Competence of Natural Languages for Describing the Physical Origin of Life

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Abstract

The physical origin of life as a unique emergent phenomenon of evolutionary systems raises an intriguing linguistic question. Although the origin of the earth-bound life was about 3.9 billion years ago, the human language one can rely upon for its description has the history of only last several hundred thousand years at most. An essence of describing the origin of life is in figuring out something very old within what has been quite new. No evolutionary discourse is exception in trying to find out the trace of oldtimers among the newcomers. One of the linguistic vehicles for accomplishing the reduction of the oldtimers from the newcomers is that which can have the capacity of indefinite continuation or sustenance. Infinite regression permissible in any natural language just happens to demonstrate such a capacity for making the indefinite continuation feasible in linguistic domain, being in sharp contrast to formal language equipped with irreducible fundamental predicates.

A physical attribute akin and traceable to the linguistic capacity of indefinite continuation is the capacity of wanting material resources from the inside. The capacity of wanting, like infinite regression in natural languages, lasts indefinitely so long as consumers of material origin survive. The evolutionary origin of life could be sought within the emergence and successive alternation of consumers carrying the capacity of wanting from their own inside.

Keywords: Agents, Consumers, Description, Externalist, Internalist, Measurement, Natural Languages, Origins of Life

1 Introduction

Difficulties in tracing the physical origin of life on the primitive earth are both empirical and theoretical. Isotope dating of carbon and other atoms has pinned the beginning of life on the earth down into the narrow window region of far less than 10 million years centered around 3.90 billion years ago (Moorbath, 1994; Schidlowski, 1988). However, empirical details on how life would have got started on the earth have been extremely scanty and have hardly been preserved. The oldest fossil record of micro-organisms available has been at most 3.45 billion years old (Schopf, 1993). Tracing the course of evolution further back toward its origin could not be facilitated by empirical studies alone. The endeavor would have to be supplemented by experimental efforts.

Nonetheless, experimental investigation of the origin of life has its own limitation ascribed to the underlying queer methodology (Salthe, 1993). Controllability and reproducibility required of any experiments simply contradict the uncontrollability and historical uniqueness of the phenomenon called life on the earth (Hahlweg, 1991; Küppers, 1992). Historical uniqueness and coherent integration of the sequence of events

over 3.90 billion years since the origin of life set forth a formidable problem to any experimental studies (Atlan et al, 1986). It is simply inconceivable to contrive an experiment on the origin of life that could guarantee the succeeding evolution since then for another 3.9 billion years. What could be possible instead is to design likely experiments at most piecemeal (Gatens-Robinson, 1993).

One principal objective of such piecemeal experiments for the origin of life is to design the onset of replicating molecules without assuming any biological organisms. In particular, RNA

molecules having catalytic capabilities of their own have been demonstrated to be able to exhibit their replication if the constituent monomers and appropriate energy sources are available (Cech, 1987; Guerrier-Takeda et al, 1983). The present likelihood of a RNA replication, though impressive (Noller et al, 1992; Picchirilli et al, 1992; Mohr et al, 1994), does not however answer the question of how the molecular replication as a harbinger of the phenomenon called life could have been settled in the first place. The original RNA templates prepared in the experiments are controlled and imposed externally (Shapiro, 1986). The issue is how to get molecular replication started out of the material and energy resources that could presumably have populated the primitive earth about 3.9 billion years ago and to sustain the evolvable capability indefinitely since then.

One of the driving forces toward the possibility of more primitive replicating molecules resides in the theoretical idea asserting that molecular replications could exhibit their evolvability if supplemented by making errors in the processes as epitomized in the phrase of molecular Darwinian evolution (Sober, 1989). If making errors is equated to making slight differences in the heritability of reproducing organisms, Darwinian evolution originally conceived in the biological realm could readily be extended over to the prebiotic regime so long as the presence of molecular replication could be guaranteed. The problem of the origin now reduces to the nature of errors to be made (Grene, 1990).

