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'ILLICIT JUMPS' – THE LOGIC OF CREATION

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1. In spite of the many breath-taking achievements in neuroscience we still do not know the most important thing of all: how do neural signals become transformed into consciousness? The following remarks are aimed at expressing this ignorance in a quasi-logical way. It is essential to clearly know what (and how) we do not know. This seems to be a precondition to even starting to move in the right direction.

2. The logic of language is traditionally divided into three parts: (1) *syntaxis*, which investigates the relations between the expressions of a given language; (2) *semantics*, which investigates the relations between a language and what that language refers to; and (3) *pragmatics*, which investigates the relations between the expressions of a language and its users. Syntactic investigations remain inside the language, whereas semantical and pragmatic investigations go from the language to the world it describes and to the people who speak it, respectively. In the following paper, I shall base my considerations on the interplay between syntaxis and semantics, putting aside, for the time being, their pragmatic aspect. After all, pragmatics is certainly a less developed branch of the logic of language.

3. There exist languages which completely lack a semantic aspect. They are purely formal languages and are often called artificial languages. In all other languages syntaxis and semantics are in a constant interplay with each other. Terms such as 'meaning', 'reference', and 'denotation' are semantic terms, or better, 'semantic operators'. They 'act' on the language, and have their 'values' in the world the language describes. Owing to such operators a given language can be a language about something.[1]

[1] Sometimes one speaks about a meaning in relation to purely formal languages but, in such a case, the meaning of a given expression is to be inferred from the rules of how this expression is used within the language.

4. It can happen that a language refers to itself. If we treat a reference as a semantic operator then this language operates on itself. Strictly speaking, we should distinguish here two languages: the language that operates – which is called a 'metalanguage' (or the language of the second order) – and the language which is operated on: this is just called 'language' (or the language of the first order). There can be languages of many orders.

Here we must be on our guard against sophisticated traps. On the one hand, jumping from a language to the metalanguage (or *vice versa*) can create antinomies (the so-called semantical antinomies) such as, for example, the famous antinomy of the liar ("what I am saying now is a lie" – is this statement true or false?). On the other hand, however, a skilful manipulating of the languages of various orders can be a very efficient method by which to prove subtle theorems related to the foundations of logic and mathematics. For instance, Kurt Gödel proved his outstanding incompleteness theorem by, first, translating utterances about arithmetics into numbers, then by performing arithmetical calculations on these numbers, and finally by translating the obtained results back into the language about arithmetics. This strategy is called the 'self-reference method', and nowadays is more and more appreciated. In general, however, jumping from one linguistic level to another linguistic level, if done without a rigorous logical control, is dangerous and trouble-generating.

5. In fact, this rigorous logical control is possible only as far as purely formal languages are concerned. Although, in principle, such languages have no semantics at all, semantics can be 'artificially' attached to them, and precisely because it is 'artificial' we obtain full control of the process. This is done by creating an *interpretation* of a given purely formal language. The truly ingenious idea is to create a purely formal linguistic substitute of the reality the language has to describe. This substitute is called a (*semantical*) *model* of a given language (I shall not here go into technical details). When such a model is created we say that the considered formal language has acquired its (*semantic*) *interpretation*. Having at our disposal a formal language and its model, the rules of going from the language to its model, and *vice versa*, can be fully codified. To do this is the principal goal of semantics. Tarski's famous definition of truth says that an utterance (belonging to a given formal language) is true if and only if it asserts something about its model and this really occurs in the model.

However, if we go beyond the realm of formal languages a mess dominates the scene. Almost every transition from syntaxis to semantics (and *vice versa*), is from the point of view of strict logic an 'illicit jump'. In spite of this, we all speak natural languages and surprisingly often we understand each other (with a degree of accuracy sufficient to act together and communicate with each other). But this is a pragmatic side of the story which I have decided to put to one side.

6. In traditional philosophy, going back to medieval scholasticism, there was a fundamental distinction between the epistemological (or logical) order (or level) and the ontological order (or level). It roughly corresponded to the modern distinction between syntaxis and semantics with a shift of emphasis from the *relationship between language and what it describes* (the modern distinction) to the relationship between 'what is in the intellect' and 'what is in reality' (the traditional distinction). The latter distinction appeared, for example, in the criticism by St. Thomas Aquinas of the famous 'ontological argument' for the existence of God proposed by St. Anselm of Canterbury. 'God is something the superior of which cannot be thought of (*aliquid quo nihil majus cogitari possit*). And what does exist is greater than what does not exist. Thus God does exist' – claimed St. Anselm. St. Thomas did not agree: the statement 'God is something the superior of which cannot be thought of' belongs to the epistemological order, whereas 'God does exist' belongs to the ontological order, and the 'proof' consists of the 'illicit jump' between the two orders. This distinction became one of the corner stones of the Thomist system and was strictly connected with its epistemological realism. Discussions like that between St. Anselm and St. Thomas (and its continuation by Descartes, Leibniz and Kant) paved the way for the modern logical analysis of language.

