Dynamics without Boundary Conditions Material Dynamics from the Internalist Perspective

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ABSTRACT

The role of boundary conditions within physics is seen to be analogous to that of "context" within human perception. Moreover, the human mind is able to create its own context by focusing attention on an object in the foreground, while simultaneously filtering out other objects in the background. We propose that a physical system may have the capacity to establish its own boundary conditions – in other words, to "create its own context". To describe this process, we introduce the concept "dynamics without boundary conditions" and explore the subtle question of how boundary conditions or constraints might arise in self-organizing physical systems such as exist within the biological realm.

We argue that robust macroscopic data (physical measurements) as described using the third-person present tense are underpinned by a microscopic context which is accessible only in first- and second-person descriptions using the present progressive tense. The use of first- and second-person descriptions in dynamics, that is referred to as the internalist perspective in short, is analogous to the process of self-measurement inherent in any physical system from within.

A major issue of dynamics without boundary conditions is to form and to transform interfaces between those movements in different grammatical tenses exclusively on material grounds. Any physical system can be seen as the robust interface between the present progressive and the present perfect tense.

Keywords: Awareness, Chemical evolution, Consciousness, Muscle contraction, Quale, Quantum Biology

1 INTRODUCTION

The standard procedure for analyzing dynamic phenomena in physics and biology alike is to separate laws of motion from boundary conditions or constraints. This scheme has been extremely successful in enabling us to discover, during the past several centuries, a small number of general laws of motion, which are believed to apply universally to all physical systems – for example, Newton's laws of motion and gravitation. At the same time, this scheme provides a systematic procedure for applying these general laws to any specific set of circumstances, namely by specifying boundary conditions. Energy degeneracy latent in a DNA molecule referring to the presence of a wide variety of configurations within an extremely limited energy range, for instance, is known to function as a memory constraint upon laws of motion within a developing organism (Pattee 2000).

However successful this scheme has been, we may still ask a question (Matsuno 1989): How does the separation between general laws and boundary conditions come to exist in the first place? Does it emerge "naturally" from the dynamics of a physical system, or is it an artifact of our own minds? In the present article, we examine the possibility that a fundamental process we call "dynamics without boundary conditions" (Conrad and Matsuno 1990, Matsuno 1993) could be the precursor or progenitor of dynamics supplemented by boundary conditions.

At first, dynamics without boundary conditions may seem a misnomer, because the laws of dynamics say nothing specific about the boundary conditions they are subject to. This criticism is valid, however, only if one tries to describe dynamic phenomena in the simple present tense. Third-person descriptions in the present tense are, by definition, always about something that remains unchanged and invariant. On the other hand, evolutionary changes in the energy degeneracy latent in a DNA molecule, for instance, cannot satisfactorily be described using third-person terms in the present tense (Matsuno 2000). An alternative attempt may be sought in dynamics to be described in first- or second-person terms. In view of the fact that no comprehensive dynamics denies its description, its descriptive stance assumes a decisive role.

Emphasis on first- and second-person descriptions utilizes our human linguistic means as a *sign language*, in the sense that the action of pointing to or being pointed to by others requires the use of demonstrative pronouns (for example, "this" and "that"). In contrast, the standard practice of describing dynamics supplemented by boundary conditions in the present tense utilizes our linguistic means as a *symbol-manipulating language*, in which the action of specifying and identifying objects is merely secondary.

2 PRESENT PROGRESSIVE TENSE

Describing any movement in progress begins with a first- or second-person description in the present progressive tense, as expressed in a sentence like: "A stone I am watching is falling down the slope” [1] The stone I am watching assumes the second-person status descriptively, differing from a third-person description such as “A stone falls down the slope.” First-person description in the present progressive tense is about a moving body in itself experiencing its local neighborhood environment, whether it may be the stone or myself. At issue is how to reach the third-person description of dynamics, which remains legitimate and objective, while starting from first- and second-person descriptions of a moving body currently in the present progressive tense. Using first- and second-person descriptions in dynamics is tantamount to saying that the material activity of pointing to and being pointed to by others is taken to be primary. The relevant question is: What does the activity of experiencing others look like in first- and second-person descriptions, rather than what is that which experiences others in third-person descriptions.

