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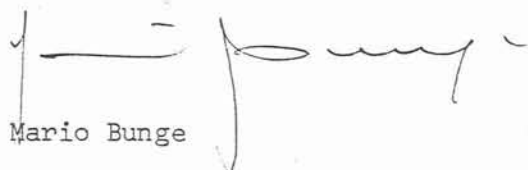
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Dear Professors Brzezinski and Marek

Thank you for your circular letter concerning the collective volume on human creativity. One of you had already invited me to contribute to it, so I wrote my paper some-time ago and I even think that I mailed it to you. In any event, I am enclosing it herewith. As you will notice, it is far shorter than what you wished to have.

May I suggest that you have the entire volume edited from a linguistic point of view by a native English speaker.

Sincerely



Mario Bunge

A NEUROPHYSIOLOGICAL EXPLANATION OF CREATIVITY

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The words 'creation' and 'creativity' are fashionable and rightly so: industrial civilization must renew itself continuously to subsist. We now honor innovators, in particular discoverers and inventors, whereas up until two centuries ago in many countries, e.g. in Spain and its colonies, being a "friend of novelties" was a crime punishable by jail. We are so fond of novelty that we often buy old things provided they come in new packages, or old ideas as long as they are expressed in new-fangled words. Moreover, our love of novelty is such, that sometimes we do not stop to find out whether the last novelty is useful, pernicious, or useless. In short, our enthusiasm for creativity is often blind.

We often boast of being creative, if not in ideas or in deeds, at least in clothes or hairdoes, in attitudes or in turns of phrase. Yet nobody seems to know what exactly is creativity, i.e. the ability to produce something new. There are even those who believe that creation is and will always be mysterious.

The concept of creation has an interesting but little-known history. For one thing, it seems not to be older than a couple of millennia. In fact, the archaic and ancient religions and cosmogonies do not seem to contain the concept of creation out of nothing. In particular, the ancient gods were unable to create things the way magicians claim to do: they could only organize the formless[^] --or mess up the organized. For example, the Genesis does not speak of a creative but rather of an organizing Yahweh, who transformed^o the original chaos into a cosmos or orderly and regular universe.

The idea of a divinity so powerful that it was capable of creating the universe out of nothing seems to have been created during the first centuries of Christianity. It was possibly an Oriental graft that must have shocked the scholars steeped in Greek

philosophy. In fact, the classical Greeks were much too rational to believe in the possibility of creation ex nihilo. In particular, the ancient atomists denied it explicitly: recall Lucretius's principle: "Nothing comes out of nothing, and nothing turns into nothingness".

The ~~G~~reek philosophers denied also that man was able to create new ideas. The idealists held that we can only grasp ideas that pre-exist in an ^aidel world, such as Plato's realm of forms. And the empiricists held that we can only refine and combine ideas originating in perception. For example, the perceptions of men and of horses allow us to form the respective concepts, which we then combine into the idea of a centaur. Even Voltaire, in the midst of a century rich in invention and discovery, denied that man could ever create anything.

But of course a mere glance at what happens around us suffices to notice, particularly in our day and age, a continual flux of novelty and, particularly, of man-made novelty. Admittedly most novelties are modest and none emerges out of nothing. (e.g. 'writed' instead of 'wrote') Examples: the toddler who regularizes an irregular verb/and thus comes up with a new word; the rascal who invents a new lie or a new excuse; the sportsman, acrobat or ballerina who invents a new pirouette; the craftsman who finds new uses for well-known tools; the engineer who designs a new machine or a new process; the biotechnologist who designs and produces a new biospecies; the manager who invents a new management style or a new type of company; the poet who describes in a new way a well-known experience, and the novelist or playwright who invents a new character; the mathematician who conceives of a new mathematical structure; the politician or bureaucrat who sketches a new law aimed at solving a social problem; the psychologist who invents a new physiological or behavioral indicator of some mental process; the pharmacologist who designs a new drug to treat a certain disorder. These are all obvious examples of creation. Even the design of a new technique for destroying life, property or society is creative.

What do all of the above examples of creation have in common? Firstly, they are man-made: they are not found in nature--unlike, say, the spontaneous formation of a molecule or the self-organization of a cellular system. Secondly, they are all products of deliberate actions, though not always of planned actions: they did not come about by pure chance, although chance always plays some role. Thirdly, they are all original in some respect: i.e. they enrich the world with something new, that did not exist before the act of creation.

Now, there are degrees of originality and therefore degrees of creativity. The last goal in a soccer game was a new fact but it did not inaugurate a new class of facts. On the other hand the invention of a new sport, such as windsurfing, was an absolute creation. The computation of a function by means of an existing algorithm, and the measurement of a physical magnitude by means of a familiar technique, are original if performed for the first time, but they are not absolute creations. On the other hand the invention of a new function or of a new theory, the design of experiments or artifacts of a new type, the invention of a new kind of social behavior (e.g. self-management), the creation of a new musical or literary style, and the like, are examples of absolute creation. In short, absolute or radical creation inaugurates a new type.