7. Strangely enough, modern tools of linguistic analysis can be used to more effectively understand the functioning of the universe, or, more strictly, to see more clearly where the gaps in our knowledge of it are located. The point is that nature seems often to employ linguistic methods in solving some of its fundamental problems. I shall briefly touch upon three domains in which this 'linguistic strategy' of nature can be seen quite transparently. All these domains are in fact fundamental as far as our understanding of the world is concerned.

8. The first of these domains is the genetic code. In fact 'code' is here a synonym for 'language'. As is well known, it consists of linear strings of only four bases playing the role of letters in the 'alphabet of life'. 'The linear sequence of these four letters in the DNA of each species contains the information for a bee or a sunflower or an elephant or an Albert

Einstein.'[2] This is clearly the syntactic aspect of the genetic code. The point is, however, that the 'syntactic information' must be implemented within the biological machinery. Syntaxis must generate semantics. And do even more than this. After all, living beings are not purely linguistic concepts, but things that are real. For this reason, the old philosophical vocabulary about the epistemological and ontological orders seems to be more adequate in this context. The vocabulary *but not the rules* of traditional philosophy! The phenomenon of life testifies to the fact that, contrary to these rules, the 'illicit jump' from the epistemological order to the ontological order has been made. The genetic code does not only describe certain modes of acting, but also implements the action within the concrete biological material.

Jacques Monod sees this 'semantic antinomy' in the following way. The biological code would be pointless without the possibility of being able to decode it or to translate it into action. The structure of the machine which does that is itself encoded into the DNA. The code cannot be decoded unless the products of the code itself are involved. This is the modern version of the old *omne vivum ex ovo*. We do not know when and how this logical loop was closed.[3]

9. Another domain in which nature uses linguistic tricks to solve its problems is the functioning of the brain. In this case, the language consists of electric signals propagating along nerve fibres from neuron to neuron across the synaptic clefts. In this case the 'illicit jump' does not consist of changing from a purely linguistic level to something external which it describes, but rather in creating something real which did not exist previously, namely, consciousness. The problem at stake is much more complex here and our knowledge about it is less adequate. Let us notice that it is consciousness that has produced human languages and, in this way, the linguistic property, the starting point of our analysis, is not the beginning but rather the final product of the whole evolutionary process.

10. The third domain in which a 'linguistic approach' seems to be essential is the universe itself or, to be more precise, the laws of nature which constitute it or structure it. It is a commonplace to say that the laws of nature are expressed in the language of mathematics. Our textbooks on physics are full of mathematical formulae which are nothing but a certain formal

[2] J. V. Nossal, *Reshaping Life: Key Issues in Genetic Engineering* (Cambridge University Press, 1985), p. 14.

[3] *Le hasard and nécessité* (Éd. du Seuil, 1970), p. 182.

language (although rather seldom a *purely* formal language, i. e., one put into the form of an axiomatic system). Physicists claim that some of the formulae of this language express the laws of nature. This means that the language has its ‘semantic reference’, that it is an interpreted language. Very roughly speaking, the universe is its ‘model’. I put the word ‘model’ in quotation marks because the universe is not a set of utterances and consequently it is not a model in the technical, semantic sense. In fact, logicians and philosophers of science construct such semantic models. The strategy they adopt is the following. They try to express all experimental results, relevant for a given physical theory, in the form of a catalogue of sentences reporting these results (these are called *empirical sentences*), and then compare the two languages: the theoretical language consisting essentially of mathematical formulae with the catalogue of empirical sentences. Physicists are usually not impressed by this procedure and prefer to stick to their own method of approaching the ‘language of nature’.

Here we also encounter an ‘illicit jump’ from the empistemological order to the ontological order. After all, no mathematical formula, even if it is semantically interpreted in the most rigorous way, is a law of nature operating in the universe.

In the case of the genetic code and of the neural code, the language in question could be regarded as a ‘language of nature’ (the sequences of bases in DNA and electrical signals in neural fibres are products of natural evolution), and in this context how to change from syntaxis to semantics seems to be a non-trivial problem. However, as far as the laws of nature are concerned the mathematical language in which they are expressed is the language created by us. By using this language we *only describe* certain regularities occurring in the real universe, and we could clain that the problem of the mutual interaction between syntaxis and semantics is no more complicated than in our human languages.

I do think, however, that there is a subtle and deep problem here. Every property of the world can be deduced from a suitable set of laws of nature, i.e., from a suitable set of suitably interpreted mathematical formulae – all with the exception of one, the most important, namely, existence. Nowadays physicists are able to produce models of the quantum origin of the universe out of nothingness, but in doing so they must assume (most often they do so tacitly) that the laws of quantum physics exist *a priori* with respect to the universe (*a priori* in the logical sense, not necessarily in the temporal sense). Without this assumption, physicists would be unable even to start constructing their models. But somehow the universe does exist. Is