The unique feature of first- and second-person descriptions in the present progressive tense is the *finiteness* of both spatial and temporal horizons available to each moving body. No moving body in the first-person status is able to detect or perceive everything else all at once. There is no physical means of simultaneous communication on the global scale. The impossibility of instantaneous communication means that each moving body carries a blind spot in one form or another with itself. The presence of the blind spot with each moving body may cause a conflict, in the sense that influences arriving from that part of the environment masked by the blind spot have no prior chance of coordination with other influences concurrently acting upon the target body. Nonetheless, those conflicts or internal inconsistencies cannot become part of the record registered in the present perfect tense. This is because the recorded movement is described in the present tense, in which no inconsistency should be observed. Otherwise, the legitimate scheme of dynamics supplemented by boundary conditions framed in the present tense could be jeopardized.

The activity of passing internal inconsistencies *constantly forward*, as a means of preventing them from being frozen in the record, is unique to the microdynamic context framed in first- and second-person descriptions in the present progressive tense. At the same time, the microdynamics in the present progressive tense has to reproduce

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[1]Footnote: In English, there are three basic tenses: present, past, and future. Each tense has a *perfect* (cont’d) form (indicating completed action), a *progressive* form (indicating ongoing action), and a *perfect progressive* form (indicating ongoing action that will be completed at some definite time). Examples of the verb “to see” in the present tense:
Simple form: “I see the stone”
Perfect form: “I have seen the stone.”
Progressive form: “I am seeing the stone.”
Perfect progressive form: “I have been seeing the stone.”
Adapted from “Summary of Verb Tenses” <http://leo.stcloudstate.edu/grammar/tenses.html>.

the macrodynamic data to be registered in the present perfect tense; otherwise our long held practice of empirical sciences would lose their underpinning. In short, present progressive tense is about concrete particulars, but *contingent* in what it implies. By the same token, present perfect tense is also about concrete particulars, but requires them to be *consistent* among themselves in what they imply via past progressive tense (Matsuno 1985). For this reason, microdynamics in the progressive mode functions as the causal agency which transfers *contingent* concrete particulars into *self-consistent* concrete particulars that are ultimately recorded as the macrodynamic data (experimental observations). In fact, evolutionary processes are replete with causal agencies conditioned on the microdynamic contexts of their own (Taborsky 2001). The internalist perspective (Matsuno 1989) implying that the observer is internalized in the movement to be observed, in fact, focuses distinctively on the contingent microdynamic context, analogous to the view in linguistics that the activity of pointing to and being pointed to by others is the primary action described by the present progressive tense. This internalist perspective on causality differs from the mechanistic view of causality employed in dynamics supplemented by boundary conditions and described in the present tense, in that the latter allows for no contingencies thanks to the absence of the blind spot.

3 MATTER AS THE INTERFACE BETWEEN PROGRESSIVE AND PERFECT TENSE

So-called “universal” laws of motion are phrased in terms of macrodynamic data, which are obtained by use of measurement apparatus. Macrodynamic data are the result of external measurements described by third person-descriptions. In contrast, microdynamic context, accessible only in first- or second-person descriptions, assumes the process of measurement internal to each moving body (Matsuno `989, Brooks 2000). What is unique in first- and second-person descriptions is the priority of measurement internal to the participating material bodies. It is imperative to both first- and second-person descriptions to identify whom or what assumes the first- or second-person status. Moreover, macrodynamic data amenable to external measurement have to be robust enough against disturbances or perturbations imputed to internal measurement for forming the microdynamic context from within, otherwise the resulting data could not be objectively identified as such. This observation suggests that any physical system participating in both the microdynamic context and the macrodynamic data holds itself at the *interface* between the present progressive and present perfect tense.

