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Potency and Structure

The remote context for this discussion is Lonergan's chapter 8 on things in Insight and his account of development in chapter 15. The proximate context is the development of a model of creative human performance. Embodied intelligence requires a potency for form. This essay explores the openness of structure with a view towards further explication of the potency afforded by, for example, free images, language (and signs in general), as difference, and consciousness as an unmediated immediacy, all of which are biologically conditioned and instrumental to human knowing.

For humans, self actualization involves the free, conscious, coordinating of operations and acts in a performance. A performance has a beginning and an end. Consider juggling, for example. Most of us can toss a ball in the air underhanded and catch it, but fewer of us can do this continuously with three or more balls as a juggler does. The juggling performance begins with the initial toss and ends with the catching of the three balls or it is interrupted with a miss.

A performance is the smallest concrete intelligible sequence (unit) of activity in terms of which operations and acts derive their functional meaning.¹ As we develop, performances become more intelligent and meaningful. The body, and particularly the brain, enables performance via the flexibility of processes embodied in performance. In other words, operations are available which can be freely and creatively combined.

With animals the situation is more constrained. There exist flexible sets of schemes of recurrence adaptable to the specifics of a situation. While the animal's creativity may be restricted or non-existent in the development of new schemes, there is an inherent flexibility in the development and application of the operations that make up the scheme. At any time there is a set of integrable, but not integrated, operations at the ready for dealing with types of situations. Let's characterize this as minor flexibility. The fact that the operations do not have to be integrated in the same way all the time admits a major flexibility. In Piaget's terms, the flexible set of schemes is a schema. The minor flexibility is assimilation and the major flexibility makes accommodation possible.

This behavioral potency indicates that the organism is not fully systematic. In turn there are two senses in which it is not. There is the minor sense as described above where elements are integrable, but not integrated. These define the range of behaviors available in the moment, for example. There also is a major sense where the lack of system permits the emergence of new forms, new behaviors and, at the limit, creativity itself. It is this sense we want to explore in understanding the organism as not fully systematic.

In a not fully systematic whole, everything is not related to everything else, but everything is related to something that is related to something else, so that all the parts do not need to be interrelated. This permits an aggregate of elements and relations that in turn constitutes the potency of the whole to perform in relation to itself and to the other, or what is not it, and to develop. Remotely it makes evolution possible. In such a whole

it is possible to have structure, system and systematic processes without the whole being fully systematic. This permits organisms to live in situations which are not fully systematic. It also provides evolutionary gradients towards greater complexity, greater variability and greater flexibility.

Though parts of the whole may be isolated from one another, they are not isolated from the whole itself. Though they can be studied abstractly as if they were isolated, there comes a point where their fuller context needs to be invoked to explain their operation. These are classic tenets of holism. To them we add the notion that there is no central organization of the organism. There are operators and what may be considered centers of organization and even of self organization. Its as if they work in contexts they did not create for reasons they may not know to meet ends or goals they may not foresee. Intelligence operative in a universe whose intelligible unity is one of emergent probability provides a clear example of this. Our concerns and examples will be more mundane but are relevant to developing an adequate context for explaining embodied intelligence.

Loneragan defines a thing as a unity, identity, whole. He notes that we have a notion of a thing, meaning that we do not have a fully differentiated and integrated conception of it. We understand the unity of a thing via insight, but the unity that is grasped ranges from a relatively cognitively undifferentiated “oneness” to unified structures such as that of a functioning plant. It is the grasp of a unity in data where all the data pertains to the thing. Yet for this understanding to transcend the immediate situation, we know from the work of Piaget and others, that the understanding of the conservation of objects, a grasp of aperiodic identity, takes months for the human infant to achieve. Grasping that the same thing is manifest in different instances over time requires additional insights. The thing is also a whole. To understand it as a whole we face greater challenges because we need to enter an explanatory framework. The understanding of it as a whole can be implicit, as it could be in the botanist’s understanding of a plant. Or it can be explicit as in the philosopher’s understanding of a whole as such. It is to the latter realm that we will turn to understand the thing as a whole. Lonergan notes that the notion of the thing is ambiguous.² As we shall see, so is the notion of structure and the corresponding notion of whole. That ambiguity is evident in his notion of development where a prior integration brings forth the conditions for the subsequent integration, which in turn comes into being via the law of effect. The organism is a whole, but it is not a fully integrated system. This lack of total integration constitutes the openness of structure, which accounts for the flexibility we experience in our self-transcendence. Perhaps the easiest way to understand this is to start with a comparison of Structuralism’s notion of structure and Lonergan’s of a functional whole.

