Further revised June 19, 2005, for ECHO V Conference, Oct. 7-9, 2005 at Amiens

Embodied Consciousness and Quantum Science

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Embodied Consciousness

I take 'embodied consciousness' to be a code word for a study of consciousness in the phenomenological tradition of E. Husserl, M. Heidegger, M. Merleau-Ponty, and perhaps, L. Wittgenstein, the neuro-psychology tradition of K. Pribram, M. Donald, F. Varela, J. Schulkin, and A. Noe, and the quantum macro-theory of embodied consciousness of H. Primas, H. Atmanspacher, G. Farre and other scholars.

The study of 'embodied consciousness' involves ontological coordination (see below) between the exteriority of the physical body in its environment and the interiority of self-aware consciousness (Heelan 1983/1988). Since all objective knowing is revealed to us only within the structure of consciousness, in which exteriority is captive to interiority, this kind of study is not epistemological but ontological. It is not focused on logic and criteria of evidence but on what is given to self-awareness phenomenologically (in Husserl's and Merleau-Ponty's sense), and ontologically and hermeneutically (in Heidegger's sense). Such a viewpoint may suggest to some comparisons with the work of J. Dewey, Wittgenstein, D. Davidson, or even R. Rorty, but I will not attempt to make comparisons with these authors since their expository languages have different historical, systematic, and scientific sources.

I begin with the top-down philosophical principle and follow with a bottom up application of the principle. The principle is: The Being of Knowing is the Knowing of Being. It is a principle about ontology only satisfied within phenomenological self-awareness. By 'phenomenological,' I do not mean just awareness of an internal or external object, distinct from and independent of the subject, but I mean a living awareness of the intentional subject-object union, as 'given' within the tradition of phenomenology of which Husserl and Heidegger are the principal exponents. Husserl inaugurated this method. Heidegger developed its historical, social, and hermeneutical dimension. 'The Being of Knowing' is *Dasein*, that is, the human subject caringly engaged with the world we navigate in (or simply, World, Husserl's 'Lifeworld') and 'the Knowing of Being' is *alethia,* or the process of revealing Being as Truth about this World for the subject. All terms are relative to the Heideggerian cultural viewpoint which is dynamic, phenomenological, local, historical, and communal. Thus, I will use active verbs rather than nouns for the functions of consciousness. The captivity of exteriority by interiority leads to the recognition that the revelation of ontological truth (alethia) about the world is an ongoing cumulative historical and cultural process that, whether initially expressed in first- or third-person objective terms, can only be studied in depth through the eyes of first-person self-awareness (Heelan 1989, 2003; cf. also Snell 1982). In this paper, I will use the term 'given' only in Heidegger's sense of 'given ontologically and phenomenologically to first-person self-aware consciousness.'

Some, such as John Searle, would find the phrase 'given in first-person consciousness' unacceptable (Searle, 2004, 174, passim). For him,'what is given in first-person consciousness' can only imply something that cannot be corroborated independently of the first-person speaker, and this would normally, in his view, exclude it from scientific or scholarly discourse. But he misunderstands 'first-person consciousness.' The phrase refers to the witness that a speaker gives in words to what he/she has experienced. But how does a hearer come to understand and evaluate what the speaker means for his/her witnessing? There is no other firm ground for understanding and assessing what a person means by his/her words than by recognizing that we, speaker and hearer, must first share a common culture, language, and World. Our understanding and assessment of the interiority of others is only as good as our understanding of our own interiority, from which flow a person's meaning, speech, and action. It is the only firm ground and condition we have for trusting or distrusting others, and it is the filter through which we learn all science, and practically everything else that we know. It is at this authentic first-person ontological self-awareness that phenomenology brings.

Hermeneutical Circle (Spiral)

The cumulative developmental, historical, and cultural process of human knowing is revealed by hermeneutical methods. Hermeneutical methods are 'strong' and 'weak.' A common understanding of hermeneutics is that it is concerned with the interpretation of texts, and similar human artifacts; this I call a 'weak hermeneutics.' A 'strong hermeneutics' is a hermeneutical phenomenology that reveals the interpretive role at the heart of sensory experience, in

particular, of perception and measurement. The strong hermeneutical circle begins and ends in the sensory World; the weak hermeneutics begins in sensory experience and ends in concepts or frameworks of interpretation (for the 'strong' form, see Heelan 1994; Lonergan 1971, Heidegger 1962, Merleau-Ponty 1962; for the 'weak' form, see Gadamer 1975) .