The separation between third-person descriptions and first- or second-person ones is exclusively linguistic in its origin. Nonetheless, the accepted laws of motion, also phrased linguistically in third-person descriptions, are required to maintain their robustness even if the separation is perturbed slightly. If the robustness fails, the laws would lose their descriptive stability. The microdynamic context, whose content is not directly accessible to external measurement, nevertheless reflects the robustness of the resulting macrodynamic data.

A concrete example of robust macrodynamic data is given by Planck's energy quantum. The underlying law of motion is expressible in a third-person description in the present tense, using the equations of quantum mechanics in either Schrödinger's representation or Heisenberg's. The robustness of an energy quantum confirmed exclusively by empirical means guarantees the law of motion supplemented by definite boundary conditions, but not the other way around. The internalist perspective now invites us to view the occurrence of robust macrodynamic data as an empirical fact that supports quantum mechanics. To explore this perspective further, we shall require more empirical data.

4 EMPIRICAL DATA BASE

4.1 CHEMICAL EVOLUTION

Microdynamic context, that is not directly accessible to external measurement, guarantees the robustness of macrodynamic data that are externally accessible. The contrast between microdynamic context and macrodynamic data can be seen in the relationship between thermodynamics and quantum mechanics. The main issue will be the nature of robust macrodynamic data. If one approaches thermodynamics through the statistics of quantum mechanics, the capacity of generating macrodynamic data would be relegated exclusively to quantum mechanics. This statistical approach to thermodynamics, while starting from quantum mechanics, would certainly be legitimate if all macrodynamic data were already generated and available in quantum mechanics. However, if there remains room to generate macrodynamic data in a de novo manner in the realm of thermodynamics, then a more integrated perspective towards both thermodynamics and quantum mechanics is required. A relevant empirical counterpart is found in chemical evolution that proceeded on the primitive Earth.

Chemical evolution is about synthetic chemical reactions, which result in the creation of entirely new molecular species (Conrad 2000). Once the robustness of the synthesized molecule is guaranteed, it could be described by its quantum wavefunction supplemented by boundary conditions. However, if the process of generating new molecular species is focused upon directly, one must also address the process of generating robust macrodynamic data in an explicit manner. The generative aspect of macrodynamic data is couched upon microdynamic context accessible only to internal measurement.

An example that demonstrates the participation of microdynamic context perceived solely in first- and second-person descriptions in the present progressive tense is the occurrence of hydrothermal vents on the sea floor and their functional role in chemical evolution proceeding in their neighborhoods. Hydrothermal vents are unique in maintaining sharp temperature gradients against the surrounding cold seawater. Chemical species synthesized inside hot vents experience a sudden temperature drop soon after they are thrown away from the vents. Rapid quenching of the synthesized products tends to keep some of them as new molecular species since their thermal decomposition is suppressed to a significant extent. Laboratory experiments on a simulated hydrothermal vent admittedly made it possible to synthesize new molecular species as demonstrated in the synthesis of oligopeptides up to octamers from monomeric amino acid molecules (Imai et al 1999a, Imai et al 1999b, Ogata et al 2000). What is significant in this synthesis is that the temperature environment surrounding a synthesized species constitutes a microdynamic context.

The microdynamic context surrounding the molecule is rapidly changing without clearly distinguishing between the laws of motion involved and their explicit boundary conditions, though nothing mysterious is proceeding there. The difficulty in distinguishing between the laws of motion and their boundary conditions is, however, only methodological in its origin. In fact, the most likely products conceivable under the rapidly changing microdynamic context are the ones that can decrease their temperatures as fast as possible. Even if a quantum synthesized in a hot vent potentially has two possibilities for decreasing its temperature, either faster or slower, only the faster temperature decrease will be actualized. For there is no chance of further temperature decrease for the latecomer.