Structure and Wholes

Levi-Strauss provides three aspects of structures.

First, the structure exhibits the characteristics of a system. It is made up of several elements, none of which can undergo a change without effecting changes in all the other elements.

Second, for any given model there should be a possibility of ordering a series of transformations resulting in a group of models of the same type.

Third, the above properties make it possible to predict how the model will react if one or more to its elements are submitted to certain modifications.³

If we consider structural transformations as systematic, then we could conceive of development as fully systematic where a prior state causes the next via a set of operations. These operations may be supplanted by the next stage, but the link between them and the subsequent stage is fixed. Development in this sense approaches a cybernetic model.

Lonergan distinguishes a whole as a collection from a functional whole. As a collection it can be an aggregate that is arbitrary or conventional. A quart of milk is conventional since as a measure one can consider it as divided into parts arbitrarily. The milk itself is a mixture. As such it is a collection or aggregate of different types of entities. A functional whole, however, approaches Levi-Strauss' definition of structure. He notes that the whole as structure is illustrated in "...highly organized products of art and nature where every part is related to the others. Every part is just what it is because of its relations to the other parts."⁴ How are we to conceive these relations?. In this account they appear to be fully interrelated.

He further characterizes the functional whole as "...constituted by mutually mediating parts".⁵ In a beautiful holistic account he notes:

The respiratory system supplies fresh oxygen not merely to the lungs, but to the whole body. The digestive system supplies nutrition not merely to the digestive tract but to the whole body. The nervous system supplies control not merely to the nervous system but to the whole body. And the muscles supply locomotion not merely to the muscles but to the whole body. The result is something that has fresh oxygen and is nourished, is under control and is moving, because you have a number of immediate centers ...and the centers make the whole, giving the whole all the properties of each of the centers of immediacy.⁶

Lest we think this means Lonergan think the organism is, or approaches being, a fully systematic whole, he notes that "...there are anticipatory developments that have no great utility at any particular given stage but are extremely useful later on...In other words, there is something more to the organism than mutual mediation."⁷ With this statement appears the possibility of a residue of aggregates outside the range of particular states of self-mediating centers placing the functional whole within a broader context. This broader context includes the whole as material, as potency for form which is found in the coincidental and non-systematic. Let me briefly provide three examples.

Early Life

The first regards one possibility of the form of early life. The gap between life as systematic and the nonsystematic convergence of its conditions is huge. The notion of

schemes of recurrence, or cyclic processes, provides some insight into emergence. If a scheme is possible where A causes B which causes C which causes D which causes A, then all that needs to happen is for any of these events to occur to initiate the scheme. Now, the scheme does not cause itself in the sense that it generates its own conditions, but it is part of the cause in that it becomes itself. Thus, emergence has two causes, the conditions for the initiation of the self-sustaining process and the process itself in its becoming. Emergence can be fully explanatory though there is a logical gap between the assembly of the conditions, the conditions as unorganized, and the resultant scheme as organized. That is an abstract account. The emergence of life probably did require the actualization of multiple schemes of recurrence which constituted its systematic elements. But the actualization is understood in terms of schedules of probabilities and all the schemes need not be interrelated. They can be independent. In that case a non-systematic model is plausible.