The strong hermeneutic circle comprises a sequence of four active functions:

1. questioning the World by attentive motor-sensory engagement with it;
2. searching for insight into possible practical or theoretical intelligibilities to be found there;
3. assessing what is revealed as intelligible and supported by appropriate standards of evidence so that the proposed hypothesis can be affirmed or denied prudentially;
4. purposefully deciding how consequently to act.

The hermeneutical circle (better called a 'spiral') may have to go round many times before an individual inquirer is in possession of a stable apodictic truth – by 'apodictic' I mean the recursive ability to return to the same problem and solution for a confirmation or review, and if for review, to revise and correct the past process.

Each of these functions has to be explored in its interiority within the context of their functional unity of operation in *Dasein*, constituting truth as *alethia*. Since possible action in the World follows from this activity, the four transcendental functions comprise a dynamic system – that transcends particular pragmatic outcomes and moves the actor forward in his/her engagement with others and the World. In its many and diverse historical turnings, the turnings of the hermeneutical circle opens to human consciousness, among other things, new windows on its historical cultural World. Such windows are constructed by the four functions, beginning with attentively questioning the World. The questioning may use measuring instruments or other technological tools (cf. 'readable technologies': Heelan 1983/1988, 197-200). As the hermeneutical circle turns, it tends to correct and refine some existing windows on the world and close others. Through these windows Worldly horizons are made accessible and new forms of human culture are invented. A horizon is the stable background necessary to foreground the diverse ways in which a stable object appears and presents itself; it is the environmental context (for Donald 2001, they would be "episodic scenarios") that provides the place where nested objects are ordered in space, time, and motion according to the contexts of interest established by scientific or cultural communities.

Geometry of Visual Space

My interest in human consciousness grew as a response to problems about the intuitional foundation of curved geometry, first posed to me in a course given by Erwin Schrödinger at the Dublin Institute for Advanced Studies in 1947-48 on the geometry of the General Theory of Relativity. It took concrete form for me later when I did research on the geometry of the pictorial space of Vincent Van Gogh's painting, 'Bedroom at Arles.' Van Gogh's use of perspective was peculiar and I found one could make sense of the local geometry of the pictured bedroom by showing its relevance to the perceptual task set for the viewer by the painting: it was to make the scene convey, as Vincent said, the peace and intimacy of the bedroom. My research showed that visual space was geometrically flexible and adapted itself to the visual task at hand - but more about this in a moment. I found that this solution could be extended to instrumental observation, and that it made sense of (what has been taken to be) the problematic character of quantum physics. This last arose from the mistaken classical assumption that science was ultimately about the necessity of theory, rather than the contingency of data shaped by the nature of the task at hand. Actual experience is always local and subject to what can be viewed locally in concrete horizons of the World, with or without technologies. It is this local character of the observer and observed, together with the incompatibility of some local horizons with others that is characteristic of everyday human life - and also of quantum physics.

Van Gogh's 'Bedroom at Arles'

I want to recapitulate here what I discovered from my study of Van Gogh's painting, 'Bedroom at Arles' (Heelan 1972; 1983/1988, pp. 114-128). At the time when Vincent painted the 'Bedroom at Arles', he was studying the theory and art of using a perspective frame. The perspective frame that he was using, however, was one of his own design that he had a carpenter make for him. The frame had an unusual feature as we learn from a sketch he drew for his brother Theo. It was organized around the diagonals and their crossing at the center rather than around horizontals and verticals as in the classical tradition. If the purpose of using the frame was, as he wrote, to capture the 'true' form of things as he himself declared in a letter to his brother. The lines he drew accorded with the frame, but did not yield a three-dimensional vision of a room of Euclidean shape. The shape seemed rather to belong in a curved finite space – like the space of General Relativity. I thought it might have its origin in a 'natural' human vision unmediated by rulers. The culturally modern way of conceiving space is to regard it as an empty Euclidean box the structure of which is displayed