Our specific example of chemical evolution demonstrates that the process of generating robust macrodynamic data leaves the separation between thermodynamics and quantum mechanics somewhat murky. That is to say, the microdynamic context making a thermodynamic temperature to be a robust macrodynamic datum does not coincide exactly with another microdynamic context making a quantum in quantum mechanics to be another robust macrodynamic datum. Conflicts in the underlying microdynamic contexts necessarily make the resulting macrodynamic data generatively variable in time. What looks like boundary conditions varies accordingly. It is one thing to distinguish between laws of motion and boundary conditions as a theoretical possibility, but it is quite another to provide empirical justification for such a separation. Chemical evolution manifests that the occurrence of robust macrodynamic data is upheld by the microdynamic context accessible only in first- or second-person descriptions in the present progressive tense. A more pronounced interplay between microdynamic context and macrodynamic data could be seen in the emergence of life on Earth.

5 MUSCLE CONTRACTION

One common feature of biological life is cell motility in general, and muscle contraction in particular. Underlying the activity of muscle contraction is an actin filament sliding on myosin molecules in the presence of ATP (adenosine triphosphate) to be hydrolyzed. We observed that an actin filament sliding on myosin molecules as driven by energy released from ATP exhibits a uniform magnetization. The strength of the magnetization fluctuates in response to thermal agitation from the ambient environment (Hatori et al 2001, Matsuno 1999). The material unit exhibiting the magnetization is each actin monomer constituting the filament. However, the magnetic dipole-dipole interaction energy is found to be far less than the thermal energy per degree of freedom at temperatures in the biological environment. If there were no mechanism for magnetic alignment other than the magnetic dipole-dipole interaction, thermal agitation would easily destroy the magnetic alignment and no ordering along the actin filament could be expected, despite our observation of the ordering to the contrary. The observed magnetic alignment along an ATP-activated actin filament therefore suggests participation of a factor other than the magnetic dipole-dipole interaction.

One likely candidate for the observed magnetic ordering along an ATP-activated actin filament may be a quantum entanglement (Matsuno 1999). A bare actin filament that is not yet ATP-activated forms an electrostatically coherent alignment of individual actin monomers. Each monomer is electrostatic in its coherent interaction with other monomers in the neighborhood. Actin filament as an electrostatic alignment of actin monomers is certainly stable quantum mechanically and remains robust enough against thermal agitations available at the ambient temperature of the natural context. At the same time, an ATP-activated actin filament, that is stable electrostatically, can also form a magnetostatically coherent alignment of individual actin monomers, in which each monomer is magnetostatic in its coherent interaction with others in the neighborhood. Consequently, each actin monomer in an ATP-activated actin filament can quantum-mechanically be in either a pure entangled state out of both the electrostatic and magnetostatic states, or in a mixed state out of the two individual states, or in between.

If each actin monomer is in a mixed state out of the electrostatic and magnetostatic ones, thermal agitations would easily destroy a coherent alignment of the magnetic dipoles along the filament because of the presumed absence of any coherent correlation between the two individual states. The magnetic dipole-dipole interaction alone would not be strong enough to hold the coherent alignment of the dipoles as being subject to thermal agitations. On the other hand, if an ATP-activated actin monomer is in a quantum entanglement out of both the electrostatic and magnetostatic states, it can participate in forming a coherent magnetostatic alignment along the filament. The magnetic ordering can have recourse to the entanglement with the underlying robust quantum coherence of electrostatic origin, which gives the filament its structural stability. What is more, the quantum entanglement out of the electrostatic and magnetostatic states is constantly preceded and followed by quantum disentanglement imputed to internal measurement derived from the hydrolysis of ATP molecules. This is due to the fact that a myosin molecule carrying its ATPase activity keeps constantly detecting or measuring target ATP molecules to be hydrolyzed internally.

Quantum entanglement is concrete and specific enough to identify the constituent quantum states to linearly be superposed. Likewise, quantum disentanglement is concrete and specific enough to identify the basis set of the quantum states constituting the material body processing internal measurement. These concrete and specific aspects of quantum entanglement and disentanglement can descriptively be accessible only in first- or second-person status, but not in third-person, though the general universal aspects of the two can unquestionably be referred to in third-person descriptions as embodied in the laws of motion. In particular, the interplay between the microdynamic contexts for quantum entanglement and for disentanglement and their frequent update can eventually precipitate the robust quantum entanglement as a macrodynamic datum that is accessible in third-person descriptions. Magnetization of an ATP-activated actin filament manifests that naturalized dynamics accessible in first- and second-person descriptions eventually comes to yield what looks like boundary conditions that can be seen as a robust consequence of the interplay between the conflicting microdynamic contexts.

