Progress in Biophysics and Molecular Biology 119 (2015) 313–323

Contents lists available at ScienceDirect

Progress in Biophysics and Molecular Biology

journal homepage: www.elsevier.com/locate/pbiomolbio

On the physics of the emergence of sensorimotor control in the absence of the brain

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ARTICLE INFO

Article history:
Available online 10 August 2015

Keywords:
Class identity
Decidability
Internal measurement
Observer
Sensorimotor control
Tense
Time

ABSTRACT

The evolutionary origin of sensorimotor control requires a sort of physical durability, other than Galilean inertia being accessible in third-person description in the present tense. One candidate to address this need is the 'class property' of a material body's durability remaining invariant during the exchange of component elements. Using grammatical tense as a descriptive attribute, this durability is accessible only in the frequent update of the present perfect tense in the present progressive tense at the 'now' of the present moment. In this view, the update of the perfect tense is equated with the onset and occurrence of on/off switching behavior of physical origin underlying the phenomena of sensorimotor control. Notably, the physical update of the perfect tense is specific only to the 'now and here' that is central in the tradition of phenomenology. The phenomena upholding thermodynamics, when taken apart from its theory, are decisive in facilitating the onset of sensorimotor control. Instrumental to the emergence of both life in general and sensorimotor control in particular may be the occurrence of a 'physical and chemical affinity' of the material bodies of whatever type. Such will let the constant exchange of component elements be feasible, so that the class identity equipped with the capacity for measurement is made available within the phenomenon. Material bodies constantly exchanging such component elements would make the material world open to biology by allowing each element to experience the organizational whole from within. The internal observer responsible for the origins of life may do double duty of letting itself be durable on the material basis while observing the conditions making it durable on the linguistic ground. The origins of life appear to us a material phenomenon when they are approached with use of our linguistic tools that can get rid of the strict stipulation of an abstract nature applied to the description of dynamical laws in physics.

1. Introduction

Phenomenology is a scheme of appreciating the ubiquity of detection and measurement in the material world. A common denominator between detection and measurement is what is called experience. This observation raises a serious contrast between experience per se and its theoretical analysis. Although both experience and theory must be decidable in order to become effective, the agency being responsible for maneuvering the decidability differs between experience and theory. While the external observer like us can maneuver the practical implication of any theoretical enterprise attempted in a decisive manner, the internal observer residing within the material world may also be decidable in implementing the exercise of experiencing concrete particular individuals in the inside.

Here, measurement is understood to be the material act of experiencing something concrete particular. That is relational to something particular on the material base, rather than merely being propositional. This understanding reveals at least the empirical fact that there is a definite distinction between before and after the act of measurement. The internal observer assuming the subjective first-person status is supposed to be a material organization carrying the capacity of measurement and remains to be justified exclusively empirically, rather than to simply be claimed to be so philosophically. What distinguishes empirical sciences from philosophy is the appraisal of the intentional act of measurement even on a purely material ground. A further scrutiny on this point will more sharply be focused upon when the occurrence of sensorimotor control is addressed empirically.

The emergence of sensorimotor control in evolutionary processes raises an intriguing question in physics. The activity of

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http://dx.doi.org/10.1016/j.pbiomolbio.2015.08.004
0079-6107/

sensing presumes the act of measurement of material origin, and the motor control requires the act of furnishing the physical law of motion with an appropriate form of boundary conditions. That is to say that although it is legitimate in its own light, the physical law of motion in and of itself remains under-complete in that both the material act of measurement and the preparation of boundary conditions are not adequately implemented in the law of motion alone.

One obvious demonstration of the significance of measurement even in the framework of classical mechanics is seen in the elastic spheres colliding with each other (Birkhoff, 1927). The concept of elastic bodies so fundamental in classical mechanics comes to meet formidable logical objections when the issue of measurement or detection is raised in a serious manner. The whole of that theory is based on the notion of continuously distributed matter subject to certain strains and stresses obeying Hooke's law. It is a characteristic feature of the isotropic elastic body that the effects of any disturbance are propagated at a definite velocity, that is to say, at the propagation velocity of a signal to be measured or detected.

With this image of the material property in mind, let us ask what would happen when two equal elastic spheres of the same size under no pressure approach along their line of centers with equal velocities which exceed the detection velocity. The parts of the spheres approaching the plane of collision, which is perpendicular to the line of the movement, have no possibility of reacting to the disturbance of collision since that plane is approaching the center of either sphere at a velocity greater than the detection velocity. On the other hand, the parts of the spheres which collide at the plane cannot rebound without interpretation. Thus it appears as if the spheres are converted into a kind of lamina of infinite density moving radially outward in the plane of symmetry. But this yields a total change of state, which the theory of elasticity does not contemplate. The process of measurement would turn out to be an integral part of the motion of material bodies even within the framework of classical mechanics.[1]