Making errors, however, sounds extremely anthropomorphic. It presumes what is correct and what is in error. Although it may be possible to conceive of the dichotomy between a molecular replication proceeding with perfect fidelity and exogenous disturbances perturbing the fidelity, the dichotomy would simply be inaccessible in any experiments. Whatever experiments on the onset of molecular replication may be intended, the complete separation between literal replication and making errors could be unattainable since there is no nonanthropomorphic standard to facilitate literal distinction between the two. A case in point is a possibility such that molecular replication could not proceed without making its own errors. In this regard, admitting the inseparability between molecular replication and its making

errors may claim its methodological legitimacy on its own, while noting an occurrence of separability at the hypothetically weakening limit of the inseparability.

One of the aids in employing the methodological inseparability between molecular replication and its making errors can be found in the relationship between an arbitrary production process and its products (Matsuno, 1984). Insofar as an indefinite continuation of production is guaranteed out of the component materials while the products would eventually disintegrate into their components, the likelihood of actualizing the production process producing products of like kind could be enhanced with the elapse of time. Those production processes that would fail in acquiring necessary material resources would be wiped out in due course of time. Molecular replication and its making errors are just the functional attributes of a production process that can hold on indefinitely (Rieppel, 1990). Our approach to examining the origin of life both experimentally and theoretically now reduces to how production process of indefinite continuation could be made possible in the first place.

2 Letting Production Last

The relationship between production and products is subtle because of the contrast between the duration of time in production and a static configuration within products (Cheetham, 1993). Nonetheless, the contrast is not clearly demarcated (Leydesdorff, 1993). Preceding products constitute boundary conditions for subsequent production so long as production keeps itself surviving. The notion of boundary conditions now introduces a new dynamic attribute pointing to the process of detection that can serve as a means of implementing and identifying boundary conditions as such. Boundary conditions necessitate the process of implementation and detection proceeding exclusively on material grounds. At the least, detection of material origin, that is to say, internal measurement (Matsuno, 1985, 1989) as opposed to the measurement by an external observer comes to take part in the interplay between production and products (Rössler, 1987; Kampis & Rössler, 1990).

Internal measurement, as compared to external measurement by an outside observer of whatever character, is local, and boundary conditions thus identified remain local (Weber et al, 1989). Internal or introspective boundary conditions imputed to internal measurement serve as a dynamic attribute of the products resulting as a consequence of the preceding production (Rychlak, 1991). On the other hand, external or extrospective boundary conditions perceived by an outside observer as being frozen in the record are global in the sense that the observer assumes the perspective making the measurement of the object external and global. These two different types of boundary conditions, introspective and extrospective, are however undoubtedly related to each other because introspective boundary conditions of local character, when transferred and integrated into the record, have to coincide with the extrospective counterpart of global character. Otherwise, the integrity of the notion of boundary conditions would collapse (Ulanowicz, 1990).

The reconciliation between introspective and extrospective boundary conditions owes itself to a unique nature of measurement in both cases. Measurement is a kind of interaction taking place between arbitrary two bodies supplemented by the irreversible characteristic such that measurement cannot identify what will be identified before the actual measurement. The anthropomorphic separation between an object to be measured and the measuring apparatus is not the rule, though it holds for external measurement on the part of an outside observer. Either one party of a pair of arbitrary interacting bodies can serve as a measuring agent internally. This amounts to saying no more than that the two bodies interact with each other. Still, the present classification turns out to be good enough for distinguishing between internal and external measurement. Although external measurement is unilateral in the direction of influence from an object to be measured to the measuring apparatus, internal measurement is bilateral in the direction influencing between an arbitrary pair of interacting bodies.

Internal measurement detecting introspective boundary conditions locally in turn serves as another introspective boundary conditions to be measured internally in a mutually interchangeable manner. Internal measurement does not only detect introspective boundary conditions but also implement them. The extent to which external measurement can make access to internal measurement is only to detect boundary conditions.