6 CONSCIOUS BEINGS

A peculiar aspect of microdynamics accessible only in first- and second-person descriptions is found in the phenomenon called consciousness. What is unique to first- and second-person descriptions, compared with third-person ones, is their built-in capacity of pointing to or being pointed out by specific other objects. Third-person descriptions do not possess the capacity of measuring and specifying others in a concrete particular manner from within. For instance, third-person descriptions are inadequate to establish bilateral commercial transactions between the concerned parties.

The speaker or the author addressing third-person descriptions can exercise no influence over the transaction partners appearing in the descriptions. Actual negotiations prerequisite for bilateral transactions are accessible only in second-person descriptions. Of course, both first- and second-person descriptions are by no means anthropocentric as much as third-person ones are not. First-person description is about a concrete particular object experiencing others, and second-person description is about another concrete particular object specified by the subject assuming the first-person status. In particular, first-person descriptions address the activity of being *conscious of the self*, while second-person descriptions take the capacity of being *attentively aware of others* for granted. Both consciousness and attentive awareness are materialistic in their origin and accessible in first- and second-person descriptions.

One characteristic unique to a physical system assuming the first-person status descriptively is its irreplaceability. First-person descriptions in the present progressive tense are full of internal inconsistencies to be passed constantly forward because of the involvement of the inevitable blind spots on the part of the participants. Those objects full of inconsistencies are not accessible in third-person descriptions in the present tense, in the latter of which descriptive consistency has to strictly be observed because of its claimed objectivity. It thus turns out that what cannot be specified descriptively cannot be replaced by others as a matter of principle, because the descriptive object to be replaced in the first place persistently defies being identified in the third-person status. It is impossible to replace any physical system in the first-person status, that cannot descriptively be identified as a consistent body by others, with perfect fidelity. What can be identified instead is the robust macrodynamic data that can be precipitated and remain stable even if the interface with the causative microdynamic context is perturbed slightly. Planck's energy quantum is one example of robust macrodynamic data. Another robust example is what is called a *quale*, such as the painfulness of a pain. While feeling a pain must be expressed by a first-person description in the present progressive tense, conceiving painfulness is expressed by a third-person description in the present tense.

When consciousness is referred to in third-person descriptions in the present tense, it is no more than a sophisticated linguistic substitute for the capacity accessible only in first-person descriptions in the present progressive tense. Similarly, attentive awareness referred to in third-person descriptions is a linguistic substitute for the activity accessible only in second-person descriptions. Further analysis of both consciousness and attentive awareness in third-person descriptions depends upon what sort of analytical tools are employed for the purpose. Instead, one may obtain a robust derivative from the capacities and activities accessible exclusively in first- and second-person descriptions in the present progressive tense. The non-unitary projection of von Neumann and Wigner within the framework of quantum mechanics (Stapp 1993), that does not follow the quantum-mechanical development of the wavefunction, has been just one attempt at connecting what is "in progress" during the process of measurement to what "could remain" robust in the record.

7 DISCUSSION

First- and second-person descriptions in empirical science are by no means anthropocentric, as much as third-person descriptions are not. What is more, first- and second person descriptions can be used to guarantee the robustness of empirical observations given by third-person descriptions. Although third-person descriptions in the present tense are extremely versatile and competent as a means of representing others in the form of a symbol-manipulating language, they do not supply themselves with the empirical robustness of what they imply. No linguistic representation claims its empirical robustness by itself. The robustness requires more than what linguistic representations could provide. Third-person descriptions in the present tense will of course remain legitimate in so far as their regularity has already been confirmed empirically. Nonetheless, science is concerned with more than just mere empirical regularities. It also addresses *how* such empirical regularities could be generated in the first place. This observation raises a serious question of whether our language is able to describe the generative aspects of empirical regularities. At this point, the significance of first- and second-person descriptions in the present progressive tense, as a sign language, enters the picture. The interface between the present progressive and the present perfect tense provides us with both the capabilities of ascertaining the regularity of empirical observations, when viewed from the side of the perfect tense, and holding the generative capacity of movement, when viewed from the side of the progressive tense. The robust interface between the present progressive and the present perfect tense is in fact embodied in what we call matter.

