On Critical Representation in Brain Theory, Part I: Critique

I. The Knowledge Representation Problem

A sound and objectively valid solution to the problem of knowledge representation has long been understood to be crucial for a science of brain theory. This has been noted not only by philosophers but also by neuroscientists, engineers, and those who work in the fields called artificial intelligence and computational intelligence. Neurophilosopher Patricia Smith Churchland wrote,

> A paramount reason why . . . neurobiologically based theories of brain functions will be of interest to philosophers is that they may contain the foundations of a new paradigm for characterizing representations and computations. To the extent that they do so, they constitute a counterexample to those who argue for a uniquely psychological theory of representations and computation.
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> A characterization of the nature of *representations* is fundamental to answering how it is that we can see or intercept a target or solve problems, whether we consider these accomplishments in psychological terms or in neurobiological terms. The same is true of the *processes* operating on representations – the computations. Questions concerning representations and computations have long been at the heart of philosophical theories about the way the mind works, and it is clear that they are now central to neurobiological theorizing about the way the brain works. [Churchland (1986), pg. 9]

Churchland is correct and this is generally acknowledged by most neuroscientists. Some object to calling brain processes "computations," but the word "computation" has no *technical* definition in mathematics, computer science or engineering. It is nothing but a loose synonym for the words calculation, appraisal, estimation, numbering, reckoning, counting, valuing or rating. To say the brain "computes" is to say *nothing specific*.

But speculations that neurologically-based theories of brain functions "might contain the foundations of a new paradigm for characterizing representations and computations" lack fecundity. It is not an unreasonable speculation for an ontology-centered metaphysic, but Critical metaphysics warns us *no* ontology-centered metaphysic will ever be capable of guiding us forward to the attainment of objective validity in a common understanding of Nature. Ultimately all ontology-centered systems of metaphysics come up against irresolvable antinomies and paradoxes, and all eventually must resort to calling upon some sort of deity to rescue their foundation premises. It matters not if the deity is personified as some sort of supernatural being or if it takes on the no-less-empty form of a god of probability, as it does in stochastic theories. The rescue is by means of an unnatural hypostasis that brings all further *scientific* inquiry to an end.

For theoretical neuroscience the problem of representation is central to discovering if there is some "neural code" or "neural coding" or "neural language" present as part of the functioning and structure of the brain. It is hypothesized that such a code, if it exists, might provide a crucial key for understanding human psychophysical phenomena. The neural coding hypothesis traces its origin back to the work of John von Neumann in the 1940s and 50s. Von Neumann wrote,

> Pursuing [the subject of the brain] further gets us necessarily into questions of *language*. As pointed out, the nervous system is based on two types of communications: those which do not involve arithmetical formalisms, and those which do, i.e. communications of orders (logical ones) and communications of numbers (arithmetical ones). The former may be described as language proper, the latter as mathematics.
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> It is only proper to realize that language is largely a historical accident. . . [The multiplicity of human languages] proves that there is nothing absolute and necessary about

> them. Just as languages like Greek or Sanskrit are historical facts and not absolute logical necessities, it is only reasonable to assume that logics and mathematics are similarly historical, accidental forms of expression. They may have essential variants, i.e. they may exist in other forms than the ones to which we are accustomed. Indeed, the nature of the central nervous system and of the message systems that it transmits indicate positively that this is so. We have now accumulated sufficient evidence to see that whatever language the central nervous system is using, it is characterized by less logical and arithmetical depth than what we are normally used to. . . Consequently, there exist here different logical structures from the ones we are ordinarily used to in logics and mathematics. . . However, the above remarks about reliability and logical and arithmetical depth prove that whatever the system is, it cannot fail to differ considerably from what we consciously and explicitly consider as mathematics. [Neumann (1956), pp. 80-82]

One must not understand von Neumann's use of the word "language" anthropomorphically. What he calls a *language* modern computer science calls a *formal language.* The topic of formal languages constitutes an important sub-area of research in computer science and automaton theory[1]. One must also note there is no implication here that a human being is born knowing how to do arithmetic or formal logic, or with some built-in prototype "meta-natural language." Von Neumann merely means that the formal representation (modeling) of the brain will be such that we will see in this description factors that are arithmetical, logical, and formal-language-like *in form*. *If* von Neumann's proposition is correct – namely, if there is a formal language or languages using some one or more forms of neural codes innate in the brain-object – then likewise there must be something present in brain-object structure and signaling processes that stands as the representation of this. But to know whether or not this is so, it is first necessary to be able to define in specific enough terms what "representation" is so that we can empirically recognize it.

By definition, the brain-object belongs to physical Nature and to the *homo phaenomenon* aspect of being a human being. This means that in all its appearances, brain-object phenomena are strictly bound to the metaphysical requirement of physical causality, i.e., that its next state of *Existenz* is partially determined by its present state and partially determined by its interactions with its physical environment. This means for *soma* that the sensible appearances of brain-object must be understood in the form of an automaton[2]. This requirement is the consequence of a Critical acroam in mental physics called *Margenau's law* [Wells (2009), chapter 9].

The automaton character of *soma* establishes a theoretical point of connection with the problem of knowledge representation in such crafts as artificial intelligence. On the whole it is fair to say that engineers in this and related technical arts have invested considerably more time to trying to understand the representation problem than have neuroscientists. Engineers tend to approach the questions pragmatically rather than philosophically – although they have discovered that their work, too, is profoundly confronted with metaphysical questions – because in the end they must *build* something and that something is certainly not a human brain, much less a human mind. The aim of these researchers is to invent and develop what are typically called "intelligent agents." Again though, the word "intelligent" in this technical context means something quite different from what "intelligent" means to a psychologist. Hence the qualifying adjective "artificial" or "computational" is always implicitly understood to modify the term "intelligence" in their technical lexicon. To forget or neglect this is to commit an ontological error in understanding. The engineer's pragmatic interest in the representation problem is well described

[1] see, e.g., Hopcroft and Ullman (1969)

[2] This is a direct consequence of the merely logical mind-brain division in the study of *homo Sapiens*. It is very different for the case of *nous* because the logical division of *nous* belongs to the *homo noumenon* aspect of being a human being. Regardless of the fact that brain-object must be understood as automaton, the Organized Being (human being) *as an organic whole* cannot Critically be so regarded.

in the following way:

> In computer science, a good solution often depends on a good representation. . . For applications in artificial intelligence, this initial choice of representation is especially important. This is because the possible representational paradigms are diverse and the forcing criteria for the choice are usually not clear in the beginning. Yet the consequences of an inadequate choice can be devastating in the later stages of a project if it is discovered that critical information cannot be encoded within the chosen representational paradigm. . . This is because the representational primitives, together with the system for their combination, effectively limit what such systems can perceive, know, or understand. . . By "representational primitives" I mean to include not only primitive concepts but (especially) the primitive elements and operators out of which an open-ended range of learned concepts can be constructed. [Woods (1986)]

It is important to know that when engineers in these fields use words like "perceive," "know," "understand," and "concept," their usage of these terms is something quite other than the Critical real explanations of these objects in mental physics. They are defined terms, i.e., nominally-named mathematically-defined objects, and the definition is always by the fiat of the engineer who then uses them. If an engineer says his machine "thinks," he means something far different from what people outside his field mean by this word. Whatever intent lies behind the naming of these objects, the language itself is very misleading and this misleading character is abusively exploited in the marketing of products. What can justly be said in defense of the naming practice is that it is used to establish metaphors between machine capabilities and human intellectual and behavioral capacities. These metaphors help guide the engineer's reasoning in design[3]. Nonetheless, the fraudulent marketing abuses cannot be justified.

Like most people who hold with pragmatic outlooks in their personal systems of pseudo-metaphysics, automatists tend to distinguish between a "real world" and the "machine model of the real world." Woods put it this way:

> It is important to realize that the reasoning [of the artificial agent system] involved here is dealing with a model of the world, not the real world. The model imposes an abstraction on the real world, segments the world into entities, and postulates relationships among them. Reasoning systems can draw conclusions about entities and propagate the consequences of assumptions, but do not deal directly with the world. Perceptual processes interact with the world to populate the internal model. Actions performed by the agent can affect both the external world and the internal model. These distinctions are fundamental for keeping track of what's going on in the knowledge base of a reasoning agent. [Figure 1] illustrates some elaborations of the basic reasoning loop to begin to take account of this distinction. Notice that at the point of action, there is an element of expectation introduced into the model to record the effect that the action is expected to have. Expectations have two roles: 1) the intended effect is modeled directly in the internal model of the world, and may be compared with the system's perceptions to determine if the action has succeeded, and 2) expectations condition perception by preparing the system to perceive what is expected (with consequent risks of perceiving only what is expected. [*ibid*.]

Figure 1 is a slightly-modified version of the figure Woods presented in his paper. One thing that immediately stands out in Woods' conception of the agent system is that the functional constructs within it have a context that could *metaphorically* be named "machine psychology" but not what can properly be called "brain function." Critical analysis agrees that a machine's so-called "psychology" is necessarily buffered from the external physical world.

[3] It should also be noted that some workers in this field take their metaphors far too literally and come to convince themselves that what they do really is directly related to the phenomenon of mind. This is merely childishly Platonic romanticism, however, and thoroughly unscientific.