when measured with rulers and presented to public vision as a 'carpentered environment.' Metric geometries are created by external measures, such as by rulers, and rulers create Euclidean geometry. But maybe there are other 'more natural' ways of measuring space, for example, by stereoscopic vision. When the eyes 'measure' the environment, they depend on three mutually independent stereoscopic angles: up/down, bipolar right/left, and stereoscopic convergence. These angles are not independent and orthogonal variables in physical Euclidean space and so would not naturally create a Euclidean space without the introduction of rulers. However, since they are physiologically independent, one might properly assume that they would be represented in 'natural' visual space as orthogonal. With the assumption that the three angles are both independent and orthogonal, one gets a family of curved non-Euclidean geometries, elliptic or hyperbolic among which are families of curved, finite but unbounded spaces. There is a long experimental research literature – mostly unsuccessful – about trying to prove experimentally that visual spaces have such curved finite geometries. Research on this question started with the work of H. von Helmholz and W. Blumenfeld in the 19th century, and R. Luneburg (of the Courant Mathematical Institute, New York) in the 20th, and it is still going on in Israel, Japan, and elsewhere.

The consensual view in this research community is that the visual curvature parameters are biologically fixed. I was not persuaded that this assumption was correct. Evolutionary development equipped early humans (*homo sapiens*) to address a diversity of mainly local tasks within the structure of small communities. Euclidean infinity would have made no sense to those early humans. From the evolutionary viewpoint, natural human vision did not have time to adjust biologically to the way we moderns live in an infinite Euclidean space and time. We notice this discrepancy ourselves when traveling. Distant mountains appear to be one-dimensional postcard cut-outs rather than three-dimensional masses penetrated by deep valleys. When we are driving fast on a curving road, the curves ahead seem to be sharper than they turn out physically to be. The famous psychologist James J. Gibson, who trained young pilots during World War II, found that so many of them crashed their planes when landing that he concluded, people are land animals, and not naturally equipped to make reliable spatial judgments from the air. He designed a sequence of ground signs for pilots to follow in landing planes and, at his insistence, such signs were standardized and adopted by international agreement for all airports of the world.

In order to compare 'natural' vision with instrumentally mediated vision, consider, for example, how far the Sun, Moon, and stars look. In 'natural' vision, they do not look as far as astronomers say they are. Using instruments to measure space, astronomers place the Sun 93 million miles away. In 'natural' vision, however, the Sun appears to be no more than, a guess, 20 miles away. The Sun's rays when seen through light cumulus clouds give the appearance of a 'sunburst,' like the golden 'Gloria' seen in Baroque churches and on the seal of the State of California, where the sun's rays appear to be bursting outwards at right angles to the gaze. In astronomical space, however, we are told that these rays reach us in parallel streams along the direction of our gaze. These are just a few of the many ways in which light rays in measured physical space differ from the same rays in 'natural' visual space; their apparent trajectories are transformed in ways that contradict modern cultural expectations of recent origin stemming historically from the time of Galileo and Newton.

I assumed then that the geometry of a person's visual space is a strongly hermeneutical function of how the body and the eye work together in intentional consciousness to prepare an optimal (for the purposes of the viewing) visual presentation of the place to which the attention is drawn (for the purpose of action). By 'strongly hermeneutical,' I mean, 'constructive of a meaningful role for space/time for the present task.' I found that among the geometries available, there is a family of 3D finite hyperbolic geometries that concentrate near-Euclidean vision only in a local finite domain directly in front of the viewer. Rudolf Arnheim called this 'the Newtonian oasis' (Arnheim 1974, 289-90; Heelan 1983/1988, 28). Outside of this domain the space is curved, finite, and unbounded. Such 3D curved spaces have two curvatures. The first curvature parameter is associated with the distance of the 'Newtonian oasis' from the viewer. That presumably is where visual attention is practically focused in order to perform a visually monitored task. Since the distance of this location from the viewer is variable, the curvature parameter should be flexible within a certain range. The second curvature parameter is associated with the size of visual space; this would relate hermeneutically to how much of the local environment has to be taken into account while attending to the visual task at hand. I concluded that the geometry of visual space was modeled on finite hyperbolic spaces with curvatures suited to the mostly manual tasks that early humans performed.