Implementing boundary conditions through internal measurement remains inaccessible to external measurement because of its unilaterality. It is in implementing and producing introspective boundary conditions where internal measurement can be more than what external measurement is all about. Of course, external measurement requires implementation of the measuring apparatus for the purpose. However, it is taken for granted that external measurement is methodologically immune to any procedures required for implementing the measuring apparatus. Internal measurement does not assume such methodological immunization against the implementation and has to squarely face how introspective boundary conditions serving as both a means and an end of internal measurement can be implemented.

External measurement associated with extrospective boundary conditions, though lacking the due bilaterality between an object to be measured and the measuring apparatus, has one great advantage. It can be consistent with the notion of state defined as a static representation of the whole moving body in motion in its every

detail. Extrospective boundary conditions take it for granted that there is something out there to be detected about its every detail and external measurement is assumed to fulfill the role. Definite identifiability of state, when combined with its dynamics, necessarily yields a one-to-one temporal mapping of the state, otherwise the identifiability would fail. Such a deterministic development of state is certainly the case with both classical and quantum mechanics that is consistent with external measurement. Even the wavefunction or a vector in the Hilbert space conceived as the quantum state can externally be measurable by applying various quantum interferometry techniques. Nonetheless, state dynamics of a one-to-one temporal mapping suffers a methodological shortcoming. Unless exerted upon externally, the state dynamics does no more than preserving the invariant state, once given, through its equivalent transformation. There is no room for generating de novo production and products within the framework of state dynamics.

In contrast, internal measurement associated with introspective boundary conditions dispenses with the notion of state. Instead, events come to assume the key role there because

detecting introspective boundary conditions is local events that take time for execution. More than that, internal measurement is always right in the middle of completion but not completed in the sense that any internally formed measuring apparatus at one moment constantly makes itself serve as an object to be measured subsequently. What is now measuring internally cannot be measured simultaneously. It will be measured only subsequently. The present successive alternation between the measuring and the being measured renders internal measurement to constantly carry with itself the leftover that defies to be identified by external measurement but causes subsequent internal measurement on and on.

The leftover that internal measurement carries with itself is the on-going variation induced at the internally formed measuring apparatuses while performing measurement, since measurement is taken to be an instance of making whatever variations at the measurement apparatus of whatever character. It is the leftover of the self-induced on-going variation that drives internal measurement, while external measurement owes its driving factor exclusively to the outside observer. Internal measurement thus incorporates into itself the capacity of generating and producing variations indefinitely. Internal measurement is endogenously generative, while the external counterpart is generative only exogenously. This distinction between internal and external measurement also induces a difference of the descriptive stance

between the two.

3 Internal and External Descriptions

If one intends to describe a consequence of external measurement, the outcome would be a description of the finished events frozen in the external record (Depew, 1986). Each event in external description has already been accomplished and remains invariant in the record (Hinde, 1991). The invariant nature of the finished events in the record is just consistent with the invariant stance that external description requires for its own sake. A clear-cut separation between a measured object and an outside observer certainly comes to terms with the distinction between subject and object. Nonetheless, external description remains incompetent in coping with the indefinite leftover of on-going variations induced in the process of internal measurement because of an easy interchangeability between the measuring and the being measured in the latter (Sattler, 1990). In order to describe the indefinite leftover with internal measurement, the descriptive stance other than the external is required (Emmeche, 1991; Muller & Wagner, 1991). That is internal description that can follow how internal measurement would proceed.