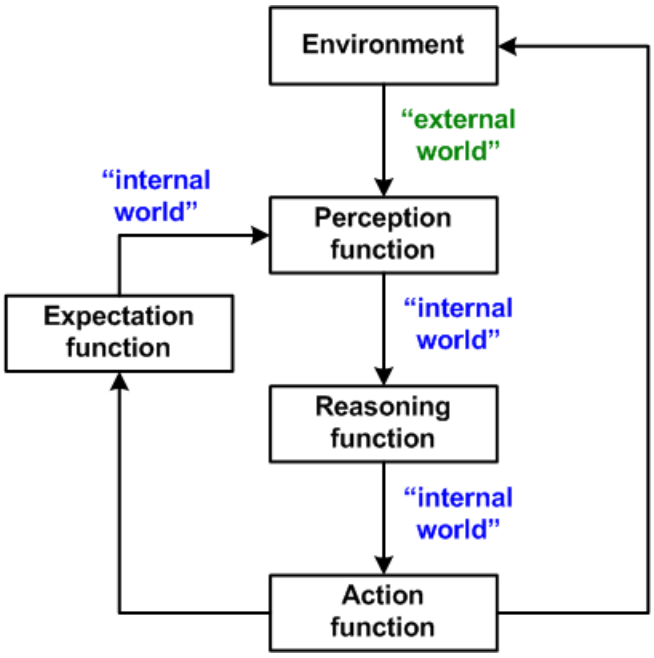

Figure 1: Woods' model of an artificial agent modeling of its environment.

On the other hand, mental physics also tells us Woods' model is far too oversimplified to stand even as an approximation of *human* mind capacity. Like theorists in other technical fields, those in Woods' field, consciously or not, must and do establish a "master point of view" in order to, in a manner of speaking, "look down upon the machine and its world." The engineer's role, as the inventor and creator of the machine, might be likened to the role typically assigned to a god in religion and, indeed, there is a pronounced Augustinian flavor in this designer's convention[4]. It is not a surprise that the human creator of the machine sets up its "world" in such a manner that, intentionally or not, an ontology-centered metaphysic *defines* it. And this is a sufficient Critical reason to conclude that machines designed according to such paradigms cannot succeed as models of human intelligence.

One consequence of this is that the researcher tends to drift into Platonism when he sets up a division between a "true world" and a "world of opinion." For example, Woods tells us

> Another way [of viewing the world and our perception of it] is that the world is as it is, and is too complex and detailed to ever be captured or even fully conceived by any reasoning agent. In this view, the world as it presents itself to our senses is the ultimate reality, and the ideal models we construct are just that – models – whose fidelity is traded off against the simplicity and efficiency of their use. From this perspective it is not necessary to postulate objective reality for the idealized models, but only to consider them from the perspective of their utility in predicting the behavior of the world. All that is necessary is predictability within sufficient tolerances of precision and accuracy so that the reasoning agent can achieve its goals well enough for the species to survive. One model can be more "true" than another in that it predicts more than the other, and there can even be incomparable models that predict different things, each of which is equally "true" (faithful). [*ibid.*]

This Platonism is often mistaken for scientific materialism. It introduces a prejudicial and false

[4] It is interesting, and not unentertaining, to contrast the engineer's modeling paradigm with Augustine's theology in books XI and XII of *Confessions*.

presupposition of a copy-of-reality mechanism – which every ontology-centered metaphysic or pseudo-metaphysic eventually requires if it wishes to avoid being skewered by the thorough-going skepticism of Hume. Both Critical metaphysics [Wells (2006), chap. 3] and the research findings of developmental psychology [Piaget (1971), chap. 4] utterly refute the copy-of-reality hypothesis. The standpoint adopted by the engineer in regard to his machine is that which general system theorist Gerald Weinberg called a super-observer. Weinberg wrote,

> The first step in testing the consistency of two observers would be to neutralize the form of their observations. We thus give each observation . . . an arbitrary name. . . This translation has the further advantage of getting rid of the *substructure* of the observations when we are not concerned if the scope or grain differs from observer to observer. . . [Observer] ***A*** is said to be consistent with [observer] ***B*** if *he never gives two different symbols for one of* ***B****'s symbols.*
>
> Mathematically, we characterize this situation by saying that there is a *many-to-one mapping* from ***B*** onto ***A***, but a *one-to-many mapping* from ***A*** onto ***B***. Since one symbol of ***A*** may map into any one of several of ***B***'s, ***B*** is inconsistent with ***A***, even though ***A*** is consistent with ***B***. . . Since ***A*** is consistent with ***B***, his observations add nothing to those of ***B***. . . We can dispense [with ***A***] if we have [***B***] for [***B***] *dominates* [***A***] as an observer. . .
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> In this discussion, we have been assuming a special position for ourselves, a point of view that is labeled "our view" . . . It is very easy to slip into imagining that we can somehow get "above the table" when talking about other people's viewpoints, but we really have no reason to believe that we have such super powers of observation. For simple cases, however, we can talk about different points of view if we are willing to introduce an explicit fiction – the "superobserver." It will not be necessary to endow our superobserver with omniscience, but only with a viewing capacity dependent on the abilities of other observers present. . . In fact, we can define our superobserver's capacities precisely if we say that *his view must dominate the view of every other observer present*. [Weinberg (1975), pp. 74-78]

The significance of this for the representation problem is that even if the engineer can, as Woods pointed out, decide what "tradeoffs" he will make regarding his machine's capacity to "understand the world" – which influences the representation system or von Neumann "language" his machine employs – he is still stuck with the limitations imposed on his own ideas of what is and is not required for function and structure in representation. A super-observer he may be with respect to his machine, but not with respect to other human beings. Furthermore, if the goal is inventing machines that can be called "intelligent" *in the same way as human intelligence is regarded*, his doctrine of representation must match up with that of objectively valid theoretical neuroscience and, consequently, it must take its basis from mental physics.

II. Primitives

What is representation? There are two contexts in which this question could be asked. In the case of brain-theory, it is crucial to ask it in the correct context. The first possible context is to ask it as an ontological question, i.e., "What *thing* is representation?" Questions asked ontologically are questions seeking an explanation of the "essence" or "substance" of the object of the inquiry. Any possibility of answering the question in this context must rely upon a call to an existing metaphysic to supply the real meaning of the answer[5]. If that metaphysic is itself ontology-centered, we step beyond the horizons of possible human experience at the outset and immediately sacrifice scientific objective validity.

The other context is to ask this question epistemologically, i.e., "What are we to understand by

[5] Any metaphysic can be described as "the way one looks at the world."

'representation'?" Because what we seek is an objectively valid understanding of the *concept* of representation, this is the context in which the question must be asked. Here, although we seek a common understanding of 'representation' as an Object[6], there is an equally important second question that is implicitly attached to the first. The full question is really, "What is representation and according to who or what?" The second part pertains to what Critical epistemology calls the *Standpoint* of the question [Wells (2009)]. This is a pertinence too often overlooked in science. In the case of our present inquiry, the pertinence of the issue is illustrated by the situation of the engineer we have just discussed, i.e., whether the Standpoint is that of a super-observer or that of an "intelligent agent." For neuroscience and psychology this "intelligent agent" is the individual human being. Piaget wrote,

> The third major problem which arises in comparative studies is that of the nature of the structures arrived at, i.e. whether they constitute simple 'models' in the service of theoreticians or whether they should be considered as inherent to the reality under study, in other words as structures of the subject or subjects themselves. This question is fundamental, because in the eyes of authors critical of structuralism the latter[7] is merely a language or a computing instrument which refers to the observer's logic but not to the subject. This problem is often raised even in psychology, where experimentation is relatively easy and where one can in certain cases be fairly sure that structure reaches down to the underlying explanatory principle of phenomena, in a sense which recalls what the philosophers call the 'essence', but with the addition of an undeniable deductive power. But in disciplines where experimentation is difficult, even in the broadest sense as in econometrics, experts often stress the divergence they see between the mathematical 'model' and the 'experimental design', a model without sufficient relationship with the concrete being no more than a play of mathematical relations, whereas a model which adopts the details of the experimental design can claim the status of a 'real' structure. It goes without saying that in most situations the models used in the human sciences are placed, still more than physical and even biological models, halfway between the 'model' and the 'structure', in other words between the theoretical design partially related to the observer's decisions and the actual organization of the behaviors to be explained. [Piaget (1970), pg. 25]

Untangling Piaget's run-on sentences, the issue boils down to whether an explanation (model) is regarded as: (1) being merely an instrument of the theoretician; (2) as knowledge of the object-of-study; or (3) as a compromised hybrid "halfway between" the former and the latter. If the first, we have the standpoint of a super-observer, a godlike standpoint. If it is the last, it represents an acknowledgement on the part of the theoretician that he is no super-observer (merely an observer). But by holding the model outside that-which-is-being-modeled, his explanation is still, metaphorically speaking, the offering of a demigod. When we are dealing with the idea of a *primitive* in science, nothing else will do than to seek the explanation "in a sense which recalls what the philosophers call the 'essence'."

The technical idea of "representation" is such an idea. Critical metaphysics tells us that the primitives of a science can never have an objectively valid explanation except one which is *practical*. This means the explanation is in terms of what *actions* provide the idea of the primitive with its root meanings. It has for centuries been the unwholesome practice of science to posit some objects as primitives without any sort of explanation of these terms being offered. The most common excuse for this omission is that such terms "are well understood by all." Newton, for example, used this excuse in *Mathematical Principles of Natural Philosophy* with his primitives of absolute time, absolute space, absolute place, and absolute motion. He spent a considerable

[6] An ontology-centered metaphysic does not seek to understand objects but, rather, *things*. There is an important Critical distinction between an object (*Gegenstand*), an Object (*Objekt*) and a thing (*Ding*).
[7] structuralism

number of words explaining what other ideas, e.g. "common time," meant with respect to these primitives, but the primitives themselves were left unexplained. Later history testified that these ideas were in fact *not* "well known to all," and Einstein succeeded in demonstrating the *meaninglessness* of Newton's primitives in his first (1905) paper on the special theory of relativity. The theory of relativity was born with *epistemological* parentage [Einstein (1905].