Looking to ancient authorities for support, I found Aristotle. He was not unaware of the finite limits of visual space. He wrote in *De Coelo* (*On the Heaven*, 279a), that beyond the visual heaven (the sphere of the fixed stars) there is nothing, not even a void or empty space: "It is evident" he wrote, "that there is no place or void or time outside of the heaven." But while Aristotle's visual imagination stopped at the boundary of the heaven, his intellectual imagination did not, for he added, "Whatever is there [beyond the heaven], is of such a nature as not to occupy any place, nor does time age it." Such is the notion of 'spirit' that has come down to us from the Greek philosophers.

Transcendental Consciousness

Pursuing this research further, I came to understand that perception is an embodied function that gets its conscious structure from physical engagement with the world. Physical engagement can be 'natural' or it can be structured 'artificially' by the use of measuring instruments and other technologies familiar only to us moderns. 'Natural' human vision is guided by the natural inclination to adapt the role of vision to the accomplishment of local tasks. Such task-oriented visual space may be only locally near-Euclidean but overall it is generally curved, finite, and unbounded. When, however, instruments, such as rigid rulers or physical light rays, are used, these can become so much part of the human embodiment that they show up in phenomenology as part of the 'body image' through which we unconsciously interface with the world. Such instruments I call 'readable technologies.' (Heelan 1983/1988,197-200). In researching the embodied character of the four transcendental functions that comprise Lonergan's notion of method in inquiry, I discovered some general principles that were applicable to these notions throughout.

Summary: An object made present in consciousness to human experience is not simply a 'mirror' of the 'already out there now real' (i.e., what is there independently of the viewer and the viewer's horizonal situation), but is what is given to it as an object of experience under the principles listed below:

Principle 1) *The intentionality condition:* The object is given directly in self-awareness as present in the World and yet distinct from the subject.

Principle 2) *The evolutionary or adaptive condition*: The object is given as adaptive to the implicit or habitual interests of the attentive viewer.

Principle 3) *The framing condition*: The object is given as situated in a compatible horizon of the world.

Principle 4) *The action condition*: The object is given as grounds for personal action.

Principle 5) *The embodiment condition*: The subject (perceiver) to whom the object is given is an embodied perceiver, skilled by physical training to search for, test for, and recognize the presence of similar objects in the flux of sensory experience. The embodiment condition has a physical dimension that permits the use of 'readable instruments,' instruments that have become so integrated with bodily activity that they have become integrated with the 'body image.' Since the use of familiar technologies, whether classical or quantum, enriches and enhances perceiving, perceiving broadly understood is structured by the same core set of neuro-, psycho-, teleo-logical transcendental functions operating within embodied consciousness that constitute the 'intentionality' of the hermeneutical circle (Heelan 1983/1988, 1989, 1994, 1998, 2002; Heidegger 1977; Husserl 1960, 1983; Merleau-Ponty 1962).

Such, for example, is a blind man's cane that enables him to 'map' his local environment through the tip of his cane. The interiority or intentionality-structure accessible to self-awareness works the same way, whether or not the perceiver uses a 'readable instrument.' This implies that, when such an instrument is used, the target of observation can be either the object-as-given-by-the-instrument or the instrument-itself-as-object. Switching attention between them changes both the embodiment of the perceiver and the relevant local horizon (framework). The two experiences are phenomenologically different – that is, despite the fact that, from an external third-party perspective, nothing may seem to have physically changed, nevertheless the critical self-awareness of the viewer has changed and, in the dynamic view of concept formation defended here, there would always be tell-tale changes at least in the follow-up confirmation tests that would show what decision had been made regarding the target of observation.

Principle 6) *The complementarity condition*: Observations of the object measured and observations of the measuring instrument are 'complementary' in the sense made familiar by Niels Bohr in quantum physics: they cannot be performed together in one cognitive action and the order of their separate performances can be non-commutative when action follows. In one act of observing (where the target is the object measured), the instrument is not an object but is instead part of the embodied subject and under the control of the subject's 'general bodily supervisor' (the practical Ego); it is accessible to self-awareness through the functioning 'body image.' In the other act of observing (where the target is the instrument), the instrument is a free and independent object located in the external horizon of perception. From a horizonal (or framing) perspective, in the former (where the target is the measured object), the instrument is not part of the subject's external horizon, while in the latter (where the target is the instrument), the instrument is an independent part of that horizon. This is a situation analogous to – and explanatory of – the notion of 'complementarity' in quantum physics, where the choice, say, of measuring position, can exclude the possibility of measuring momentum at the same time, and vice versa. It is important ot note that the two acts of observing are not phenomenologically compatible, since each involves a different subjective embodied self-awareness as well as a different horizon or framing in the ontology of the perceptual process; these belong together and cannot be ontologically separated in practice.

