Example of a Coincidence*



The two red lines in the figure represent the two independent causal histories of *A* and *B*.

But which kind of independence is Cournot talking about? All that can be said is written in the following passage:

> Il n'est donc pas exact de dire, avec Hume, que «le hasard n'est que l'ignorance où nous sommes des véritables causes» [...]. Sans doute le mot de hasard n'indique pas une cause substantielle, mais une idée: cette idée est celle de la combinaison entre plusieurs systèmes de causes ou de faits qui se développent chacun dans sa série propre, indépendamment les uns des autres. Une intelligence supérieure à l'homme ne différait de l'homme à cet égard qu'en ce qu'elle se tromperait moins souvent que lui, ou même, si l'on veut, ne se tromperait jamais dans l'usage de cette donnée de la raison. Elle ne serait pas exposée à regarder comme indépendantes des séries qui s'influencent réellement, ou, par contre, à se figurer des liens de solidarité entre des causes réellement indépendantes.[1]

According to Cournot, it is not correct to say, with Hume, that chance is only due to our ignorance of the real causes[2]. In fact, a supreme intelligence would probably be able to trace all of the causal sequences, and then to see that some phenomena observed are still fortuitous.

[1]Cournot, pp. 62-63.
[2]Hume, Book I, part III, section XIV.

Although not explicit, what Cournot is probably trying to say in the passage quoted above is that it may exist some kind of *global* independence between the causal lines involved.

However, as it is well clarified by Thierry Martin:

> D'une part l'analyse de Cournot, ne se situe pas sur le plan métaphysique. […] En toute rigueur, elle n'affirme d'ailleurs même pas l'existence physique effective des séries causales, mais n'en tient à poser que l'on peut se représenter les relations causales unissant les événements sous le forme de telles séries.[1]

And again:

> Cournot le précise clairement «le mot de hasard n'indique pas une cause substantielle, mais une idée».[2]

Hence, while in Monod a conception of coincidences that comes from a *global* independence between the causal lines involved seems to remind a fundamental kind of coincidental events, in Cournot the situation is different. The discussion, in fact, moves from an ontic level to an epistemic one, so that it does not have any sense to talk about coincidences as ontic events[3].

According to Poincaré's conception, ontic coincidences do not exist. Hence, coincidental situations show phenomena which are clearly only methodologically fortuitous. Let us consider what Poincaré says concerning that:

> Notre faiblesse ne nous permet pas d'embrasser l'univers tout entier, et nous oblige à la découper en tranches. Nous cherchons à le faire aussi peu artificiellement que possible, et, néanmoins, il arrive, de temps en temps, que deux de ces tranches réagissent l'une sur l'autre. Les effets de cette action mutuelle nous paraissent alors dus au hasard.[4]

Based on Poincaré's view, our ignorance is the sole and the primary reason we say that a phenomenon is fundamentally coincidental.

To conclude, Monod's notion of coincidences, in being a fundamental conception of chance, seems to be different from Cournot's one and Poincare's one.

[1]Martin, p. 111.
[2]Martin, p. 113.
[3]For a more extended discussion on Cournot's conception of chance see T. Martin, 1996.
[4]Poincaré, p. 11.

Conclusion

In this paper, I have shown that Jacques Monod's notion of absolute coincidences is an ontic conception of chance, in fact:

1) Monod considers the causal chains that produce coincidental events as something of very similar to real processes in the world.
2) His conception of chance does not depend only on our partial knowledge about the phenomena observed.
3) The independence between the causal lines involved is *total*, namely *global*.

A deeper inspection suggested that not only the notion of independence has an important role in defining coincidences, but also that the distinction between *global* independence and *local* independence is important to make a discrimination between fundamental and methodological coincidences.

I have also shown that Monod's conception of coincidences, even though closely related to French literature, presents a kind of originality when compared to that tradition. More precisely, Monod's notion of absolute coincidences, in being a fundamental conception, seems to be different from Cournot's and Poincaré's one.

Many problems concerning coincidences are still open. It remains, for example, to be seen whether there is a relation between this causal conception of chance and other notions of chance.

Further investigations along this line will be the object of developing papers.

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