Mathematics, too, has been for the most part rather too cavalier about its primitives. Bertrand Russell wrote,

> But, though familiar, [natural numbers] are not understood. Very few people are prepared with a definition of what is meant by "number," or "0," or "1." It is not very difficult to see that, starting from 0, any other of the natural numbers can be reached by repeated additions of 1, but we shall have to define what we mean by "adding 1," and what we mean by "repeated." These questions are by no means easy. It was believed until recently that some, at least, of these first notions of arithmetic must be accepted as too simple and primitive to be defined. Since all terms that are defined are defined by means of other terms, it is clear that human knowledge must always be content to accept some terms as intelligible without definition, in order to have a starting point for its definitions. It is not clear that there must be terms which are *incapable* of definitions: it is possible that, however far back we go in defining, we always *might* go further still. On the other hand, it is also possible that, when analysis has been pushed far enough, we can reach terms that really are simple, and therefore logically incapable of the sort of definition that consists in analyzing. [Russell (1919), pp. 3-4]

It is noteworthy that Nelson's *Dictionary of Mathematics* does not actually define "number." It instead presents the terms "natural number," "integer," "complex number," "real number," "rational number," "irrational number," "cardinal number" and "ordinal number" as *examples*. It nowhere tells us what this thing-called-number is that is modified in context by these adjectives.

Yet Russell, far better than Newton, came within a whisker of putting his finger on the Critical solution to the problem of primitives. Perhaps it was only his own ontology-centered prejudices that stopped him short of this achievement. The "human knowledge" of which he wrote is that subspecies of knowledge[8] Critical metaphysics calls *objective* and which belongs to the manifold of concepts in *nous* [Wells, (2009)]. Analysis, put in ordinary words, means breaking down a concept into parts, each of which represents something that is regarded in some context as being "simpler" or "more primitive" than the concept from which it is drawn. As all concepts represent objects of one kind or another, when one reaches a point where one is "logically incapable of the sort of definition that consists in analyzing," what this means is that one's understanding has reached the point of what Kant called ***the horizon of possible experience*** and is now dealing with what Critical epistemology calls a *noumenon*. Figure 2 illustrates this idea of the horizon of possible experience and the *noumena* that stand as its "outer boundary markers."

All objective analysis, pursued far enough, eventually reaches this point, and there *ontological* analysis must cease if objective validity is to be retained. This, however, is not the same thing as reaching the end of explanation. When further objective explanations are impossible, we still have recourse to *practical* explanations. Kant tells us that a *Realdefinition* ("real definition") is a practical definition, i.e., contains a clear mark by which the object (of the definition) can always be *recognized* and makes the concept to be explained *usable in application*. All ideas in science that are taken as primitives require practical *Realdefinition*. The Critical term *practical* means *pertaining to actions or to the determination of the appetitive power of an Organized Being* [Wells, (2009)]. This means no more and no less than that *all real meanings are at root practical*.

[8] Knowledge (*Erkenntnis*) is any conscious representation or capacity for making such a representation by or through which meanings are determined.

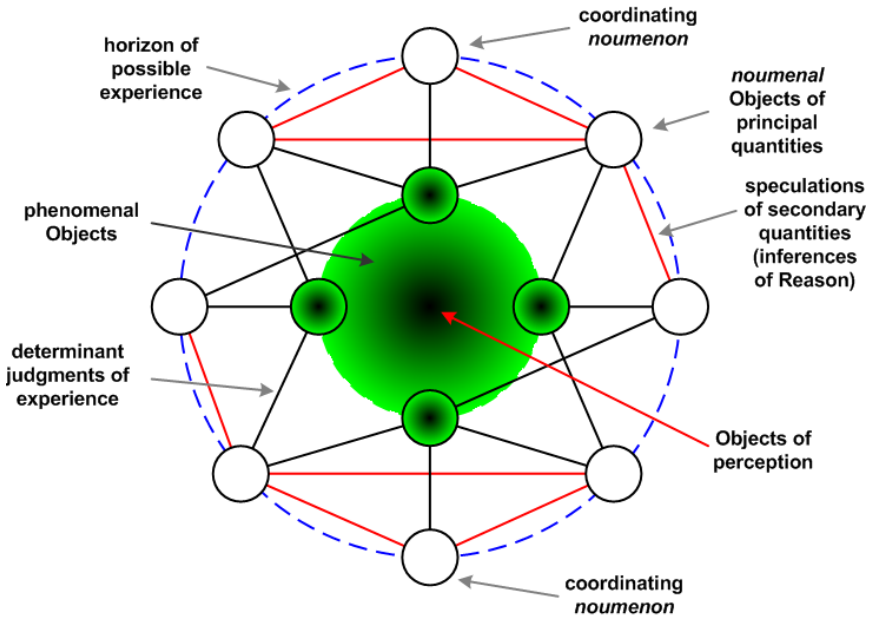

Figure 2: The structure of Critical scientific ontology.

This Critical theorem has consequences testable by psychology, and when these are put to the test the findings are congruent with Critical predictions. Piaget and Garcia concluded,

> It follows that an object is a set of conjoined predicates and its meaning amounts to "what can be done" with it, and is thus an assimilation to an action scheme (whether the action is overt or mental). As for actions themselves, their meaning is defined by "what they lead to" according to the transformation they produce in the object or in the situations to which they are applied. Whether we are dealing with predicates, objects, or actions, their meanings always implicate the subject's activities, which interact either with an external physical reality, or with elements that were previously generated by the subject, such as logico-mathematical entities.
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> Furthermore, we may distinguish various degrees in meanings: They may remain "local" in that they relate to limited data and to particular contexts; they may become "systemic" in laying the groundwork for structures; and finally they may become "structural" when they pertain to the internal compositions of already constituted structures.
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> As for the meaning of meanings, it is that they [meanings] are only the instruments for understanding, in contrast with mere observations which, before being endowed with meanings, can only provide extensions devoid of any intelligibility. [Piaget and Garcia (1987), pp. 119-120]

It is a credit to Woods' model (figure 1) that the "internal world" of his reasoning agent has its representation sourced, both immediately in "expectations" and mediately in "perception," from the action functions of his agent. This is the case for all objectively valid primitives in science. We must consider the question of "representation" from this practical Standpoint.

III. Representation and Representations Regarded Metaphysically

Representation is a primitive in Critical epistemology. As such, its definition can only be a practical definition. This, in turn, fixes its context to the individual human being who is said to do the representing and make for himself the representations. A *theory* and a *doctrine* of representation must start from this basis. Kant recognized this as early as the 1750s. In his hand-written notes from this period, preserved in the Academy collection of Kant's work, we find,

> Representation is mental determination where a thing is being referred to as if it were separate from myself (that admittedly I did not regard as a representation). [Kant (*c*. 1753-59), *Die Vernunftlehre*, 16: 76]

Here the action is the *making* of a mental transformation, *viz*. mental determination (a mental phenomenon logically assigned to the division of *nous*), yet also an action with *meaning* vested in either an immediate connection to some phenomenon (*noumenon* standing as cause to some sensible object as effect) or through mediate connection to sensible phenomenon (a coordinating *noumenon*; refer to figure 2 for illustration of this terminology). We can see that even during what is today called "Kant's pre-Critical period," his metaphysics was already beginning to take on the root-practical character that constitutes its foundations. Kant never departed from this basic way of looking at the question of representation. Years later (1794-5), we find him holding to this early understanding:

> What representation is in itself is inexplicable. A definition of it cannot be given because a representation can be explained only and in no other way than when one again represents a representation to oneself, hence there is lacking grounds of cognition in the logical sense. This act of mind can be described as something in me that refers to something other. This reference to this something other in me is representation now taken subjectively. The representation is aimed in part *at the Object*, to which I am referring, in part *at that action of mind* through which I compare something in me with the Object. [Kant (1794-5), *Metaphysik Vigilantius*, 29: 970]

Although this might seem at first look to refer to a twofold character of representation (the mental action and the Object), closer Critical examination reveals that the character of this primitive is *threefold*: the action, the object referred to, and the mental "depiction" that we posit as the immediate outcome of the action (what we usually would call "the representation" resulting from "the representing action"). This is because: (1) a Critical Object represents the unity in a disjunction between a "something other" (the object proper) and the "depiction" or "mental picture" the human being makes (a mental schematic); and (2) representation is an act of mental synthesis and synthesis always involves *three* terms, e.g., the determinable, the determination, and the determining factor [Wells, (2009)]. To represent is to synthesize.

It is probably quite evident that this rather abstract explanation needs further refining if we are to make the idea usable in practice. A reasonable starting point is to deal first of all with a severe limitation in the English language, namely the homonymous use of one word, representation, to refer to two distinct contexts (the action and the outcome of that action). It is an unfortunate accident of natural language that neither English, German, nor Latin contain distinct words distinguishing these homonymous contexts. Over twenty-three centuries ago, Aristotle warned of the baneful effect of using homonyms in science:

> When things have only a name in common and the definition of being which corresponds to the name is different, they are called *homonymous*. Thus, for example, both a man and a portrait are animals[9]. These have only a name in common and the definition of being which corresponds to the name is different; for if one is to say what being an animal is for each of them, one will give two distinct definitions. [Aristotle, *Categories*, 1^a1-5]

Antoine Lavoisier, the great 18th century chemist, repeated and amplified Aristotle's warning:

> The impossibility of separating the nomenclature of a science from the science itself is owing to this, that every branch of physical science must consist of three things: the series of facts which are the objects of the science, the ideas by which we represent these facts,

[9] ζώον. In ancient Greek this word had two meanings: a living creature and also a figure or image of one in a painting, embroidery, or sculpture. English does not contain this particular homonymous usage of animal.