Principle 7) *Principle of task-related sensibility*: The geometry of the spatial horizon of experience depends on the embodiment of the perceiver. Only when the embodiment includes a 'carpentered' horizon, will the geometry be universally Euclidean. When the embodiment is 'natural,' such as when binocular vision alone is used to structure the space of experience, its geometry is task-related and, as such, can be virtually Euclidean only in the limited domain of the task to be performed while overall its structure is non-Euclidean, curved, finite and unbounded.

To my surprise, I found that Wigner's measurement problem – that human consciousness plays an essential role in quantum measurement – could be construed along these lines (Wigner 1967). The solution is an expression of the relativity of data 1) to the choice of what to measure and 2) to the laboratory horizon of measurement brought into play. Such choices are not antecedently predicable. Horizons of measurement are consciously learned, then monitored and consciously adapted by each observer to the best occasions that occur during the learning process. Generalizing this finding to all sensory experience, I began to read the transcendental functions in the light of Husserl's notion of phenomenology as transcendental self-awareness of the embodied intentionality (Husserl 1983, 1960). I also began to read them in the light of Heidegger's notion of *Dasein* – the human inquirer - as *Being-in-the-World* – and as the carrier of historical/cultural tradition (Heidegger 1962, 1977). By going to the sciences of anthropology, linguistics, physics, neuro-psychology, theology (see, e.g., refs. to Pribram, Donald, Noe, Varela, Thompson, Tomasello, Lakoff, Schulkin, Lonergan, and others not mentioned). I folded their insights about the origins and development of human perceiving into the highest-level transcendental notions, I came to the conclusion that *human consciousness is the human subject's self-awareness of the historical cultural World expressed in language and other symbols, that it contains dimensions that are this-worldly and embodied, and also dimensions that go beyond. This self-awareness defines a self-creating, self-assessing, self-expressing, and self-developing subject always engaged with the pre-existing historical cultural World, freely making decisions, and acting in relation to this cultural environment, but aware of the insufficiency of its temporal worldly calling to satisfy the transcendental drive of Dasein.*

Embodiment: Complementarity of Symbol and Symbolized (Representation and Meaning)

I drew some conclusions about the nature of those generalized functions, functions that make self-creation possible. Among them are functions, experienced as 'insights,' that result in the formation of concepts. Concept formation at the perceptual level depends on the formation of *search programs* on the sensory flux, the labeling of the search programs internally in memory, and the labeling of them externally in words or phrases. The formation phase of concepts is conscious in the learning stage but subsequently unconscious in habitual operation (except when being revised). The search programs are embodied physically in neurological motor networks with or without embodiment in instruments. (cf. refs. To Donald, Pribram, Noe, Varela and Thompson, and others). How are we to understand 'embodiment' in such cognitive structures?

Meaning ('intentionality') is embodied in language and other symbolic (representational) forms. A search for meaning is generally begun as a search for some set of symbols (representations), usually linguistic. A search for a set of linguistic symbols does not necessarily result in or coincide with a search for a specific meaning, because meanings belong to a higher interpretative level than mere perception of the symbol and involve human intentions that can be embodied symbolically in many ways. A Google search, for example, will turn up no more than a set of linguistic uses, but the search for meanings is a search for something that can be embodied in many different linguistic or other representations. The dependence of meaning on symbols is a hermeneutical (interpretive) problem, one of connecting a (cultural) meaning with a (cultural) symbol use. Symbols may be considered either as perceptual objects in themselves, such as letters of the alphabet, or as functioning embodied parts of the operating subject, such as spoken or written words. In the former case, the symbol is just a free and independent perceptual object apart from the subject and dominated by its 'mimetic' - lowest level 'performative' - meaning (Pribram 1991; for 'mimetic,' see Donald 2001, passim; Noe 2004 uses the term 'enactive'). In the latter case the symbol functions as a part of the operating subject and generates a meaning at a higher level than the physical (mimetic) sense of the symbol, this meaning is usually theory- or network-dependent. All perceptual entities, whether used as independent objects or given representational functions in the generation of meaning, depend in addition on the formation and maintenance by the subject of his/her pyramid of dynamic embodied search programs.