The emergence of life is not simply the emergence of schemes, but is the emergence of a whole. The most basic question is what kind of structure does the whole need to have to be self-sustaining whole. As self sustaining, life does, in a sense, reproduce itself within itself. As reproductive it produces another. Stuart Kauffman's hypothesis regarding the form of early life revolves around the notion of sets of autocatalytic processes.⁸

Autocatalytic sets produce the biochemicals needed for their own operations. These would be structures of interrelated bio-chemical processes which recurrently replicate states of polymers sufficient to maintain existence as a whole. In this case we need to shift from a consideration of schemes of recurrence where the schemes are linked sets of events to the recurrences of non-systematic states yielded by the processing of sets of independent schemes of recurrence. The notion of a whole as having recurrent non-systematic states is compatible with a unity of independent recurrent processes yielding results in the context of a schedule of probabilities. It is this notion which underlies Kauffman's hypothesis of the origin of life consisting not in the emergence of a self-replicating entity embodying complex strands of DNA, but of a bound set of biochemical processes open to the environment that maintain a threshold of cycles of reactions that maintain existence within a range of states and that self-replicate. The states can be cyclic while not being fully systematic. There is enough order to maintain existence and to replicate and enough "disorder" to permit adaptation. His working hypothesis is that organisms exist "...on the edge of chaos".⁹

Development

The second example is found in Lonergan's account of development. As a succession of integrations the form of the organism at any one time is an integration of parts, which themselves can be integrations. In the discussion of development in Insight, this higher integration is characterized as a higher system which fulfills the two major roles of being the operator of development and the integrator at each developmental stage. Development is from lower to higher integrations. It is not fully systematic. First, the operator is an upwardly directed, but indeterminate, dynamism. Second, the operator as bringing forth the conditions for the higher integration "...provokes the underlying instability."¹⁰ The higher integration occurs not deterministically, but via the law of

effect. “The law of effect states that the ground of functioning advances to a new ground of functioning where functioning occurs successfully.”¹¹ The higher integration is conditioned and is itself a de facto accomplishment. This indicates that it could be different. If the operator of development in moving from one stage to another is understood as the “assembling of conditions” and if these conditions come from parallel, unintegrated processes, then the “operator” is diffuse and non-systematic. As in our prior example it is conceivable that there can be schemes of recurrence that operate concurrently but in relative isolation from one another producing independent results which provide the aggregate, or set of conditions, for the emergence of a possible range of structures or integrations. In these instances, development is the exploitation by organisms of the key evolutionary event, emergence. While evolution relies on large numbers and long periods of time for significant change to occur, development manages large numbers within short periods of time. This is because the organism assembles its own conditions for emergence within a constrained environment. There is no reliance on the chance occurrence of the conditions, and there is a limitation of the possible interactions the conditions can have.

Neural Structure

A third example is found in the development of neural networks. If we consider that sensory-motor behavior became conscious with the emergence of the first neural network, then the evolution of the brain and consciousness both occurred with the evolutionary differentiation of functions and increasing complexity of behavior. Specialized neural networks evolved to enable more complex behavior.¹²

Using Edelman’s model as a working hypothesis, we find that neural function which underlies perception and behavior relies on neuronal groups which map complexly to one another constituting a primary repertoire of operations. This repertoire is dynamically structured via mappings of neural activity across the groups. It is refined via the development of mappings. This occurs via a selective process where the degree of neural activity determines which mappings develop via both enlargement, by incorporating more neurons, and facilitation. Induced by the activation of neurons, facilitation results from individual neurons creating more synapses increasing the likelihood of innervating their other neuronal contacts. These changes facilitate the reoccurrence of similar patterned activity. The neuronal refinements support the secondary repertoire. Since the instigating aggregate can be exogenous as in sensing or endogenous as in hormonal changes, the model can be used to explain sensing as well as biologically based behavioral development. The primary repertoire is illustrated by a baby’s ability to move their fingers and to grasp objects at birth. The secondary repertoire is illustrated in the development of fine motor coordination.¹³

Edelman’s notion of the degeneracy of neuronal groups is similar to the notion of equipotentiality. Neuronal groups need to be of sufficient size to manage multiple complex mappings of activity. For example the visual system has to have sufficient complexity to distinguish an indeterminate range of possible objects where many may not have been seen before. This requires supporting large numbers of combinatorial possibilities. The neuronal group as a part of the primary repertoire is a set of neurons, any one of which can become specific to the mapping of one of a range of mappings.