> and the words by which these ideas are expressed. Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact. And, as ideas are preserved and communicated by means of words, it necessarily follows that we cannot improve the language of any science without at the same time improving the science itself; neither can we, on the other hand, improve a science without improving the language or nomenclature which belongs to it. However certain the facts of any science may be and however just the ideas we may have formed of these facts, we can only communicate false impressions to others while we want words by which these may be properly expressed. [Lavoisier (1789), *Elements of Chemistry*, preface]

Representation as an act and in action is a primitive ability of *nous* within mental physics' three-way logical division of the human being in terms of *nous*, *soma*, and *psyche*. The *outcome* of this action is also called a "representation" (whether in English, German, or Latin) and we typically depend upon our recognition of the context in which the word is being used to tell us the difference between these homonymous usages. Often this context is clear enough that what is meant is unequivocal, but this is not always the case. For those cases where equivocation in meaning is not unlikely, it is wise to have two terms, one for the making of the determination (*repraesentatio*, "representing") and one for the determined outcome (παράσταση, *parástase*, "depiction"). We may then reserve the word representation (*Vorstellung*) for the synthetic unity of the depiction (*parástase*) and the making of this depiction (*repraesentatio*).

We can now see that the *real meaning* of the primitive term *representation* is vested in an ability of the representing subject (that is, the human being) and, consequently, refers to something entirely *subjective* in human mental Nature even though the idea of representation-as-Object always contains under it that-which-representation-depicts (an object). As we have to deal here with a *noumenon* in Nature, *practical explanation* of representation must recognize that this subjective ability is *logically understood* in terms of an existence predication. This logical (which is to say conceptual) understanding is formally understood in Critical epistemology as a combination of two factors: (1) a *composition*; and (2) a *nexus* or connection with other concepts through which the concept of the object is provided with a ***context*** and obtains a meaning. The first pertains to the *parástase* of "what-exists" while the second pertains to the *repraesentatio* of "how-it-exists." *Dasein* is existence in the context of what-exists, *Existenz* in how-it-exists.

This *logical structure* is called a first level analytic representation or 1LAR in mental physics and is diagrammatically represented as illustrated by figure 3. Composition ("what-exists") is called the ***matter*** of representation while *nexus* ("how-it-exists") is called the ***form*** of representation. It is important to note here that we are now moving away from ontological context (which is the context of an object) and into *mathematical* context, which is the context of *Object-theory* in epistemology-centered metaphysics. Representation-as-object is a *noumenon* placed at the very boundary of the horizon of possible human experience, and the Critical consequence of this is that all further elucidation and explanation of representation can only be of a *mathematical* nature in accordance with the Critical doctrine of method [Wells, (2011a)].

Now, while the 1LAR structure is a synthetic union of composition and *nexus*, what one quickly discovers is that this merely pushes the explanation problem "down one level" and leaves us faced with explaining composition and *nexus*. These, too, are but mathematical ideas and this means their representation-in-detail proceeds by means of making *another* analytical division, resulting in a *second level* analytic representation or 2LAR. Figure 4 depicts this structure.

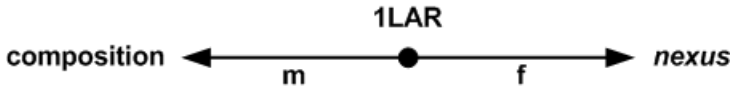

Figure 3: First level analytic representation. m denotes matter of representation, f denotes form.

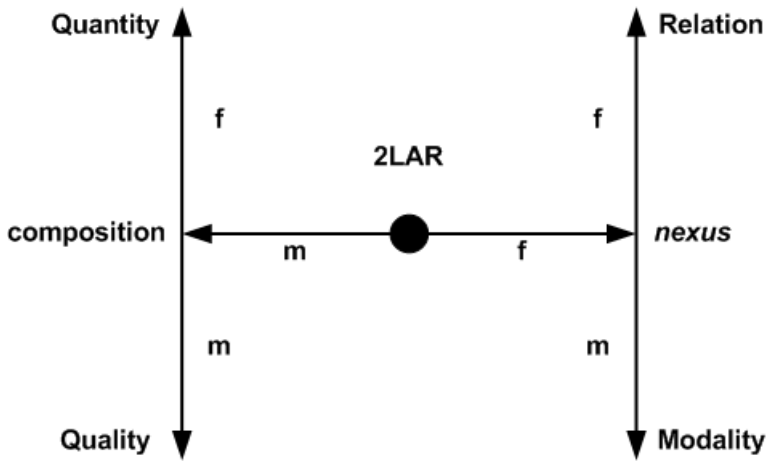

Figure 4: Structure of a second level analytic representation. Technical terms are used at this level to denote matter of composition (Quality), form of composition (Quantity), matter of *nexus* (Modality), and form of *nexus* (Relation). Note that these terms are always capitalized to denote their technical context.

This process of analytical division can be carried out howsoever far the analyst wishes to take it, producing a 3LAR, a 4LAR, etc. What we see here is the analysis to which Russell earlier referred. At some point in this analysis process, though, the analyst will come to an end of the division process, if for no other reason than that it is not *actually* possible for anyone to make an infinite number of such divisions. It is at this point where *synthetic* functions of representation must be taken into account.

IV. The Schematic Structure of Representation and Representations

In hypothetical mathematics and in abstract formal logic (whether classical or symbolic logic), this accounting is formally ignored. However, no representation (*parástase*) satisfies a purpose unless that representation is meaningful. Formalism in mathematics and logic remove through abstraction all notions of purposes in their representations, and by doing so sever the necessary linkage between what Slepian called the mathematical world, facet B, and the physical world, facet A [Wells, (2011a)]. This is not so in the case of Kant's transcendental Logic.

Transcendental Logic was introduced by Kant in *Critique of Pure Reason*, although he lectured about it in the years preceding the publication of that work. Kantian Logic *differs essentially* from the merely formal logic systems that are taught in school, although it does borrow heavily from the terminology of the scholastic logic of the Middle Ages. A fuller discussion of the differences and reasons for these differences between Kantian Logic and formal logics is provided elsewhere [Wells (2006), chapters 4 and 7; Wells (2011b)]. Kantian Logic regarded from the practical Standpoint is what Piaget called a *logic of actions*. From the theoretical Standpoint it constitutes the laws of human understanding and cognitive reasoning, and from the judicial Standpoint it constitutes a transcendental Aesthetic of human sensibility. To paraphrase Kant (*Kritik der reinen Vernunft*, B: 79-82), transcendental Logic takes into account the sources, domains, and objective validity of human knowledge. It has to do with the *a priori* laws of human understanding and reasoning. It does not do away by abstraction with the Object of human cognitions, like formal logic and formal mathematics do, but, on the contrary, informs what we know and think about objects generally.

For a 2LAR to *mean* something, it must be possible to re-traverse back from the ending points in Quantity, Quality, Relation, and Modality to re-arrive at the synthetic unity *in* the representation (*parástase*). To do so requires that the logico-mathematical method include *synthesizing functions* at each endpoint in the 2LAR. These are called *momenta* in mental physics

and it is the mathematical Nature of synthesis that each heading (Quantity, Quality, etc.) requires *three momenta* in order to form a complete set of synthesizing functions [Wells (2009)]. Thus, a complete 2LAR representation always has 81 combinations of *momenta* (3 each in 4 headings for $3^4 = 81$ total) in producing possible synthetic contexts for the *objective* function of the 2LAR. One should note that this logico-mathematical character of 2LAR representation pertains to the *Existenz* of representations, i.e. "how it exists" rather than to "that-it-is" (*ens*, *Ov*, i.e., existence in terms of *Dasein*; one literal English rendering of *Dasein* is "here-be").

Because the *Existenz* of representation-in-general has only a practical and mathematical explanation[10], Kant treated it in his lectures and publications on logic. Representation theory is a logico-mathematical theory and belongs to what I have elsewhere called Critical mathematics [Wells (2006), chapter 23; Wells (2011a)]. Kant tells us,

> All our cognitions can be regarded in a twofold interrelation:
>
> 1. In regard to the object. This is representation[11].
> 2. In regard to the Subject [Kant refers here to the human being who represents]. This is consciousness of the representation.
>
> . . . In all knowledge, matter and form are different. Matter means the object, form the way of recognizing the object. [Form] becomes [recognition] from consciousness. A cognition of which I am conscious is called clear. If I am not conscious of it, it is called obscure. Consciousness is the standard condition for all logical forms in our cognitions. Hence obscure cognitions are not Objects of logic because no logical rule that is obscure to us can help us.
>
> All our clear representations can be distinguished logically into distinct and indistinct representations. Indistinct representation is the consciousness of a representation as a whole but without distinguishing the manifold that is contained in the whole. Distinctness is clarity that also extends to the parts. [Kant (*c*. 1780), "The Wiener logic," 24: 805]

Elsewhere he tells us,

> What representation is cannot really be explained. It is one of the simple ideas that we necessarily must have. . . Knowledge and representation are taken in logic to be of the same sort. Every representation is something in us which, however, refers to something else which is the Object. Certain things stand for something, but we present things to ourselves. Logic does not teach us how we should represent something by means of consciousness, but rather it presupposes consciousness of something as a psychological event. . .
>
> The object that we represent is the *Object*, while the manner of the representation is called the *formal*. If, e.g., I represent a virtue then I can look in part to what I represent, in part to how I represent; the latter is the *formal*, the former the *material* in the Representation[12]. Logic has to do for the most part with the formal in cognition. Cognitions can have various forms in one matter, however. [Kant (*c*. 1770), *Logik Blomberg*, 24: 40]

That the theory we are dealing with is a transcendental Logic is clear from these remarks. Since the dawn of Hilbert's formalism and the rise to prominence of the Bourbaki mathematicians, mathematicians have given up reaching out to connect with Nature, but it is this connection that justifies and grounds the application of mathematics to empirical science. Russell and Whitehead were correct to point out the close affinity between formal logic and formal mathematics, but they

[10] The metaphysical understanding of representation-in-general pertains to the *Dasein* of this *noumenon*.
[11] i.e., *one* type of representation. There are also non-cognitive representations.
[12] Here Kant's lecture used the word *Representation* in place of *Vorstellung*. It is one of Kant's obscure technical terms and seems to correspond to the term *parástase* used in this paper.

were not so correct in trying to absolutely equate them and they were wholly incorrect, and unphilosophic, to mechanize them. Whatever trace amounts of good the Bourbaki movement in mathematics may have accomplished, on the whole this pseudo-philosophical radicalism has been a major blunder, a setback for mathematics, science and education, and has done much damage.