Symbolic networks link symbols on the same meaning level; when interpreted, they share a common subjective intention and a common external horizon of possibility, both necessary for common meaningful discourse. When the symbols are not on the same meaning level, there is a problem of interpretation – but more about this below. All aspects of meaning are expressed symbolically through language or other symbolic forms, e.g., mathematical equations, measure-numbers, physical measurements, motor-sensory activity, *Vorhanden* ('present-at-hand,' contextually indeterminate objects), *Zuhanden* ('ready-to-hand,' contextually determinate objects), and so on. This hierarchy of meanings is

symbolized by a hierarchic pyramid of representations that all belong to the perceptual order. The meanings, however, are mediated by the hierarchy of symbols, the lowest - whether words, pictures, diagrams, or monuments - being objects directly given and recognizable in the sensory World, while higher level meanings – what words mean, pictures mean, diagrams mean, or monuments means - are mediated by embodiments of the lower level representations. All the representations eventually return on analysis to concrete meanings in the World. The building of such a pyramid of representations is clearly fraught with dangers, such as, of thinking that the pyramid is flat – leading to *empiricism* or *idealism* - or of failing to recognize a representation's proper place in the pyramid – leading to *rationalism* and other - *isms*.

Though all representations return ultimately to the perceptual for their meanings, all meanings are not on the same meaning level. Difference in levels of meaning introduces the kind of complementarity found in quantum physics (for reasons already presented), namely, that the search programs for the lower level (of physical symbols) are incompatible with the search programs for the higher level (of meant objects), because the symbol when functioning meaningfully is not free and independent on its own but rather a part of the subject's embodiment, bound to, enslaved and controlled by the subject's 'general bodily supervisor' (the practical Ego).

Human Development: Synthetic Analysis

The origin of human self-awareness as Being-in-the-World is mysterious, emergent, and connected with the origins of language. To the extent that self-awareness is embodied and reaches out to the World as to its natural home, part of it – the embodied part - can be studied scientifically, even to the point of giving it a provisional name, a Quantum MacroSystem (QMS).

In a paper of mine published in Harald Atmanspacher's journal, *Mind and Matter* in 2004 under the title: "The Phenomenological Role of Consciousness in Measurement" (Heelan, P. 2004), I wrote the following (the citation is from the Abstract):

> A structural analogy is pointed out between a hermeneutically developed phenomenological description, based on Husserl, between the process of perceptual cognition on the one hand and quantum mechanical measurement on the other hand. In Husserl's analytic phase of the cognition process, the 'intentionality-structure' of the subject/object union prior to predication of a local object is an entangled symmetry-making state, and this entanglement is broken in the synthetic phase when the particular local object is constituted under the influence of an ειδος ('inner horizon') and the 'facticity' of the local world ('outer horizon'). Replacing 'perceptual cognition' by 'measurement,' and 'subject' by 'expert subject using a measuring device' the analogy of a formal quantum structure is extended to the conscious structure of all empirical cognition. This is laid out in three theses: about perception, about classical measurement, and about quantum measurement. The results point to the need for research into the quantum structure of the physical embodiment of human cognition.

Although Heidegger and strong hermeneutics are not mentioned in the Abstract, they are also part of the argument of that paper since I take Heidegger's Being-in-the-World to be a development of what is already implicit in Husserl's work on perception and explicit in his posthumous works, such as the *Crisis of European Civilization and Transcendental Philosophy* Husserl 1976), rather than a total repudiation of Husserl's transcendental phenomenology. I have in this presentation extended the argument of that paper from perceptual acts to the embodied human knower as a physical system, that is, to his notion of the human subject as Heidegger's Being-in-the-World.