Needless to say, the process of measurement is also accompanied by the motion of the supporting material body. In the paradigm of sensorimotor control in the full-blown biology, the movement of the body of an organism goes along with the predictive and regulatory interpretation of the measurement as demonstrated in various behaviors observed in vertebrates. However, such a coordinated control of the body is not limited only to vertebrates carrying their specific brains. Even dragonflies are found quite skillful in maneuvering their tiny invertebrate brains in catching small insects such as mosquitoes (Mischiati et al., 2015). When a dragonfly chases its prey, it is guided by the anticipated movement, and not just by the mere movements of its target. The dragonfly predicts where its prey will be headed to next and then adjusts its trajectories to intercept the target. Predictive rotations of the dragonfly's head continuously track the prey's angular position, and the head-body angles established by prey tracking appear to guide systematic rotations of the dragonfly's body to align it with the prey's flight path.[2]

These two examples of the colliding elastic spheres and the dragonfly catching a mosquito seem to suggest to us the likelihood that the process of measurement may have preceded the occurrence of the motor control in evolution. That is about the ubiquity of measurement already internal to the material world. What makes the act of measurement special is the contrast between before and after this very act. The act of measurement is marked and executed through the intervention of the present perfect tense made at the moment of now, while the physical law of motion is stated exclusively in the present tense. There is no likelihood of foretelling what will be measured before its actual measurement as much as no one can tell what will be experienced before its actual experiencing.

2. Internal measurement

Measurement assumes the participation of a measurement apparatus of whatever sort, whether it may be of a natural origin or else. One requirement for any measurement apparatus to meet must be its durability. If the durability of an apparatus is in question, its qualification would require another measurement apparatus that is more durable than the one in question. To be sure, Galilean inertia must be a supreme example demonstrating the durability to be found in the physical world. Nonetheless, it stops short of serving as a durable measurement apparatus because it is conceived of in a manner of being totally isolated from the rest of the world. Inertia alone cannot fulfill the role of a measurement apparatus because of its total isolation from all of the rest.[3]

One candidate for meeting this challenge of serving as a durable measurement apparatus may be a material body of the larger scale that can maintain its class identity even if the component elements are constantly exchanged with the different individuals of the similar kinds.[4] The class identity of the larger scale is much weaker than the individual identity of the smaller scale of a material

[1] The role of measurement in classical mechanics is peculiar in that it does not distinguish between theory and measurement. What Birkhoff (1927) called our attention to is the uneasiness in the initial claim on no distinction between theory and measurement even in the framework of classical mechanics. Quantum mechanics, on the other hand, faces the issue of measurement head-on. Although it has the state dynamics like the classical counterpart does, quantum mechanics also addresses how the now of the present moment could be experienced. One possible scheme for coping with the phenomenological aspect of measurement is sought in the further scrutiny and appraisal of our linguistic tools (Pattee, 1977). While it is legitimate in its own light, the physical law of motion alone framed in eternal time referable in the present tense, whether in classical or quantum mechanics, is not competent enough to address how the now could be experienced. The tenseless time accepted in physics is convoluted and stressful in admitting that the physical law of motion is addressed in third-person description in the present tense. That is equivalent to admitting the tenseless time in the 'present tense'. Measurement differs from the physical law of motion as much as the now in experience differs from the present tense in description. The watershed separating between measurement and the law of motion is in the distinction between the now and the present tense. Measurement is thus subjective and agential in making a punctuation at the moment of now.

[2] The role of measurement in the full-blown biology is already functional in facilitating the activity of resource intake in whatever organisms. Measurement here is quite peculiar in exhibiting a time-mediated affinity connecting the initial act of detecting a target and the consequential effect of capturing the target in a durable manner.

[3] Husserl (1936/1970) has been more eloquent in denouncing Galilean physics as saying: "In his view of the world from the perspective of geometry, the perspective of what appears to the senses and is mathematizable, Galileo *abstracts* from the subjects as persons leading a personal life; he abstracts from all that is in any way spiritual, from all cultural properties which are attached to human praxis. The result of this abstraction is the things purely as bodies; but these are taken as concrete real objects, the totality of which makes up a world which becomes the subject matter of research. One can truly say that the idea of nature as a really self-enclosed world of bodies first emerges with Galileo" (Husserl, 1936/1970, p.60). Needless to say, Husserl's bodies in the above should not be taken for Merleau-Ponty's flesh (Merleau-Ponty, 1962).

[4] Due attention paid to the act of measurement on the part of matter may mitigate the uneasiness Husserl might have experienced with European sciences admitting the forced splitting of the world into the two of nature and the psychic world, that was initiated by Galilei and soon followed by Descartes. In a nutshell, the material act of measurement and Galilean physics are simply incommensurable with each other. Although Husserl's original transcendental idealism accepting the abstraction of an idealistic form has almost been rejected even by his earnest followers, this rejection would come to revive a naturalization of Husserlian phenomenology as witnessed by Merleau-Ponty (1962, 1968). Despite that, Merleau-Ponty's flesh stops short of elucidating how it could be constructed in a bottom-up manner.