It is precisely because mathematical representation theory must maintain contact with Nature (facet A) that Kantian Logic requires synthesizing *momenta* at the termination point of every n-LAR. Without them analysis is no more than chopping apart an Object of representation and laying its severed parts in mere juxtaposition with one another. The synthesizing functions of representation *supply the explanation represented* from the practical, the theoretical, and the judicial Standpoints for a Critical applied metaphysic of the special science of the Object.

This brings us to an important pragmatical issue in representation. This is the combinatorial explosion in the complexity of the *system* of synthesizing functions encountered as the level of analysis is extended. A 2LAR requires 12 *momenta* ($3 \cdot 2^2$) and provides 81 (3^4) distinct synthetic functions. A 3LAR requires 24 *momenta* ($3 \cdot 2^3$) and provides 6561 (3^8) distinct synthetic functions. At the 4LAR level we have 48 *momenta* and over 43 million distinct synthetic functions. In general the number of *momenta* required by an n-LAR is $3 \cdot 2^n$ and the number of combinations is 3^m, $m = 2^n$. The analyst who sets out to mechanically go about his task will very quickly be overwhelmed by the resulting complexity to the point where his analysis is worthless.

Fortunately, however, we are not dealing here with contextless formalism. The Logic is transcendental, which means it is a logic of meanings, and this makes it possible for us to carry out a synthetic procedure based upon a functional principle called *the transcendental place and topic* of a representation [Kant, *Kritik der reinen Vernunft*, B: 316-346; Wells (2009), chapters 2 and 8]. A 3LAR can be regarded as the *synthetic combination* of two 2LARs. A 4LAR is the synthetic combination of four 2LARs, etc. Recombination via synthesis of any n-LAR as a synthesis of 2^{n-2} 2LARs can be carried out by successively applying twelve *general synthetic ideas of combination*. The general ideas are illustrated in figure 5 in 2LAR form.

We can call the ideas (*momenta*) of this 2LAR *the meta-functions of combination in general*. Their application to some specific Object always calls upon the synthetic addition of a specifying concept of the object being represented in order to provide the context of the idea in its specific application [Wells (2011c)]. The way in which this is done is illustrated throughout Wells (2006) and Wells (2009). What I shall do here is explain the general ideas themselves.

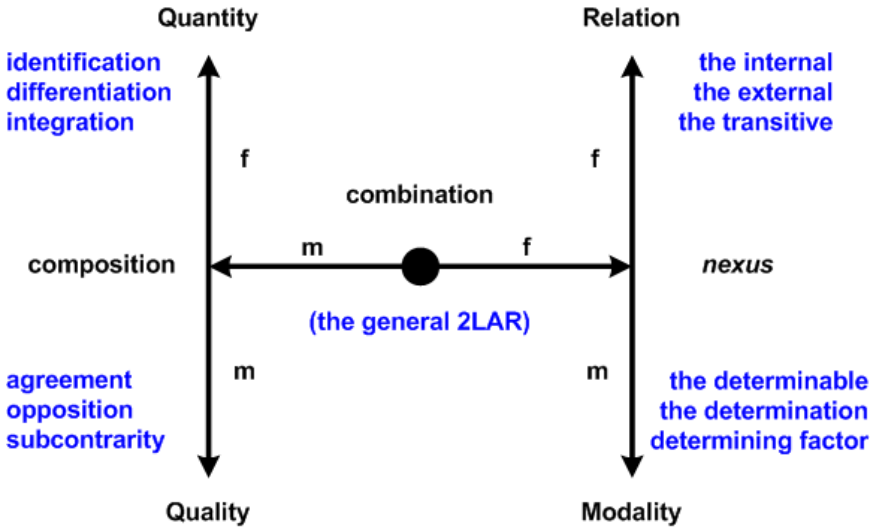

Figure 5: 2LAR structure of the general synthetic ideas of combination.

A. The general ideas of Quantity. A representation represents something and so all *momenta* of representation are required to convey to us *practical* meaning of what it is we are representing. Quantity in representation is the form-of-the-matter of a combination (*nexus* of a composition). Quantity is a *form of aggregation* and there are three ways in which a synthesis of aggregation can be made. **Identification** *identifies* the aggregation as being the representation (*parástase*) of a *singular object*. The ancient Greek idea of an atom and the mathematical idea of a Euclidean point are examples of employing the idea of identification. If I think of something as "*a* member of a set," I am regarding that something simply[13] and with identification-aggregation. Any actions undertaken, endowing a singular object with a practical meaning, act upon the object *as a unit-entity* and without attempting to in any way divide the object. **Differentiation** is the idea contrary to identification. It is aggregation as composition of parts. An object represented with the synthesis of differentiation is object-as-parts. If I think of something as "the members of a set," this is differentiation-aggregation. **Integration** is the synthesis of a totality of parts, i.e., a "whole-of-the-parts." If I think of something as "a-herd-of-cattle," this is integration-aggregation, a unification (but not an identification) of a differentiated composition. Obviously it is possible to think of any Object in any of these ways, and thinking of the Object in one of them does not preclude thinking of it (at some other moment in time) in either of the other two ways. These different ways of thinking aggregation-composition lead to different practical meanings for the representation. They also establish the *practical idea* of a mathematical *set* (its real explanation).

B. The general ideas of Quality. Quality is matter of composition (matter-of-the-matter of a combination). It is a synthesis of *coalition*, i.e., the melding or coalescing of homogeneous parts to produce a fusion in representation. Although the notion of "quality" has been in use in logic and in metaphysics since the time of Plato and Aristotle, it is interesting to note that neither Blackburn's *The Oxford Dictionary of Philosophy* nor Mautner's *Dictionary of Philosophy* provide a technical definition of quality. Nor is quality a technical term in mathematics according to Nelson's *Dictionary of Mathematics*. The Critical idea of Quality can be a difficult idea to grasp. Because it is clear that Kant adapted this term from Aristotle's "quality" when he applied his Copernican turn[14] to Aristotelian theory, it is appropriate to make a short digression and review how Aristotle viewed the idea of quality.

Aristotelian quality is one of the "ten categories" scholars today think he inherited from his teacher, Plato. Smith correctly points out,

> The names of most of the categories are, in Greek, interrogative or indefinite expressions: "what is it?" (*ti esti*); "how much?" (*poson*); "what kind?" (*poion*); "in relation to what?" (pros ti); "where?" (*pou*); "when?" (*pote*). Various abstract nouns have traditionally been used in translation ("quantity," "quality," etc.), and these are both convenient and in wide use, but they are not quite translations. [Smith (1995), "Logic," pg. 56]

Debate and controversy about how to view Aristotle's ten categories is long-standing. Are they highest *genera*, or predicates, or predications? Do they have ontological import? Logicians since the time of the Scholastics in the Middle Ages have tended to treat "logic" and metaphysics as two entirely separate doctrines, but it is quite clear to the unbiased eye that Aristotle's "science of demonstration" (Aristotle's actual name for what we today call Aristotle's "logic") is laced with basic metaphysical notions and ideas, and so divorcing his categories from his metaphysics is an

[13] "That thing whose act can at no time be looked at as the concurrence of many acting things is *simple*." Kant (1781), *Kritik der reinen Vernunft*, A: 351.

[14] Aristotle's metaphysics is ontology-centered, whereas Kant's is epistemology-centered. Much of what one finds in the Critical metaphysics bears a strong resemblance to Aristotle's system *after* that system is de-centered from ontology and recast as an epistemology-centered system. This is what is meant by the metaphor "Kant's Copernican turn" and the idea is like turning from Ptolemaic to Copernican astronomy.

error. Of the categories Aristotle tells us,

> Each uncombined word or expression[15] means either 'what' or 'how much?' or 'of what sort?' or 'related to what?' or 'where?' or 'when?' or 'to depend' or 'to have' or 'to make so' or 'how affected?'. [Aristotle, *Categories*, 1^b25]

This is a rather different rendering than the schools teach in the various "major" or "traditional" translations of *Categories*, but it is what the Greek text really says unfiltered by the distorting lens of tradition. Tradition *names* these terms, in the order above, *substance*, *quantity*, *quality*, *relation*, *place*, *time*, *condition*, *state*, *action* (or activity), and *passion* (or passivity)[16].

Of the "category of quality" Aristotle tells us,

> By quality I mean that by which things are said to be qualified. . . One form of quality let us call states and conditions. . . Another sort of quality is that . . . by which we refer to a natural capacity or incapacity. . . A third class consists of affective qualities or affections. A fourth kind of quality is the shape and form of each thing. [Aristotle, *Categories*, 8^b25-10^b26]

These are classifications of Aristotle's various examples of quality. His examples sometimes seem to overlap some of his other categories in some ways. The important idea for us to extract from *Categories* is the idea of "being qualified" or "distinguished" or "speciated" in some way. If we move off Aristotle's ontology centering and look at the issue in terms of *judgments*, what the Aristotelian predications above have in common is that each of the four makes some sort of attribution to a thing. The *fusion* of all an object's attributes constitutes a representation of the *Existenz* of that object *qua* its matter of composition. All such judgments are *synthesized* representations. Judgments of Kantian Quality in general representation are the fusing acts. There are three functional *momenta* for performing an attributing synthesis.