Internal description, however, imposes upon itself a formidable burden such that the internal descriptive agents are widely distributed and there should be no monopoly of descriptive agents, whereas the consequence of internal description frozen in the record has to be approached and identified as an external description by a single external descriptive agent. One of the constraints to which any internal description

succumbs is to observe the principle of the excluded middle in the resulting external description so long as the integrity of external description is taken for granted (Ereshefsky, 1991). Since each internal descriptive agent can recognize what others have described only afterward, fulfillment of the principle of the excluded middle found in the consequence of internal measurement cannot pre-exist in an atemporal manner but has to be accomplished at any cost so as not to leave its violation behind. Internal descriptive agents are to drive themselves toward fulfilling the principle of the excluded middle at the least while being involved in description. This means that if internal descriptive agents stop acting, a violation of the principle of the excluded middle would come to the surface and the whole descriptive enterprise would come to collapse.

Contrast between internal and external description is inescapable in regard to the principle of the excluded middle. Needless to say, there is no room for violating the principle within the realm of external description that presumes the integrity of the descriptive subject. This is however simply a consequence of monopolizing descriptive agents by a single external agent, though inevitable in any discourse including even the present article by this author. At issue is how an external descriptive agent can appreciate the involvement of many of internal descriptive agents properly. The stance that an external descriptive agent assumes while facing many internal descriptive agents residing in the descriptive object is ambivalent in observing the principle of the excluded middle in one and the action for the principle in the other. But, the present ambivalence is a necessary price to pay for adopting the dichotomy between internal and external description.

In spite of its methodological clumsiness, however, a single most significant advantage for accepting the ambivalence latent in the dichotomy between internal and external description is to enable one to perceive the generation of variations internally in an endogenous manner (Matsuno & Salthe, 1995). This sharply contrasts with external description seeking the source of de novo variations always in the outside regardless of their real origins unless supplemented by internal description.

Internal description that has to be integrated into an external description while fulfilling the principle of the excluded middle as a consequence is as a matter of course a description of the relationship between internal and external measurement. What the principle of the excluded middle is to external description, that is an incontrovertible empirical principle to external measurement, such as the principle of the conservation of energy. External measurement is by definition free from any conflicts interfering with the incontrovertible empirical principle. By the same token, internal measuring agents involved in internal measurement act so as to eliminate any conflicts with the invariant empirical principle from the record (Gayon, 1990). Constant removal of conflicts by internal measuring agents inevitably induces those further conflicts, that may also be eliminated without being entangled in the record, because of the absence of any central agency coordinating all the local actions globally in a synchronous manner. Internal measurement constantly generates and passes over internal conflicts without leaving any of them behind.

4 Handling Internal Conflicts

Internal measurement requires internal measuring agents as much as internal description requires internal descriptive agents. However, any discourse assumes only one agent that is the

author. The present single authorship brings about a difficult challenge to both internal measurement and description because of the involvement of multiple agents in the latter. In this regard, external measurement and description are consistent with the scheme of discourse accepting only one agent that serves as the subject facing an object.

Internal description participated and sustained by internal descriptive agents is like a conference attended by many conferees. Although the reporter as an outside observer can report on what the conference has come up with, it is not the reporter but the conferees as internal descriptive agents that determines the descriptive content of the outcome of the conference. This does not necessarily imply that descriptive integrity on the part

of each conferee could hold indefinitely because of the principle of the excluded middle to be observed

in what the conference has brought about. Only those conferees that could conform with the conference can hold themselves. Practicing the principle of the excluded middle on the part of each conferee is to constantly adjust each internal description to the context the conference would come to provide. Internal description is to be written in a natural language that admits

context dependence in the fullest sense.

Nonetheless, observing the principle of the excluded middle is not directly relevant to internal descriptive agents because the principle applies to external description pointing to a definite static nature of an invariant descriptive object. It is simply a consequence of making and adjusting to the context among the participating internal descriptive agents. Context searching and making capability is primary to internal descriptive agents.

