CONSCIOUSNESS AS EMERGENT PROPERTY OF THE INTERACTION BETWEEN COGNITIVE LEVELS

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ABSTRACT

The search for possible neural correlates of consciousness is a particularly complex issue. Nonethess it appears ascertained that consciousness is the result of the simultaneous interaction between several brain areas. At a cognitive level, consciousness can be represented as an emergent structure typical of superior animal species that manages and coordinates different cognitive levels. However, the subjective characteristic of the conscious experience does not seem to be fully explained either by neural correlates or by a cognitive interpretation. The paper presents a formal solution of the so-called “hard problem” that takes as its starting point the important works of D. Hofstadter, G. Spencer-Brown and F. Varela.

INTRODUCTION

By "emergent property" we can mean a discontinuous step towards a greater acquisition of the system autonomy with respect to the environment. However, it must be said that there is a lack of clearness about the degree of irreducibility of such a discontinuous step: in fact the notion of "emergent property" has been adopted both by the reductionism and by the vitalism.

According to S. Alexander (Space, Time and Deity, 1920) and C.L. Morgan (Emergent Evolution, and The Emergence of Novelty, 1923) more and more complex levels of evolution produce new qualities which are not predictable on the basis of the lower-level laws (1).This position originated in the frame of the controversy between reductionism and vitalism, and it is debatable if it means that every emergent quality will remain absolutely irreducible even after the development of further theories.

But it is an open problem to find out if there exist absolutely irreducible laws in principle.

According to C.D. Broad (The Mind and its Place in Nature, 1918), it can be shown that, for instance, in chemistry it is in principle impossible to deduct the property R starting from the interactive components C_1,C_2,…, C_n, if R is a secondary quality, i.e. a disposition to some specific sensations, for example a pungent smell: whereas it would be possible to deduct R if it were a physical disposition of the components.

Broad asserts that "neither the archangel of Mathematics could predict the smell of NH3 if no one before had smelt it".

Thus the law "if (C_1,C_2,…, C_n) then Q" is emergent if it must be directly confirmed by perception of examples of Q before deducing it from a general composition law.

It can be drawn that such a quality Q can include predicates defined ostensively, which must indicate already tested qualities. But it is not possible to figure out non experite qualities, because a law which puts in relationship variations of physical quantities with variations of experienced qualities (e.g. "more resonant"), is absolutely emergent due to the limits of the semantic analysis (1). Besides, it is clear that the transition from an organizational level to the next involves a change of the description language, which includes - differently expressed - the previous elements, but whose new elements result to be formally inconsistent with the previous language. However, this fact does not have any vitalistic meaning.

V. Weisskopf suggests (cited in(2)) that when a discontinuity is not quantitatively explainable, it should be treated as a qualitatively different whole, due to a significant relationship among its parts.

According to Weisskopf the quantum indeterminism could be avoided if an effective quality theory existed. However, as we mentioned before, the methodological problem of quality is its lack of a complete relation of order: Lasswell has proposed a configuration method, which can be treated with a matrix calculus or graph theory.

THE ROLE OF THE SUBJECT

The Weisskopfs interpretation of emergence is meant in a holistic way: we can define an emergent quality as what makes the whole different from the sum of its parts, emerging from their interrelations.

A clear example are the Gestalt perceptions, which can be different even in the presence of the same components (see the renown picture in Fig. 1)

Fig. 1 – Gestalt theory: classical picture

This presupposes the presence of a percipient subject able to distinguish and integrate a set of factors not determinable through the usual analitic method.

A matrix model for the qualitative analysis could fit with the modular the Eccles-Popper preception model (3), where different Gestalts could be distinguished due to a different opening of emotional modules linked to the limbic system of the brain.

In other words, it can be said following Hofstadter (4) that the complexity of the brain structure originates the emergent quality "consciousness", which determinates our ability of perception of qualities as well as our ability of managing self-reference forms.

According to Hofstadter, in fact, consciousness is an epiphenomenon of the "tangled" complexity of the brain.

Thanks to the "foldback" (or "strange loop") the brain is able to self-observe itself "from the outside" and to overcome in this way those self-referent situations which cause an infinite loop in a computer. Following Hofstadter, computers don't have the emergent property "consciousness" because they did not yet reach an analogous degree of tangled complexity.

A FORMAL MODEL

In order to formalize such ideas it can be useful to apply the theory of F. Varela and H. Maturana (5). The authors define an autopoietic system (from □□□□ς□□□□□□□) as a homeostatic system

characterized by the interconnection and the self-organization of its own internal processes. The autopoietic systems turn out to have emergent features of autonomy and individuality.