The synthesizing function of **agreement** predicates congruence of the attribute with the *Existenz* of the Object (e.g., "*x* is true of the object"). The synthesizing function of **opposition**[17] predicates that the attribute contradicts the *Existenz* of the Object (e.g., "*x* is-not true of the object"). Agreement is a transcendental affirmation, opposition a transcendental negation. There is, however, an important difference between being in *contradiction* to *Existenz* and merely being *contrary* to *Existenz*, as every logician knows. If *A* and *B* are contradictory then asserting "*Z* is *A*" necessarily means "*Z* is-not *B*" and vice versa. But if *A* and *B* are merely contrary then asserting "*Z* is-not *B*" does not necessarily mean "*Z* is *A*." In classical logic this is illustrated by the proposition "some *Z* are *A* AND some *Z* are-not *A*." This is called a *subcontrary proposition*. The *momentum* of **subcontrarity** is a synthesis function that converts contradictories of attribution to mere contraries of attribution in the representation (*parástase*) of the Object. This can be regarded as a "qualified qualification," e.g., "if *Z* then ⟨*X* is *Y*⟩ AND if not-*Z* then ⟨*X* is-not *Y*⟩." More generally, it *restricts predication*, i.e. "*X is* not-*Y*." If I say "Fred *is* not-a-German" I determine nothing about the Object "Fred himself" (not even that Fred is a man; he might be a dog). All I do is assert that "being German" is incongruent with "being Fred." The function of subcontrarity places *limitations on the contexts* in which the Object has meaningful *real* representations. It limits the Object's "place in Nature" insofar as the Object's manifold of real meanings is concerned, *but it does not determine anything else* about its meaning. Subcontrarity is a fusing

[15] said of something

[16] A strong argument can be made that if Aristotle's philosophical works were a child, history has treated it like an abusive stepfather. We are probably long overdue for a new, unprejudiced and *technical* translation of Aristotle's works to be made because the existing ones are a sorry and tattered lot indeed. It is one thing to take some license when translating Ovid or Homer, but something else altogether when translating the work of a scientist like Aristotle or Kant – and that something else is called malpractice.

[17] *Widerstreit.* This is opposition in the real sense, as when two objects cancel each other's effects.

function for objective *real contexts*, albeit a peculiar one since it is a negation *seen as* affirmation.

C. The general ideas of Relation. Critical Relation is the form of *nexus* (form-of-the-form in a combination). It pertains to what Critical terminology calls the material manifold (*physische Mannigfaltige*), by which is meant *the placement of an Object in Nature*. "Nature" here can be either physical Nature in regard to objects of sense or it can refer to the intelligible, i.e. the psychological, Nature of being a human being. It ties a representation (*parástase*) to other representations in a manifold of representation, and by doing so provides human understanding of the former with ***context***. Critical context (*Zusammenhang*) in understanding is the sphere of concepts, combined by judgment with the concept said to have the context, which delimits the applicable scope of that concept in Reality and places its object in Nature. Under Critical ontology all objects are real in some contexts, unreal in others, and non-real in yet others. *Contexts define the Reality of any thing*. Physicist-philosopher Henry Margenau wrote,

> Aside from concern for the general and the permanent (Greece), aside from an orientation toward the thing-like (Rome), our idea of existence is dominated by a lively measure of pragmatism. The real and the actual are close together; indeed the German word *wirklich*, though not implying anything like *res*, means nevertheless the same thing as real. Literally, *wirklich*[18] is that which acts, that which is capable of having an effect. In detail, the meaning of the word is loose, for it fails to signify whether the effect is to be on another object or on the mind. What is not real in the Roman sense may well be real in this. An idea is pragmatically real inasmuch as it may have important effects. [Margenau (1977), pg. 9]

In some ways Relation and Quantity are similar. Both are ideas of form. The difference is that Relation deals with placing the Object *in* Nature (*Existenz* in Nature) rather than with *Existenz* in an aggregate composition. Quantity is a composition of homogeneous representations; Relation is a connection of non-homogeneous representations *and with* this connection regarded as necessary *a priori*. By this I mean the connection is due to "the nature of Nature" and not to "the nature of the Object." Subsistence-and-inherence and causality-and-dependency are examples of this.

One manner of representing *Existenz* in Nature is when a manifold of non-homogeneous representations is viewed as connected *in* an Object. The synthesis function for this manner of connection is called the **internal Relation**. A second way is representing a connection of two different (that is, non-identical) representations. In this case, the material *nexus* is regarded in terms of the Objects being connected by something that is not contained in either Object as such but is nonetheless necessary due to "the nature of Nature." A representation of cause-and-effect is an example of this sort of connection. An example of an empiricist's line of reasoning regarding such a connection was well described by David Hume:

> It may, perhaps, be said, that after experience of the constant conjunction of certain objects, we reason in the following manner. Such an object is always found to produce another. 'Tis impossible it cou'd have this effect, if it was not endow'd with a power of production. The power necessarily implies the effect; and therefore there is a just foundation for drawing the conclusion from the existence of one object to that of its usual attendant. The past production implies a power: The power implies a new production: And the new production is what we infer from the power and the past production. [Hume (1739), book I. vi][19]

The synthesis function for this kind of connection is called the **external Relation**.

---

[18] more precisely, the adjective *wirklich* carries the English connotations of being actual, real, or genuine.

[19] There is a subtle difference between what Hume calls the "power" of the causing object and that which is the object of the representation of the connection. The Critical notion of this *connection* is called *causality & dependency*, and this notion is not regarded as "belonging to" either connected Object but, rather is something else that can only be regarded in terms of "the nature of Nature." To use a simile, what is represented by a *connection* of external Relation is like what a physicist represents by the idea of a "field."

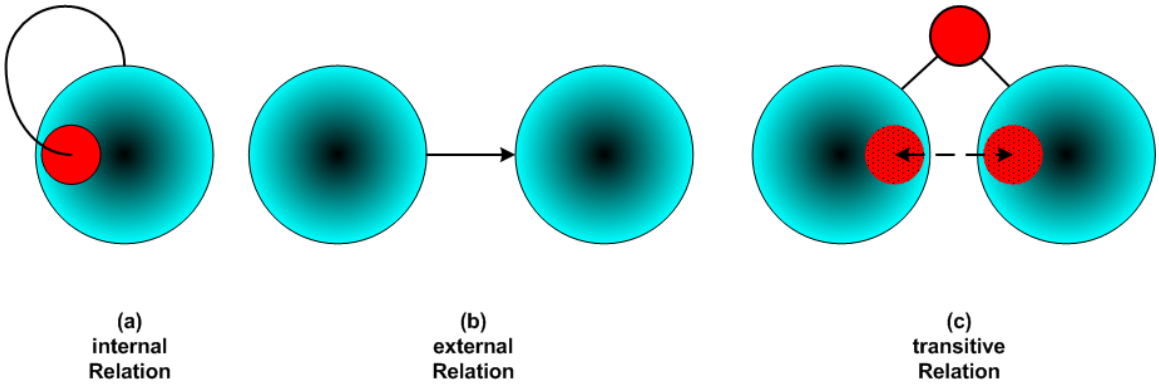

Figure 6: Graphical illustration of the ideas of internal (a), external (b), and transitive (c) Relations

Lastly, the third kind of representation of Relation is the reciprocally co-determining Relation, the synthesis function of which is called the **transitive Relation**. In some ways the idea of the transitive Relation is easy to grasp but in other ways it can be the most difficult of the three ideas of Relation (a situation hinted at in figure 6). Yet this Relation clears up a great many of the more famous perplexities in science, including the mind-body problem and the many puzzles that seem to defy "common sense" that an ontology-centered thinker finds himself confronted with by the theory of quantum physics. It is probably best to regard transitive Relation by means of a synthesis of the ideas of internal and external Relation. A couple of examples can serve to illustrate the character of this form of connection.

Consider first the predication "the ceiling is above my head." Here "the ceiling" is the subject term and "above my head" is the predicate term. But this relationship also and at the same time implies a second predication, "my head is below the ceiling." Now "my head" is the subject term and "below the ceiling" is the predicate term. Taking the two subject terms *in the context of their being objects* neither "above" nor "below" is a concept of any inherent objective property of either object. Nonetheless, the non-homogeneous representation "above AND below" is in some sense a common property of both since the two predications mutually imply one another, and to negate one of them ("it is not true that the ceiling is above my head") necessarily negates the other ("it is not true that my head is below the ceiling"). If we wish to put a name to the *parástase* represented by this example, the name "places" is probably as good as any inasmuch as "to always be in or at some place" is, so to speak, "in the nature of Nature." The "places" here are *co-determining*.

As a second example, consider the pair of predications "the desk is heavy" and "the table is heavy." Here, quite obviously, the state of the desk "being heavy" seems to say something about an inherent property of the desk but does not by itself imply anything about the table. The second predication would seem to stand independent of the first (and, in one particular context, it is). However, it is important to take note that "heavy" and "being heavy" are *not* the same concept. The *parástase* of "being heavy" can be truthfully applied to each subject term and, in this context, "heavy" *as an Object* "belongs" to neither of them but, rather, is something non-homogeneous that connects each in "the nature of Nature." In other words, in the context of "heavy" being regarded as an Object, if we observe something about the desk that leads us to say "the desk is heavy" and we also find this same something observed of the table, then we are *bound* to predicate "the table is heavy." We make a clear distinction between "heavy," "table," and "desk" if we predicate "the table is heavy *too*." In this context "heavy" is, in a manner of speaking, "given its own place in Nature" *outside* of "desk" and "table," and this is what figure 6(c) attempts to illustrate. Whatever occasions practically define "heavy" also *co-determine* a desk and a table as "being heavy" whenever we find those occasions presented in the representation of

these objects. "Being heavy" is no part of the composition of either the desk or the table but is part of their *nexus* in the manifold of Nature. "Being heavy" in this context "belongs to" *both* Objects *at the same time* and so in that sense "heavy" *also* belongs to *neither*. We see this situation in the construction of a logical relationship of disjunction, where the determination of one member of the disjunction also *reciprocally* implicates determinations of the other members. Representation of transitive Relation is at the very core of what it means to say a system is *organized*.

