

The Importance of the Concept of Vigilance for Psychophysiological Research

G. ULRICH

Freie Universität Berlin, Psychiatrische und Neurologische Klinik und Poliklinik, Eschenallee 3, D-1000 Berlin 19 (West)

Abstract — The variety of meanings nowadays attached to the notion of “vigilance” essentially conceals H. Head’s object in view when introducing the term more than half a century ago. It may be supposed that a major reason for the existing confusion is that Head failed to distinguish explicitly between “vigilance” as a force, i.e., a reorganizing power (“vital activity”) on the one hand and as a system’s state (“state of the nervous system”) established by the action of the reorganizing power, on the other. We try to explain that the original intention of “vigilance” is compatible with recently elaborated proposals according to which *living* systems have to be regarded as organizationally closed. Rather than regarding an organism only alternatively, i.e., either as organizational closed (alive) or open (dead), “vigilance” implies a graduated description according to the state of order which has actually been realized by “vigilance”.

Introduction

The term “vigilance” goes back to the English neurologist Henry Head. Having attended some of Sherrington’s experiments with spinal and decerebrate preparations, Head became engaged with the observation that the intensity of a physical stimulation of nerve-muscle preparations did not correspond to the observable response, that is flexion or extension, in the expected regular manner. Among other things, reaction essentially proved to be dependent on the number of previous stimulations. Head concluded that it was not only the intensity of the physical stimulus but also the intrinsic state of the system which determined the responses.

Later on (5, 6) he denoted this property of the system as its “vital activity” or its “vigilance”. In order to demonstrate the general importance of “vigilance”, he gave the example of patients with certain damage to the central nervous system. As a common denominator, damage to the central nervous system should result in a lowered state of “vigilance”, followed by a spontaneous recovery of function. The extent of this functional reorganization should depend on the severity, i.e., intensity and localization, of the injury. Thus there must be a spontaneously acting reorganizing power, which effects a more or less complete recovery to the predamage level of functional organization. In strokes, for

example, one observes initially a half-sided paralysis of the limbs, i.e., of one arm and one leg, which in some cases subsides after hours, in other cases after days or weeks. But there are also cases where paralysis shows only a slight improvement over months or years.

The Problem

A conceptual difficulty arises from the fact that Head did not explicitly distinguish between cause and effect, i.e., between the reorganizing power and the state of neuronal order. In so far as Head derived "vigilance" from the notion of "vital activity", it may be concluded that the term should properly denote the reorganization power. The theoretical impact of Head's concept essentially remained unrecognized in the following decades. The reason probably was that "vital activity" or "vigilance" as a kind of a mysterious power or force appeared to be inaccessible to empirical investigation. Thus, the notion of "vigilance" seemed to be incompatible with the scientific standards of medical sciences just developing in those days. Furthermore, "vigilance" was at variance with the simplifying and therefore attractive S-R paradigm becoming obligatory in neurophysiology and also in psychology. Last, but not least, life as such was being excluded from science, and therewith concepts relating to the property of life. Living beings were regarded as systems whose output was linearly determined by their input. This general view no longer holds true (e.g., 4, 7, 8, 11, 2). Nowadays science is also interested in the question of what is going on within the black box. From a general system's theory point of view living beings must be regarded as systems which, while changing their structure (for example when growing up or growing old or getting hurt or mutilated), keep their organization invariant. This means, while being alive, living beings retain their identity. Man-made artificial machines lack this property. There is no intrinsic force which reorganizes a computer when it is structurally changed, for example by a blow with a hammer. While it is true that living beings are thermodynamically open systems subjected to the second law of thermodynamics, the so-called law of entropy, it has been claimed that they are simultaneously closed systems with regard to their relation to the environment (7). A living being cannot be understood or adequately described without considering its

environmental interactions. To adequately describe an animal, for example, means not only to describe its isolated anatomical structure and its isolated physiological functions, but also its vital dependence on oxygen, calorie-intake, social interactions etc. Thus, the living organization must be regarded as an organizational closed system. Without this organizational closure there is no life or suspending this closure means death, respectively. In other words, to consider an organism in isolation, i.e., to ignore its interactions with its environment means to consider a dead organism. We have to face the fact that this basically inadequate approach predominates in biological sciences up to now.

Conclusions

Much has been theorized in recent years about the ability of living beings to keep their organization closed and thus to keep their identity invariant while undergoing structural change. Terms like self-referentiality and autopoiesis were coined to denote this fundamental property. While a theoretical framework has been outlined in a very impressive and convincing manner (e.g., 7), a pertinent concept upon which empirical research in biology can be founded is still lacking. It is proposed that it is exactly the notion of "vigilance" as the functional principle underlying organizational closure or self-referentiality, respectively, which could satisfy this requirement. Rather than considering an organism only alternatively as organizationally closed (alive) or open (dead) this concept entails a graduated evaluation according to the state of order which has been realized actually by "vigilance".

Credit has to be given to Bente (1, 2, 3) for developing a concept for electroencephalographical research based on Head's "vigilance". Bente distinguished a series of spatiotemporally defined patterns of EEG activity which occur in a regular manner between alert wakefulness and sleep-onset. These patterns should represent different levels of central-nervous order or of "vigilance", respectively. Like Head's original concept Bente's empirical application within electroencephalography had been regarded rather reservedly for a couple of years. It is only in the last few years that its fruitfulness and usefulness have become more and more evident, especially within the domain of psychiatry (e.g., 9, 10). Apart from this special empirical application,

“vigilance” is of a general epistemological importance. This may be elucidated by focussing our attention to the seemingly unbridgeable gap between the so-called hard and soft sciences and to the four different kinds of causes postulated by Aristotle.

If one, for example, builds a house, he first must have an intention to do so (*causa finalis* or purposive cause). Second he must have material (*causa materialis* or material cause). Third he must have a blue-print (*causa formalis* or formal cause), last but not least, he must do some work (*causa efficiens* or effecting cause).

Whereas for Aristotle science needed all of these 4 causes together, science later on was only based upon the one or the other of these different causes. Two lines of reasoning can be opposed.

One line stressed the importance of the purposive cause as the proper or primary cause. It seemed to subordinate interest in how the purposive principle acted to achieve a certain purpose. Consequently empirical research was neglected. This line of reasoning led to the doctrines of holism or vitalism, which, while not being testable empirically, remained a matter of irrational belief and which are no longer taken into consideration seriously in natural sciences. Nevertheless, the onesided predominance of the purposive cause has survived as the methodological basis of the soft sciences (hermeneutics), whose primary interest is to understand, not to explain.

The other line of reasoning restricted itself in a likewise one-sided manner to the effecting cause. Science was based only on powers, forces and energies. This led to the doctrine of physicalism, which has become the decisive factor in forming our modern world-outlook. Such a doctrine does not give any credit to purposes which are considered as non-scientific formulations. Undoubtedly this view, which is the methodological basis of natural or hard sciences, was very successful when dealing with man-made artificial machines, but far less when dealing with living beings.

Restricting our reasoning to purposes, i.e., to understand, is not enough. We have also to explain the mechanisms to gain insight and real

knowledge. On the other hand, only considering the mechanisms without simultaneously accounting for the purposes is also insufficient, at least when dealing with living beings.

It is the biological concept of “vigilance” which implies both purposive cause and effecting cause. Neither is “vigilance” a pure force (without purpose) nor a pure purpose (without force). Thus, one may be confident that it will prove to be useful and valuable in psychophysiological research as we understand it. Moreover, “vigilance” as a purposive force permits a methodological synthesis of so-called hard and soft sciences.

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