What is unique to internal descriptive agents is the generative capability from the inside. This exhibits a marked contrast to external description by an external descriptive agent that perceives an object prepared by whatever means just as it is. Those internal causes and conflicts that drive internal descriptive agents remain unfathomable to external description. An irony about the unfathomable nature of internal causes can easily be reckoned if one considers, for instance, the origin of a human language. If external description is employed, the origin would have to be totally of exogenous nature because of its methodological stipulation. On the other hand, if internal description is attempted, internal descriptive agents would now have no alternative other than to live with on-going internal descriptions. That means that internal conflicts driving internal descriptive agents should be focused even though whose definite identification would remain constantly out of reach. The language that each internal descriptive agent lives with is a natural language.

The generative capability from the inside that drives each internal descriptive agent, however, takes the contrast between the inside and the outside for granted. In particular, the activity from the inside toward the outside is focused. The present generative capability from the inside is duly prohibited in external description that a formal language can cope with, in the latter of which a set of irreducible invariant predicates is guaranteed. The present prohibition of causes from the inside, of course, does not apply to internal description performed within the framework of a natural language that would remain immune to any forcible intervention imposing invariant fundamental predicates of whatever sort. Natural languages provide themselves with an opportunity to see how evolutionary processes would proceed in the eyes of the participants, even though they have had only several hundred thousand years' history behind themselves.

The origin of life on the earth was about 3.90 billion years ago. In contrast, a human language employed as a means of describing the origin has been at most several hundred thousand years old (Bloom, 1994; Corvalis, 1994). The intriguing conversion of letting quite a newcomer evolutionarily preside over the oldtimer could not be the rule. That could be saved only methodologically if ever possible (Paton, 1992). The situation is quite different from the case of external description attempted in the scheme of a formal language, in the latter of which anything can happen depending upon how the invincible outsider would intervene. If internal descriptive agents can find their precursors even much before the evolutionary appearance of a human language, one could legitimately conceive of a double image upon those precursors of how natural languages would have got started.

One kind of the evolutionary precursors to internal descriptive agents that we have recognized is internal measuring agents. Both the agents have the capacity of influencing and being influenced by others of the similar nature, while observing the constraints that the corresponding external agents do not fail in recognizing in the record, such as the principle of the excluded middle or the empirical principle of the conservation of energy. Internal measuring agents constantly generate internal conflicts just so as to remove any of those conflicts that may violate the empirical principle from being left behind.

In fact, it is no more than a historical contingency upon a human language that those terms such as measurement and interaction have been invented and accepted in natural languages. Thanks to measurement or internal measuring agents, can one extend the notion of internal descriptive agents processing natural languages to that of internal measuring agents including the former as a special case. This perspective reduces the problem of the physical origin of life to figuring out the physical characteristic of internal measuring agents available on the primitive earth at about 3.90 billion years ago.

5 Physical Origin of Life

Ubiquity of internal measuring agent is certainly unquestionable. Atoms and molecules are undoubtedly legitimate candidates of the agents. However, internal measuring agents appeared at the onset of life and afterward assume a unique quality of continuity even if they are alternated frequently. Internal measuring agents are intrinsically coherent in generating and passing over internal conflicts without leaving any of them behind. Such coherent alteration of internal measuring agents may sometimes effectively be halted by either no alternation or too frequent alternations involving too many agents. If a solid crystal is the case, the crystal as a measuring agent would stay as it is indefinitely unless exerted upon externally. On the contrary, if gas molecules are the case, each molecule serving as an internal measuring agent would be alternated by too many of other molecules too frequently with the result that the consequence of internal measurement would reduce to an aggregation of incoherent molecular motions. Except these two extreme cases, though quite ubiquitous in the realm of physics, coherent alternation of internal measuring agents remains as the rule.