D. The general ideas of Modality. Critical Modality is the matter of *nexus* (matter-of-the-form in a combination). It pertains to what Critical terminology calls the metaphysical manifold, by which is meant the connection of the representation with the *subjective* state of the Organized Being (human being) who makes the representation. Every representation is a representation of a matter and a form. In general the *parástase* of representation can be formally regarded as a formula. One example is the *Dasein-Existenz* formula of an objective representation. In predicate logic the formula of a predication is *subject-copula-predicate*. In propositional logic the formula is usually *proposition*$_1$*-connective-proposition*$_2$. With regard to Relation a formula is like a connection of blank spaces, e.g., _____ – _____. Because *nexus* pertains to the connecting of one representation to another, something has to supply a rule for what representation is to occupy which blank and for how to set the manner of their connection. Such a rule is necessary for the connected representation to have a meaning. ***Judgment*** (*Urtheil*) in general is the act of subsuming a particular under a general rule. Regarded in these terms, a judgment of Modality is a *judgment of a judgment*.

For example, consider the following two predications:

time flies like an arrow;

fruit flies like a banana.

In the first predication "time" fills the role of subject-term and "flies like an arrow" fills that of the predicate. In the second, "fruit flies" is the subject-term and "like a banana" is the predicate. The word "like" denotes a simile in the first predication but denotes valuing in the second. It is probably fairly obvious to most people that a computer programmer attempting to make a computer produce grammatically correct English sentences might find it difficult to get the computer to properly distinguish between and handle these two examples by employing mere symbolic logic. Symbolic logic and its immediate predecessor (called the Port Royal Logic[20]) lack the Modality function[21]. The significance-and-meaning aspects of representation has its similarities to aspects of linguistic theory. Chomsky wrote,

> The central fact to which any significant linguistic theory must address itself is this: a mature speaker can produce a new sentence in his language on the appropriate occasion, and other speakers can understand it immediately, though it is equally new to them. Most of our linguistic experience, both as speakers and hearers, is with new sentences . . . Normal mastery of a language involves not only the ability to understand immediately an indefinite number of entirely new sentences, but also the ability to identify deviant sentences and, on occasion, to impose an interpretation on them. It is evident that rote recall is a factor of minor importance in ordinary use of language, that "a minimum of the sentences which we utter is learnt by heart as such – that most of them, on the contrary, are composed on the spur of the moment," and that "one of the fundamental errors of the old

[20] composed by Antoine Arnauld and Pierre Nicole, 1662. Refer to Kneale and Kneale (1962), pp. 315+.
[21] So-called "modal logic" also lacks the Modality function. This is because the de-evolution of Scholastic logic (misleadingly called "Aristotelian logic") from Aristotle's "science of demonstration" made an abstract removal of any ontological significance of the terms in a predication. In Aristotle's "science of demonstration," ontological significance was a key and central part of his system.

> science of language was to deal with all human utterances . . . as something merely reproduced by memory". [Chomsky (1964), pp. 7-8]

Computers can easily be made to handle formal languages, because these are logico-mathematical inventions and are easily describable as state machines (Hopcroft *et al*., 1969), but no computer so far can produce or interpret a natural language, in part because the theory of formal languages utterly lacks Modality functions[22].

The general idea of ***the determinable*** is the *momentum* (function) for *selecting* the matter of representation in a representation of connection. Put another way, it designates the parts of the manifold in representation to be connected in a *nexus*. The general idea of ***the determination*** is the *momentum* for *placing* the selected matter terms appropriately in the form of the *nexus*. Yet these two functions by themselves are insufficient for carrying out an act of representation. Still missing is the function for connection of the objective *nexus* in a relationship with the Organized Being who is doing the representing. This function of connection is called ***the determining factor***. One way to describe this is to say, "there has to be a reason the Organized Being takes the action that it does." Thus, the idea of the determining factor refers to a rule or rules governing the process of representation in the Organized Being, i.e., the human being. Figure 7 illustrates the overall process of the synthesis of Modality.

V. Signals, Information and Data

At the 2LAR-level of description, every *complete individual act* of representation calls upon one *momentum* function from each of Quantity, Quality, Relation, and Modality to go into the overall act of synthesis. Thus, for example, a particular act might be structured as

{integration, opposition, external Relation, the determination}.

There are, therefore, 81 specifically identifiable *constituted* functions of representation, comprised of four specific sub-operations, at the 2LAR level of description. If we enumerate the three *momenta* under each heading as (1), (2), and (3), each of the three possible acts of synthesis for that heading can be regarded as a synthesis of the other two terms (as "poles" of the synthesis) to produce the outcome result of the specific act. Using notation similar to that used in chemistry to denote a simple chemical reaction, these three forms of synthesis would be written

form (A) (1) + (2) → (3)

form (B) (1) + (3) → (2)

form (C) (2) + (3) → (1) .

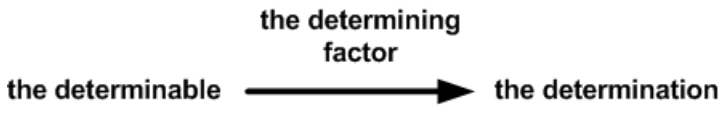

Figure 7: The process of the synthesis of Modality

[22] Merely adding some modal forms does not suffice to solve this problem. If it did we would not be witness to the numerous faults and shortcomings found in translating books and papers from one language to another. Human beings do not lack the Modality functions yet there are very significant differences in rendering the same original work by two or more translators. Context and scope-of-concepts also play an important part, and this is one place where different human translators differ from one another.

Viewed from the vantage point of mathematics, these ideas are not overly difficult to grasp. But what do they mean, and how are we to regard them, when *somatic* representations are involved? Somatic representations are sensible appearances in the logical division of *soma* that are regarded as representations *only by virtue of their being meaningful* in some way. But "meaning" is not an object of the senses. It is, rather, a mental object. Thus, for a somatic appearance to be regarded as a representation means it has an equivalent counterpart in noetic representation. This context for somatic representation is inherent in the system theorist's definition of a ***signal***. A system theorist defines this as *any physical phenomenon exhibiting variations that is said to carry information*. This *mathematical* definition at once raises another and somewhat perplexing question, namely, what is *information*?

One might expect the science of information theory to provide the answer to this question, but here we find that this expectation is not met. Instead, the term is treated as an undefined primitive and information theory is devoted to making statements about "how much information" is contained in a "message" according to presumed and prescribed probabilistic rules. Information theorist Warren Weaver put it thusly:

> The word *information*, in this theory, is used in a special sense that must not be confused with its ordinary usage. In particular, *information* must not be confused with meaning.
>
> In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent, from the present viewpoint, as regards information. It is this, undoubtedly, that Shannon means when he says that "the semantic aspects of communication are irrelevant to the engineering aspects." But this does not mean that the engineering aspects are necessarily irrelevant to the semantic aspects.
>
> To be sure, this word information in communication theory relates not so much to what you *do* say, as to what you *could* say. That is, information is a measure of one's freedom of choice when one selects a message. If one is confronted with a very elementary situation where he has to choose one of two alternative messages, then it is arbitrarily said that the information associated with this situation is unity. Note that it is misleading (although often convenient) to say that one or the other message conveys unit information. The concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole, the unit information indicating that in this situation one has an amount of freedom of choice, in selecting a message, which it is convenient to regard as a standard or unit amount. [Weaver (1949), pp. 8-9]

Probability is used in information theory as a *proxy* for "choice." It will not do to let the idea of information float undefined and primitive. We must have its real explanation, and this is provided by mental physics. In order to best grasp its metaphysical explanation it seems best to begin with the distinction drawn in information theory between information and data. These stand together in relationship as object and representation (*parástase*) of the object. Information is that something regarded as *dabile* (givable) by or carried in a representation. The *parástase* that is said to carry it is a *datum* (given). The same information can be represented by many different *data* representations. Different numeral systems provide one example of this, e.g.,

11 (Arabic) = XI (Roman) = ια′ (ancient Greek).

All three data representations represent the same notion of substance that in English we call "eleven." The object-*parástase* Relation is inner Relation (specifically, the Relation substance & accident), in which "information" denotes the substance and the *parástase* (e.g., 11) denotes its accident. A *datum* is always a sensible representation, whereas the substance it represents is always supersensible. Mental objects are always supersensible and are represented by principal quantities of Critical mathematics. Somatic objects are always sensible objects, and the *parástase* of one that pertains to mental phenomena is called a **signal**. *Information is the substance that is*

common in both the somatic and the noetic parástase.

Common habits of thinking tend to confuse the *parástase* with the information it gives. For example, many engineers call that which is stored in a computer's disk drive "data" but will say in nearly the same breath that this stored pattern of magnetized "bits" *is* the information stored in the disk drive rather than saying that the information *subsists in* the stored data. This results in a homonymous and equivocal usage of the terms "data" and "information." A data representation *signifies* something (and is correctly called a *sign* of that something for that reason). This is easily illustrated by comparing the notations used in different mathematical systems of notation that express precisely the same mathematical idea. For example, consider the following comparisons:

modern Arabic notation	Diophantine notation[23]
$8x + 4$ equals a square[24]	$\varsigma\eta' \overset{o}{M} \delta' \iota\sigma. \square^{\Upsilon}$
$x^2 + 4x + 4$	$\Delta^{\Upsilon}\alpha' \varsigma\delta' \overset{o}{M} \delta'$.

