## Dynamics of ambiguity\*)

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G. Caglioti, Dynamics of Ambiguity, Springer-Verlag, Berlin, 1992. (Ed. Yu. L. Klimontovich)

Giuseppe Caglioti's popular book Dynamics of Ambiguity has appeared in Italian (1982, 1986), German (1990), and English (1992). Professor V. A. Koptsik has prepared a Russian translation. The English language edition has a forward by H. Haken, the founder and propagandist of synergetics. His books have been published in Russian and are well known to most specialists.

The Russian edition, which is being prepared for press has a foreward by Professor I. Prigogine, one of the founders of the theory of self-organization, who has introduced the now familiar phrase *dissipative structures* that emphasizes the constructive role of dissipation in selforganization processes. His name has been well-known to our readers for many years.

Why is Caglioti's book held in such high regard?

Its principal concern is the relationship in the modern world between science and the arts or, as we now say, the relationship between the 'two cultures.' The range of its ideas is indicated by the chapter and section headings. Here are some of them: Ambiguity in the cultural relationship between man and natural structures; Symmetry, simplicity, order; Symmetry, information, and ambiguity in quantum physics and design; Symmetry and broken symmetry in science, in perception, and in art; Entropy and information; Dynamics of ambiguity; Musicality in Virgil.

The drift of the author's own opinions is indicated by the evolution of the headings of his book: in Italian the book was called *Broken Symmetries in Sciences and Art*, but this was replaced with *Dynamics of Ambiguity* in the English-language edition. The Russian-language edition has the tentative title *From Perception to Thought with the subtitle Dynamics of Ambiguity and Broken Symmetries in science and art.* Books of this kind undoubtedly attract considerable interest among a wide circle of readers, especialy when they are written by a specialist of such distinction and when they are so beautifully illustrated. This does not, however, obviate the many questions that come to mind as one reads the book.

What is the meaning invested by the author in words such as 'ambiguity' and 'from perception to thought'? He illustrates this by considering phase transitions when, in an approach to a point of bifurcation, e.g., in second-order phase transitions, subsequent evolution can proceed along one of a number of paths.

It is important to note, however, that when sufficient information is available about the structure of the system, this type of ambiguity can be removed by the choice of the initial conditions: 'a vehicle can be steered in a desired direction.' In complex cases, it is 'unpredictability', i.e., the absence of sufficient information, and not 'ambiguity' that comes to the fore.

The author adopts the same approach to the transition from perception to thought. On page 2 of the Englishlanguage translation we read: 'If one studies the perceptive process, unifying factors can emerge. During this process the sensorial stimuli, disordered at first, become organized, correlating themselves in orderly fashion in coherent schemes which then become thought.' This can be stated more concisely thus: the transition from perception to thought is a transition from a less ordered to a more ordered state of the brain.

This is, of course, a very pretty scheme, but it is open to the question: to what extent does it correspond to reality? The answer is not to be found in this book because it is not concerned with objective criteria for the relative degree of order that could enable us to distinguish between the ordered and the less ordered states, i.e., to distinguish between order and chaos. In the absence of such criteria, it is difficult to distinguish in the course of evolution between degradation and self-organization.

Of course, this is not a criticism of this author because the question of self-organization criteria is a relatively recent one. In particular, a sufficiently complete analysis of the relative efficacy of the different criteria of order is still lacking. It is clear, however, that the use of such objective criteria could substantially reduce the 'ambiguity' in our views of the complex interrelation between perception and thought and between science and the arts, and could help in the evaluation of the effects of art on man.

Existing self-organization criteria include the criterion proposed in Refs. 1-4 (see also Refs. 5-8), which is begining to play an increasingly important role. It was called the S-theorem in Ref. 1 (S for self-organization) where it was formulated for the special case of self-organization in the van der Pol oscillator as it passed from the equilibrium state to the state of developed oscillation. This was then used in Ref. 2 to demonstrate the considerable degree of order in steady turbulent flow in a pipe as compared with the Poiseuille laminar flow (see also Refs. 6 and 9).

It was shown in Ref. 3 that the S-theorem could be applied directly to experimental data as a criterion of relative degree of order. This was followed by investigations by other groups who used this criterion to estimate the relative degree of order in the operation of different organs in the human body, e.g., in breathing when different factors that disturb its rhythm are introduced, in peristalsis perturbed by a variety of factors, in disturbances of balance, in the difference between cardiograms recorded under stress in men and women, and, finally, in the analysis of encephalograms exhibiting changes in the degree of chaos.

The last of these is of direct utility in estimating the relative degree of order in the organism, and is of direct relevance to the transition from perception to thought. Indeed, by analyzing encephalograms recorded at different stages of this process, we can use the above criterion to verify Carlioti's proposition that there is an increase in order when 'thought is born'. A whole range of possible experimental investigations of the rate at which thought is born then becomes possible, and we can ask about differences between men and women, about the effect of art on the human organism, and so on. Of course, the success of such a complex range of studies will be possible only by combining the efforts of different research groups. There is no doubt that Caglioti's book will facilitate this unification of effort, and this alone will justify its publication in Russian.

- \*)On the Russian original, there is a statement that the copyright for this article belongs to Yu. L. Klimontovich.
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- <sup>5</sup>W. Ebeling and Yu. L. Klimontovich, *Self-organization and Turbulence in Liquids*, Teubner, Leibzig. 1984.
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- <sup>7</sup>H. Haken, Information and Self-organization [Russ. transl., Mir. M., 1991].
- <sup>8</sup>Yu. L. Klimontovich, *Turbulent Motion and the Structure of Chaos* [in Russian], Nauka, M., 1990.
- <sup>9</sup>I. Prigogine and I. Sterngers, Order from Chaos, Bantam, N.Y., 1984 [Russ. transl., Progress, M., 1986].

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