What signifies coherent alternation of internal measuring agents is in generating and passing over internal conflicts without leaving any of them behind the predecessors. In particular, in view of the fact that internal measurement acts at least so as to fulfill the empirical principle of the conservation of energy retrospectively, each internal measuring agent comes to exercise the capacity of wanting energetic resources from the inside (Matsuno, 1992). This agent is no more than a form of consumer. The onset of coherent alternation of internal measuring agents can thus be equated with the appearance of consumers to be alternated successively (Matsuno, 1995). If one associates behaviors as consumers grounded upon the capacity of wanting from the inside with a major characteristic of the phenomenon called life (Rosen, 1991), those evolutionarily significant events occurred on the primitive earth at about 3.90 billion years ago would certainly have included the emergence of consumers wanting carbon dioxide, water and light energy from the sun. Of course, a fine tuning of the coding mechanism between protein and nucleic acid molecules would have had to be installed almost at the same time, otherwise those primitive consumers, even if got started, could not have sustained themselves afterward.

The present perspective on the physical origin of life can also suggest a new directive to how one can design a successful experiment on the origin. The emphasis should be on the significance of internal measurement and on the emergence of sustainable consumers grounded upon the capacity from the inside. Although any experiments deal with external measurement and are methodologically incompetent for internal measurement, the products that internal measurement has come up with are certainly visible to external measurement. If one can set up an experiment that could enhance energy concentration locally in microscopic regions of protocellular size, it may be seen as a consequence of energy intake on the part of those microscopic bodies behaving as consumers.

The possibility of approaching the physical origin of life on experimental basis shed a new light on the relationship between experimental research as a methodology and scientific language as a means of description (Farre, 1994). Needless to say, description of an invariant configuration of experimental or empirical findings requires a formal language that can preserve the invariance uncovered while being supplemented by the principle of the excluded middle. However, the externality of a formal language, which is sometimes also referred to as a scientific language, is destined to be intrinsically incompetent in coping with variations and changes because of the imposed externality. Although one can circumvent the invariant

constraint latent in a formal language by supplementing it with the source of variations sought in the outside, this sort of modification could not work any more if the problem of the origin turns out to be a matter of concern. To say that the matter of the origin goes beyond any scientific discourse because of its genuine externality may be one possibility though smacking of a defeatism. Another possibility would be to switch the descriptive means from a formal or scientific to a natural language.

Appreciating the role of natural languages in experimental and empirical researches is at least two-fold. One is to provide an internal generator of variations. The other, that is far more

significant, is to open the perspective that enables one to see the problem of the origin to be internally caused. The physical origin of life would certainly be an internally caused material phenomenon that could be deciphered exclusively in natural languages.

6 Concluding Remarks

Competence of natural languages for describing evolutionary processes in general and the physical origin of life in particular resides within their capacity of admitting internal descriptive agents, since natural languages are grounded upon dialogues instead of monologues. Internal measuring agents serving as the dynamic of evolutionary systems could happen to be the evolutionary precursors of such internal descriptive agents. Nonetheless, external description as a monologue like the present article by this author is also inevitable. What is specific to external description is that the descriptive object, whatever it may be, is to be out there and remains invariant. The external descriptive agent as the author of the description who is informed about the object does neither increase nor decrease the information about it during the process of description. This comes to imply that information is conserved in the eye of the external descriptive agent irrespective of how information could be identified externally (Kuppers, 1995). In contrast, internal measuring agents are constantly gaining and losing information about the others through their internal measurement. Gain and loss of information to internal measuring agents is certainly consistent with the conservation of information to the external descriptive agent, since the difference is merely methodological. The only constraint on internal measuring agents is that they act so as to come to terms with the conservation of information in the eye of the external descriptive agent.

One particular instance of the conservation of information to external description and its gain and loss to internal measuring agents is seen in the evolutionary emergence of energy consumers. The conservation of energy is incontrovertible in the empirical material world, while energy consumers act towards energy resources so as to make both ends of energy intake and outgoing meet. Associating the physical origin of life with the emergence of durable energy consumers, though being able to be alternated frequently, as facing the conservation of energy lets us see the appearance of information consumers in the face of the conservation of information as a principal characteristic of evolutionary systems.

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