That the self-awareness of this human system belongs to the scientific category to which a quantum-like theory applies, is what I have tried to show. I am aware that I am not the first to do this. What I have done I hope would be seen as a contribution to what was begun by London and Bauer, Wigner, and von Neumann (see refs.), and developed by Primas, Atmanspacher, Farre (see refs.), and their colleagues, and others. In this paper today, I tried to show that the embodied human subject, as Being-in-the-World, in its engagement with the World, can be described overall as a Quantum MacroSystem.

Returning to my First Principle: The Being of Knowing is the Knowing of Being, and substituting 'embodied knowing' for 'Knowing,' we get 'The Being of Embodied Knowing is the Embodied Knowing of Being. But you may ask: if quantum systems, such as atoms and molecules, are merely material things to which consciousness is not ascribed, how is it that humans to whom consciousness is ascribed, fall under the same description? The truth is that the objective target of the quantum theory is not an isolated material thing, small or large, but a material thing united physically with an embodied human subject within the self-awareness of embodied human knowing. Human embodied self-awareness

includes the *disembodied presence* to the knower of what is also in its own being embodied (such as people, things, or World) but beings other than the knower, since the other, though physically distinct from the human knower, is nevertheless present to the self in consciousness. Though not physically a part of the subject, the other (people, things, or World) is present to, while physically united with, the embodied self without, however, blurring the physical distinction between them; as known. The other is possessed in a disembodied ('mental') state by the embodied knowing subject; the disembodied presence is, as it were, the product of an *interior mimesis of the object and the product of an interior performance called (by Husserl) 'noetic-noematic'intentionality.'*

We can trace the origins of the embodied subject in infancy. Nature provides the human infant at the start of life with the transcendental functions (or 'notions' as Lonergan calls them) that make its self-creation within a historical culture possible. Every individual person gains his/her Being-in-the-World only through living in an already historically constituted community (Tomasello 1999). This building of self through the interiorizing of communal Worlds begins in infancy and continues through childhood and adulthood to constitute an integrated function of the subject as self and the other as people and World. In addition, the self's desires and expectations reach out beyond the World, a fact whose existence is witnessed by human biology, anthropology, literature, history, and religious worship. Human desires are essentially unfulfillable and unendurable without a transcendent faith, hope, and love to bring 'rest' and 'satisfaction' to human 'lives' (Lonergan 1971).

Among these functions are *mimetic* (alternatively, *enactive*, Noe's term) transformation functions that are intelligibly modeled by group-theoretic theories that define symmetries given as invariants in relation to group-theoretic transformation. It is plausible to think of these mathematical transformations and symmetries as normative representations that serve the purpose of concept- and category-formation; they model the real mimetic performances in motor-sensory activity that act as 'search-programs' (or internal 'demons,' as Donald 2001 calls them) that pick out and recognize real instances of the invariants or symmetries in the sensory flux. Whether real instances occur depends on whether or not the contingent local background or horizon of search permits the search program to be successfully fulfilled; and if it is successfully fulfilled, it will be fulfilled only locally, at certain particular places and times in the World.

Turning now to the two kinds of objects, categorial and individual, that relate to perception. 1) Categorial objects are the ideal symmetries (invariants) that objectively define general essences as ideal objects; these are *interior* (mental) objects and ignore any background horizonal constraints that may condition possible fulfillments in the World. 2) individual particulars are individual external space-time objects, present-at-hand or ready-to hand (*Vorhanden* or *Zuhanden*) that are given empirically as locally fulfilling the norms of the category; these fulfillments are merely factual, contingent, and prudential.

1) Categorial (mental) objects are given to consciousness through public representations, usually linguistic, of internal search programs that can find individual referents in the regulated motor-sensory sensory flux. Such search programs are (in their making) consciously 'symmetry-making,' and (in their use) consciously 'symmetry recognizing.' These search programs are constructed by consciously managing internally a stylized choreographed engagement between the embodied subject and a possible and imagined worldly object (Pribram 1991; Donald 2001; Heelan 2004). Once constructed, they are held unconsciously in long-term memory; they can be consciously revised at any time by new experiences. The search programs actively embody ideal normative conditions or relate to standard exemplars under imagined group-theoretic transformations. A symmetry is an ideal normative (categorial) unity in (motor-sensory) diversity of object-defining profiles (appearances) under the defining group-theoretically structured set of transformation functions that bring about the permutation of the profiles among themselves (Pribram 1991; Cassirer 1944; Heelan 2004). Consider, for example, the geometry of the space of human experience: its category can be Euclidean or non-Euclidean (see above). It is Euclidean when its function is to define a homogeneous public general-purpose space of unlimited extent; its metric is appropriately constituted by standard rigid rulers. It is non-Euclidean when its function is to provide an individual agent with the personal spaces adapted to some localized task; in this case the hyperbolic geometry is defined by measures of the three binocular angles (convergence, bipolar azimuth, and elevation) that are independent and mutually orthogonal variables in the geometry.