Since they have no specific function, they are “degenerate”. This is akin to the notion of neo-natalism in evolution where the former ontogenic development is arrested permitting the subsequent specification of function at a later time. The neuronal group, then, supports a bound indeterminacy of operations. The degeneracy of the group enables the development of the secondary repertoire via the further structuring of activity at the neuronal level. The recurrence of similar patterns is facilitated through the development of connections (i.e. synapses) between neurons. It cannot totally explain it because this type of processing enables multiple states but does not determine what those states are. The specification of the secondary repertoire can partially explain development, learning, memory and other operations.¹⁴

Combinations of neurons map to operations. There is an indeterminate number of possible combinations that are limited via constraints. Consider the network of motor neurons that enables the coordination of hand movements. The motor neural network is an “organizer of the hand”, but it cannot organize independently of its materials. The range of positions is dependent on the structure of the muscles, bones, tendons and so on in the hand. Though there are limitations, the range of combinations is very large. Consider the finger positions required to play all musical instruments, for example. We find a similar situation with vision. Due to the matrical neural relations and the combinations they support, the visual system can support a bound “indeterminacy” of visual experience. First, there are more than a million rods and cones in the eye. Second, they are specialized in terms of function, creating more possibilities for sets of combinations. Third, they interact with an elaborate set of neural structures for further processing and for integration with other neural modes giving us the potential to see all possible movies or all possible sunsets.

These considerations support an operational model for memory. For example, we could have a set of elements, or neural operations, which are dynamically structured in complex patterns to support a virtual infinity of possible memories. Different memories can emerge at different times from the same complex due to different combinations within the complex. Memories, then, would not be stored, but would emerge. As described memories would simply be specifications of the network. However, if new memories are formed via the introduction of new patterning to the network, then there needs to be the potency to embody a new pattern via “rewiring” of the network. The hypothesis is that this is done via the growth of new synapses which is related to the frequency of the concurrent firing of the neurons. The growth of new synapses facilitates the synchronized firing in the future.

Implications

We have looked at three instances where the organism is not fully systematic. Development of the first would show how life in its inception and evolution embodies the non-systematic. Indeed, a strong argument can be made that it is intrinsic to life and enables evolution to select for increasingly flexible organisms. Reflection on the evolution of development would show how the potential for evolutionary variation extends beyond mutations to every situation where there is organic adaptation to the variable “internal” and “external” milieus. It also would show how evolutionary differentiation occurs within the context of wholes just as development is a process of differentiation and integration within a whole. Reflection on the third would provide a

neural model for learning and subsequent modification of behavior during the life cycle. At its term it would provide the neural conditions for intelligence.

With the evolution of intelligence major modification to current and invention of new behavioral cycles need not rely on evolution, but on the organism itself. This involves neural processing which is enabling rather than causal. For example, the mere difference of signs permits them to be meaningfully arranged, since they are not constitutive of their meaning. Speech involves signs and expression. Neural processing (along with physiological structures) is constitutive of expression, but it does not determine its meaning. Rather it enables the expression of any meaning we can conceptualize. We have a hint here of how intelligent consciousness is neurally conditioned but transcendental. Combined with a further understanding of the potency of neural processes as conscious, the possibility arises of understanding how the emergence of form became a matter of the moment of insight, respecting, but transcending the limitations immanent in both evolution and development in its achievement.