What is the creative process? This is a problem for psychological research. The behaviorists did not tackle it because they were not interested in the mind. Nor do information-processing (or cognitivist) psychologists wrestle with the problem of creation because they conceive of the mind as a computer, and computers work to rule, and there are no known rules for creating. (There are only rules for destroying, e.g. those of military strategy.) The only psychologists who have tackled the problem of creativity are the gestaltists and the biopsychologists or physiological psychologists. Regrettably, ^{although} the gestalt school stressed that we (and other higher animals) are capable of creative acts, ^{it} denied that we can analyze the

creation process. In fact ^{it} held that problem-solving is, like perception, an instantaneous and unitary event.

On the other hand biopsychology suggests an explanation sketch and a research project. According to the biopsychological approach, every mental process is a brain process. In particular, every creative mental process is the same thing as the self-organization of a new plastic neuronal system. (A connection between neurons is called 'plastic' if it may change, e.g. strengthen, in a lasting way.) A creation is absolute or radical if the corresponding plastic neural system has emerged for the first time in the history of the world.

In other words, when an animal thinks up something new, it is because in his brain a new system of neurons has emerged, either spontaneously or in response to an external stimulation. If two people have independently the same idea, it is because in their brains certain very similar new neuron assemblies have been formed as a result of having thought of the same problem on the basis of similar experiences. This explains simultaneous discoveries and inventions as well as single innovations. This explanation sketch has a solid foundation in the experimental study of neuronal plasticity, which is probably the most exciting novelty in neuroscience over the past two decades. (See e.g. Hebb 1980, 1982, Bunge 1980, and Bunge & Ardila 1987.)

The explanation of creativity in terms of the self-organization of neuronal systems is only sketchy. We still do not have a detailed theory of neural plasticity. Moreover no such theory will be forthcoming unless psychologists work more intensely on creativity, and unless they overcome their fear of mathematical modeling--and unless mathematical psychologists turn from black boxes to neurophysiological models.

The physiological explanation of creativity as the emergence of new neuron assemblies is necessary but insufficient: a reference to the social matrix is needed as well. There are conservative societies, where novelty and personal initiative are regarded with suspicion, hence inhibited. On the other hand a plastic society, where novelty and initiative are highly valued, will stimulate creativity--though not

necessarily for the common good. If we value creativity we must work for a plastic society, one where social bonds are not rigid, and experiments in (prosocial) behavior are encouraged rather than discouraged.

In order for creations to be beneficial, social plasticity is not enough, because there are noxious creations, such as the invention of new mass murder and mass destruction weapons, new types of deceitful publicity, or new types of political oppression. Technological and political creativity ought to be controlled democratically in the interest of society. (On the other hand pure science, the humanities and the arts ought to be free. If you ask someone to come up with something of kind X he will not dare inventing anything of kind Y.)

To sum up, creativity is marvelous but not mysterious, for it can be explained, at least in principle, as the self-organization of new systems of neurons. And creativity ought to be encouraged as long as it does not result in things or processes aimed at harming people.

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REALISM AND MATERIALISM

1. VARIETIES OF REALISM

- 1.1 Ontological and epistemological realism
- 1.2 Naive, critical, and scientific, and surrealism

2. VARIETIES OF ANTIRREALISM

- 2.1 Skepticism
- 2.2 Idealism, conventionalism, pragmatism (instrumentalism)

3. VARIETIES OF MATERIALISM

- 3.1 Vulgar materialism, or physicalism
- 3.2 Emergentist materialism

4. VARIETIES OF IMMATERIALISM

- 4.1 Metaphysical idealism
- 4.2 Phenomenalism (sensism)

5. RELATIONS BETWEEN REALISM AND MATERIALISM

- 5.1 The history of philosophy suggests that R and M are logically independent
- 5.2 A materialist philosophical system is realist but the converse is false

6. REALISM AND SCIENCE

- 6.1 Scientific problems, hypotheses, methods and test presuppose R
- 6.2 When realism is given up, science fails: the case of neoclassical economics

7. REALISM AND TECHNOLOGY

- 7.1 Technological problems, designs and tests presuppose R
- 7.2 When realism is given up, technology fails: the case of monetarism

8. MATERIALISM AND SCIENCE

- 8.1 Scientific problems, hypotheses, methods and tests presuppose M
- 8.2 When materialism is given up, science fails: the case of parapsychology

9. MATERIALISM AND TECHNOLOGY

- 9.1 Technological problems, designs and tests presuppose M
- 9.2 When M is given up, technology fails: the case of psychoanalysis

10. CONCLUSIONS