Living systems are autopoietic machines. J. Goguen and F. Varela developed these ideas by using a formalism (6) which goes back to the G. Spencer-Brown's calculus of indications (7).

The main feature of the Spencer-Brown's algebra is the use of the two operators

 (indication)

and

(non-indication)

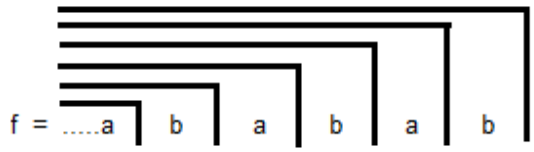
and of the two axioms

Condensation

Cancellation

According to Spencer-Brown, the original act of the subject's perception is the distinction of the "id" from the background.

As any distinction is indication of a value, we can speak of a calculus of indications. An important feature of this calculus is its particular way of handling self-reference and making it consistent, by expressing forms like



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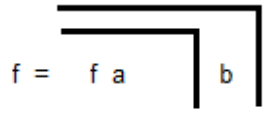
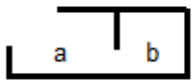


This is to say that the expression f *re-enters* into itself, *in-forms* itself, as a Klein's bottle or a Moebius' ring.

Maturana and Varela carry forward the Spencer-Brown's formalism by indicating the re-entering form with



and expand the calculus by including a third state, called the *autonomous state* indicated by

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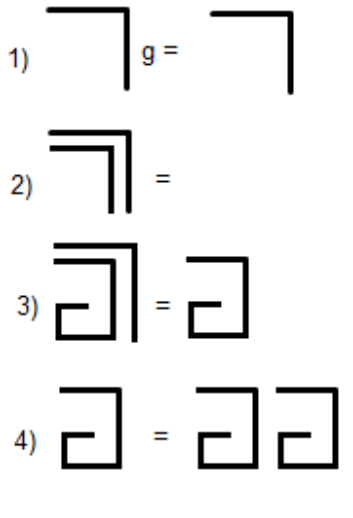
The axioms of the extended calculus of indications are now



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The basic idea is that self-reference is now included in the calculus, by introducing a third state which forms itself in an autonomous way by self-indication. The third state is *not reducible* to the laws of the two early states, but comes out from the co-operation of the elements of a two-valued systems.

An example can be the autopoietic organization of cells, given by a set of chemical species interacting each others.

In the molecular self-organization the interaction among the component variables leads to the emergence of an autonomous unity.

Douglas Hofstader confirmed his theory in (10). The formalism presented above has been enhanced in (8)(9) by developing a fixed-point equation which represents the emergence of an autonomous state (in this case the consciousness) from the act of the subject's self-observation.

CONCLUSION

All the theories above mentioned have developed a conceptual model of the interaction between cognitive levels where the role of the perceiving subject is inseparable from the phenomenology of the environment.

The cognitive levels present a strict interaction where circular connections are not vicious thanks to the presence of the subject in a double role: of physical being and of self-conscious mind which can look *from the outside* at the system which the subject is set in.

The circular connection between cognitive levels allows - once a theshold of complexity has been overcome - the emergence of properties whose features are non reducible to lower levels.

A formalism due to H. Maturana and F. Varela has been chosen to represent this model, and new developments have been carried on to justify consciousness as an autonomus state coming from the complex interconnection of the mind's processes.

REFERENCES

(1) Pap, Arthur. 1962. *An Introduction to the Philosophy of Science*. New York: Free Press of Glancoe.

(2) Lerner, Daniel., ed. 1961. *Quantity and Quality*. New York: Free Press.

(3) Popper, Karl, and Eccles, John C. 1977. *The Self and its Brain - an argument for interactionism*. Berlin: Springer Verlag 1977

(4) Hofstadter, Douglas. 1980. *Goedel, Escher, Bach: An Eternal Golden Braid*. Brighton: Harvester Press.

(5) Maturana, Humberto, and Varela, Francisco. 1973. *De Máquinas y Seres Vivos: Una teoría sobre la organización biológica*. Santiago: Editorial Universitaria.

(6) Spencer-Brown, George. 1969. *The laws of Form*. London: Allen & Unwin.

(7) Varela, Francisco. 1979. *Principles of Biological Autonomy*. New York: Elsevier.

(8) Pizzi, Rita, Degli Antoni, Giovanni. 1990. “An Introductory Model of Artficial Reality: Relationship with Spencer Brown's Calculus of indications.” *Proc. First Conference on Cyberspace,* Austin, May 1990:79-81.

(9) Degli Antoni, Giovanni and Pizzi, Rita. 1991. “ Virtuality as a Basis for Problem Solving ?” *AI & Society* 5:239—254.

(10) Hofstadter, Douglas. 2007. *I am in a strange loop*. New York: Basic Books.