¹ The meaning of act differs implied here differs from Lonergan's in that acts are free operations. This contrasts with operations that are not free but are constitutive of a performance. Thus, within a skilled performance there are operations that occur "automatically" and other points where the person provides control within the course of its unfolding.

² Bernard Lonergan, Understanding and Being (Toronto: University of Toronto Press, 2005) p. 106

³ Claude Levi-Strauss, Structural Anthropology, (Harper Collins, 1963) p. 279

Structuralism views structures either synchronically or diachronically. The synchronic view lays out the structure at a particular time while the diachronic explores the changes over time. At its most general, the synchronic would provide a model applicable to the structure at any particular time. At its most particular, it would explain its current state. Lonergan's account of cognitional structure typically is synchronic. But if we consider its development we confront dead ends, discontinuity, breakthroughs, coincidental but unrelated developments in different areas and so on. Consideration of the non-systematic requires a statistical approach and a subsequent consideration of the relating of states of mind to one another insofar as this is possible. Emergence of multiple schemes of recurrence yields states. This enables another type of "organization", the emergence of recurrent states which are functionally interrelated

⁴ Bernard Lonergan, "Philosophical Positions with Regard to Knowing" in Philosophical and Theological Papers 1958-1964 (Toronto: University of Toronto Press, 1996), P. 216

⁵ Bernard Lonergan, "The Mediation of Christ in Prayer" in Philosophical and Theological Papers 1958-1964, (Toronto: University of Toronto Press, 1996), p. 165.

⁶ Ibid, p. 165.

⁷ Ibid, p. 167.

⁸ "We reach a new and fundamental conclusion: for any fixed probability of catalysis P , *autocatalytic sets must become possible at some fixed complexity* level of numbers of kinds of polymers. The achievement of the catalytic closure required for self-reproduction is an *emergent collective property in any sufficiently complex set of catalytic polymers.*"

Stuart A Kauffman, The Origins of Order, (New York: Oxford University Press, 1993), p.310.

⁹ Ibid, p. 30.

Provides a general account using chaos theory. The metaphysical view does not require considering any particular types of distributions (i.e. strange attractors) but notes only that a statistical understanding is required.

¹⁰ Bernard Lonergan, Insight (Toronto: University of Toronto Press, 1992), p. 490.

¹¹ Ibid, p. 492

¹² It is possible that consciousness was a quality immanent in the original neural networks. Its emergence was coincident to the interrelated firing of neurons. We find primitive networks today in jellyfish. The simplest has two types of neurons. The first type is sensitive and the second is motor. They are directly connected to each other. An incipient intentionality is immanent in this primitive network as the sensitive neurons are related to what is other and the motor neurons permit transformation of the organism and its behavior in terms of the other as mediated via the sensitive neurons. The next most complex network has neurons between the sensing

and motor neurons permitting self mediation of sensitivity and movement. Rather than terminating directly on motor neurons, sensory neurons terminated on the intermediate ones which in turn innervate the motor neurons. Thus, the intermediate neural net emerged which led to the evolution of the brain. Since the state of these operations can be conditioned by what is not the organism, the other as mediated via the senses, there is an analogical structure linking the organism and the other. Since the neural net can also “sense itself”, it can organize itself in terms of its own state, which encompasses the state of the other for it. This enables the organization of movements in terms both of the other and of the state of the organism itself. The analogical relation between birds’ movements and the building of a nest would be a sophisticated example of this. Minimally, in the case of the initial neural networks motor patterns could vary based on sensory patterns. The sensory patterns also would vary based on motor activity. Given this, it makes sense that the evolution of the brain and the evolution of behavior are linked.

¹³Gerald M. Edelman, Bright Air, Brilliant Fire: On the Matter of the Mind (Harper Collins, 1992),p.. 83-85

¹⁴ Gerald M. Edelman, Neural Darwinism: The Theory of Neuronal Group Selection, (Harper Collins, 1987), pgs. 67-68.