In particular, our descriptive access to Planck's energy quantum is made possible through such an interface. The energy quantum incorporates into itself a robust interface separating its inside and outside. This perspective does not denigrate the conventional representation of a quantum obeying Schrödinger's equation of motion supplemented by specific boundary conditions. The difference is in the descriptive stance on whichever is taken as primary, either first- and second-person descriptions or third-person ones. Apart from all of the other advantages, however, third-person descriptions owe the capacity of making the descriptive foreground vivid and explicit, as compared with the receding background, solely to the descriptive author. In contrast, quantum phenomena carrying the material capacity of forming interfaces separating inside from outside of the quanta are approachable in first- and second-person descriptions.

Once a quantum is taken to be a robust interface between the present progressive and the present perfect tense, it becomes straightforward to extend quantum phenomena to a much wider context. First- and second-person descriptions make the activity of pointing to or being pointed out by others more primary than anything else. This is related to self-measurement proceeding internally in a physical system of any kind. Internal measurement thus turns out to be a material agency of forming and transforming a quantum, through the material activity of receiving influences from others to the mold of the receiver. This molding "reverberates" in matter, in the sense that movement in progress cannot be exhausted at any time moment. One implication of reverberating internal measurement in quantum phenomena is realization of a macroscopic quantum entanglement that can remain robust despite being subject to constant quantum disentanglements from within. From this perspective, we see how biological organisms could be quantum mechanical in their material makeup. Biological life is linguistically approachable through the robust interface between the present progressive and the present perfect tense, which is dynamically maintained as the robust quantum entanglement subject to constant quantum disentanglement or internal measurement originating from within.

8 CONCLUDING REMARKS

The occurrence of first-, second- and third-person descriptions in linguistic practice sets the ground for the robust interplay between microdynamic context and macrodynamic data. What is unique to the microdynamic context accessible only in first- and second-person descriptions is its causality connecting concrete particulars, contingent in the progressive tense to other concrete particulars, consistent among themselves in the perfect tense. This causality is not expressible directly in third-person descriptions. The form of causality phrased in first- and second-person descriptions is about dynamics without boundary conditions. Of course, it is not inconsistent with conventional dynamics supplemented by specific boundary conditions. The macrodynamic data as a robust derivative from dynamics without boundary conditions turn out to retroactively satisfy a form of dynamics supplemented by specific boundary conditions.

Dynamics without boundary conditions grounded upon first- and second-person descriptions in the present progressive tense can naturalize the capacity of forming and transforming interfaces, as embodied in the capacity of consciousness and attentive awareness. According to the internalist perspective (Matsuno 1989, 2000) this naturalization is exclusively linguistic in its origin, though it is not a linguistic artifact. Naturalization of both consciousness and attentive awareness rests upon the legitimacy of first- and second-person descriptions, as much as the standard scheme of dynamics supplemented by boundary conditions rests upon the legitimacy of third-person descriptions. Therefore, the proper role of physics within biology would be more evident once it is recognized that there exists a linguistic vehicle for naturalizing the capacities of consciousness and attentive awareness that is ubiquitous in the biological realm. First- and second-person descriptions are intrinsically more capable than third-person ones in coping with material dynamics in the empirical domain. Although matter described by the standard practice of physics is legitimately said to be inert in third-person descriptions in the present tense, biological matter taken as the robust interface between the present progressive and the present perfect tense approachable in first- and second-person descriptions is intrinsically active and alive.

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