2) Individual objects are given as factual 'fulfillments' of categorial search programs. A fulfillment occurs when a local embodied subject, confronted by the empirical World and guided by the prudential dynamic of a specific inquiry, recognizes as given locally the presence of an individual object instantiating the normative standards of the categorial search program. Whether the categorial standards can be or are fulfilled is contingent on a number of factors: a) the individual case can be put under question; b) the background horizon of the case can be put under question; and c) the historical and cultural a priori structure of the subject's World can be put under question. Just as the search program is *symmetry-making*, so fulfillments are '*symmetry-breaking*' for they are individual and local, while the symmetries of the

search programs are general and non-local. Symmetry-breaking involves two steps. The first is a phase of union by physical 'entanglement' between the embodied subject and the profiles of the individual case as these are received, sampled, and tested by the motor-sensory system. Much more needs to be said of this phase, but not here (see Heelan 2004). The second phase is 'disentanglement' or 'objectification'; in this phase the object is recognized as being a found individual in the World of the given category, and other than, and separated from, the knower-subject; it has a place and a time and other concrete qualities that break the generality and symmetry that defines the search program. In Husserl's terminology, the first phase corresponds is the *noetic* phase of intentionality and the second is the *noematic* phase (Husserl, 1983).

In summary, from the point of view of phenomenology, a categorial object is *internal* (mental); its ontology is the symmetry of an internal search program characterized by this symmetry. An individual empirical object or instance is the product of an internal process of *constitution* whereby an external (space-time) instance of the category is recognized as fulfilling the normative conditions of the search program and as physically present in local space and time. A theoretical model of this process would represent *symmetry-making* and s*ymmetry-breaking* as two different and distinct symbolic operators acting on a symbolic model of the ideal state representation of the embodied subject-in-the-World.

In such a representation some pairs of operators would commute and others would not. They would commute only if there is a common background horizon that permits commutation; otherwise they would not commute. In such a model of the embodied-subject-in-the-World, the operators that define categories would be context-dependent with respect to the World, and those that define individuals would be context-dependent with respect to horizons of the World.

The general formal structure so described exemplifies in a striking way the same Hilbert space structure and Uncertainty Principles that characterize the quantum theory, in which the Hilbert space of the embodied-subject-in-the-World is partitioned by two sets of operators, those that define horizonal categories and those that define observational data; the operators in each set may or may not commute pair-wise with one another (Heelan 2004). This brings forward once again those questions relative to the proposed quantum structure of human embodied consciousness first posed by F. London and E. Bauer, and later taken up by J. von Neumann, E. Wigner, J. Wheeler & W. Zureck, K. Pribram, H. Atmanspacher, H. Primas, G. Farre, and the present author (see the references below) and many others not mentioned here .

Acknowledgments:

I am greatly indebted to many colleagues in many disciplines from whom I have learned much that shaped my thinking. I want to mention a few in particular. My mentors in physics and philosophy respectively were the late E. Wigner, Professor of Physics at Princeton University and Jean Ladrière, Professor Emeritus at the Catholic University of Leuven, repectively. Among colleagues, I have been influenced by H. Atmanspacher, Director of the Institut für Grenzgebiete der Psychologie und Psychohygiene at Freiburg i.B; B. Babich, Professor of Philosophy at Fordham University; J. Brough, Professor of Philosophy at Georgetown University; Heidi Byrnes, Professor of German at Georgetown University; G. Farre, Professor Emeritus of Philosophy at Georgetown University; K. Pribram, Distinguished Professor at Georgetown University; J. Schulkin, Research Professor of Physiology at Georgetown University; R. Sokolowski, Professor of Philosophy at the Catholic University of America; and many others to all of whom I offer my warm thanks and friendship.

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