The Arabic and Diophantine notations in each of these pairs "say" precisely the same thing, i.e. carry the same information, but as *data* are obviously very different *appearances*. At the risk of belaboring the point, the same information carried in the first example pair above is represented in the notation of mathematical logic as

$$8x \ +4 \in \left\{ y \mid \exists z \in N \wedge y = z \cdot z \right\}.$$

For the appearance of any somatic material-object[25] or event[26] to be regarded as a *signal*, it must pair with some *parástase* of a noetic object. If it does not, its appearance *signifies* nothing with meaning, therefore it cannot properly be regarded as a representation, and therefore it is not proper to call it a *signal*. Again, *information* is the substance a somatic and a noetic *parástase* share in common as accidents "of the same essential thing."

VI. The Need for an Applied Metaphysic of Signaling

These considerations bring us to the question: What is *necessary for the possibility* that a sensible somatic appearance could be *at the same moment in time* a noetic representation and, therefore, for it to be a signal? One obvious and even tautological requirement is that it be the appearance of an object of possible experience (i.e., its concept must lie within the horizon of possible experience). Another is that the somatic Object, *in the context of its being a part of brain-object* (Quantity of differentiation, Quality of agreement, Relation of internal Relation), must have an *immediate* relationship, through the animating principles of *psyche*, to a *parástase* in perception. For example, the hair on your head regarded *as* a-thing-called-hair is not itself the immediate object of an intuition that pertains to the thorough-going reciprocity of *soma* and *nous*. You can get a haircut and, so far as we know, having a hair cut has no immediate effect on any of your mental representations. Hair *qua* hair is, therefore, not a signal-object. On the other hand, there is an array of measurable brain-object activities involved in seeing a strand of hair that *do* stand in some relationship between somatic appearance and the mental Objects called sensibility and perception. These activity-objects *are* to be regarded as signals. A hair-*as*-hair is not a

[23] Diophantine notation is the notation used by Diophantus (*c*. AD 250) in *Arithmetica* (Thomas, 1941).
[24] 1, 4, 9, 16, 25, etc., i.e., a square is a natural number resulting from a natural number multiplied by itself. The first solution to the expression is $x = 4$, the next is $x = 12$, etc.
[25] In the lexicon of mental physics, a *Sache*-thing.
[26] In the lexicon of mental physics, an *Unsache*-thing.

signal[27], but the *sight* or the *touch* of a hair occurs by means of brain-object activities that *are* signals.

An additional consequence of this, and one unlikely to be immediately obvious upon first encounter, is that a somatic signal-*object* is always, *and can only be*, the object of a concept in the manifold of concepts, understood from the *judicial* Standpoint of Critical metaphysics, and, therefore, *is always a mathematical object*. To appreciate and understand this point, consider the following: There are some measurable activities within the central nervous system that pertain immediately to somatic motor phenomena without an immediate linkage to brain activities that pertain to perception (and, therefore, to receptivity in *psyche*). The firing of a motor neuron in the ventral horn of the spinal cord is one example. The firing of a neuron in the motor cortex of the brain that makes a direct synaptic connection to spinal cord interneurons is another phenomenal example. Their immediate correspondence with *nous* is placed with the noetic *parástase* of appetition and practical rules in the manifold of rules in pure practical Reason. These noetic representations are never conscious representations, hence never perceptions. For this reason, the mere *appearances* of such somatic actions *cannot in themselves alone be regarded as signals*. Instead, it can only be the *whole concept* in one's understanding of these somatic *actions* that stands in relationship to *parástase*. Thus, a signal is part of a *composition* that corresponds reciprocally to a whole of noetic *parástase*, and such a *parástase* is an object of mathematics rather than of empirical objective perception[28]. ***Signaling*** is the *nexus* for signals.

Put another way, signaling is a complex that in composition is understood in Quantity by the general idea of integration. Its idea is always a *holistic* idea. It is not correct, for example, to empirically measure the occurrence of a single action potential in a neuron and say "that phenomenon is a signal." It is not to be understood in this way. The appearance of that action potential *in combination with the representations of a manifold of other somatic appearances* is, or could be, "a signal." There is in this a close and enticing similarity to how William James explained "what the Object of a thought is." James wrote,

> In popular parlance the word object is commonly taken without reference to the act of knowledge, and treated as synonymous with individual subject of existence. Thus, if anyone ask what is the mind's object when you say 'Columbus discovered America in 1492,' most people will reply 'Columbus,' or 'America,' or, at most, 'the discovery of America.' They will name a substantive kernel or nucleus of consciousness, and say the thought is 'about' that, – as indeed it is, – and they will call that your thought's 'object.' Really that is usually only the grammatical object, or more likely the grammatical subject, of your sentence. It is at most your 'fractional object;' or you may call it the 'topic' of your thought, or the 'subject of your discourse.' But the *Object* of your thought is really its entire content or deliverance, neither more nor less. It is a vicious use of speech to take out a substantive kernel from its content and call that its object; and it is an equally vicious use of speech to add a substantive kernel not articulately included in its content, and to call that its object. Yet either of these two sins we commit whenever we content ourselves with saying that a given thought is simply 'about' a certain topic, or that that topic is its 'object.' The object of my thought in the previous sentence, for example, is strictly speaking neither Columbus, nor America, nor its discovery. It is nothing short of the entire sentence, 'Columbus-discovered-America-in-1492.' And if we wish to speak of it substantively, we must make a substantive of it by writing it out with hyphens between all its words. Nothing but this can possibly name its delicate idiosyncrasy. [James (1890), vol. I, pg. 275]

[27] Indeed, in the typical context of the usage of the word, "hair" does not belong to brain-object. It is a part of the phenomenon of being a human being that stands in *subcontrary* relationship with the phenomenon of mind ("hair is not-mind"). Brain-object is that in *soma* which is-not not-mind.

[28] Were it otherwise, Critical metaphysics tells us we could not *define* the concept of "signal" with objective validity at all.

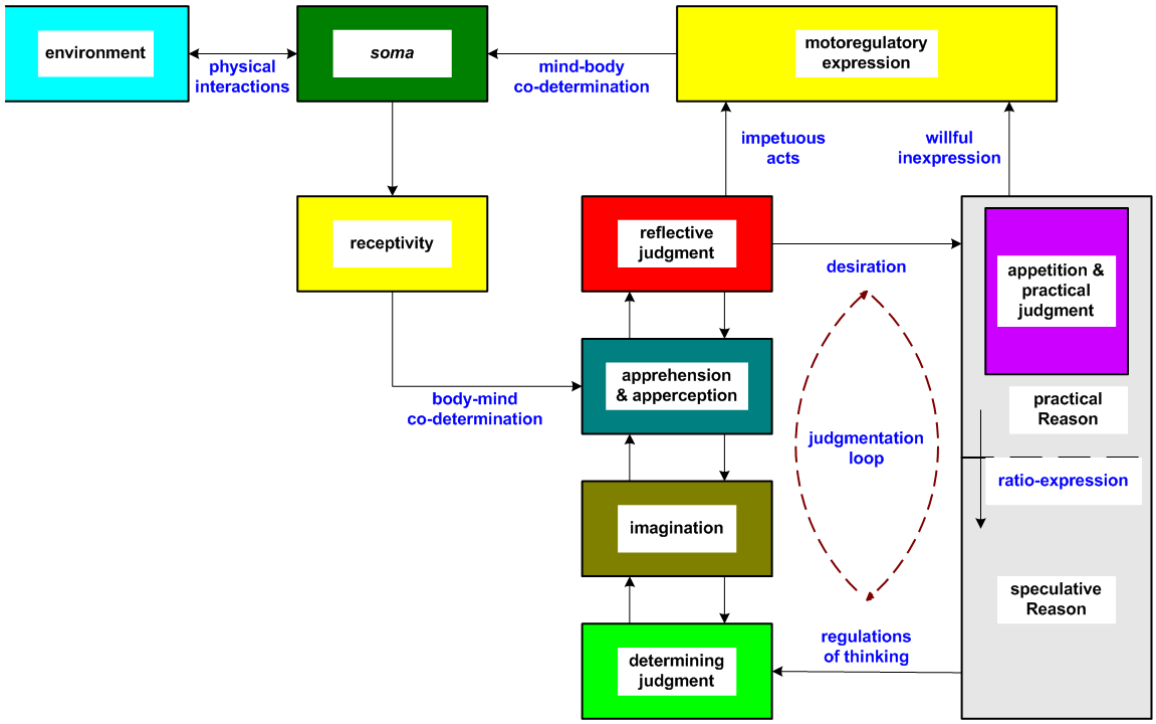

Figure 8: The general structure of the Organized Being (Wells, 2009)

The idea of a *signal* can have objectively valid meanings only within the context of *signaling* as a *nexus* of somatic activity. To put this another way, a signal as an object must be regarded as an outcome or consequence of an action, namely the action of signaling. Before we can make a logically *essential* representation of what a signal is, we must understand and represent what signaling is. To make a beginning to answering the latter question, it is pertinent to look at how and where the logical division of *soma* fits in the general context of the Organized (human) Being as a whole. In this way we can proceed from what is clearer to us *empirically* to what is to be *understood* from rational first principles *a priori* and avoid the fatal pitfalls of ontological misconceptions dictated by the mere fiat of ontological prejudices. Figure 8 illustrates the logical placement of *soma* within the general structure of the Organized Being.

Motoregulatory expression and receptivity both belong to the logical division of *psyche*, and so it is easily seen that *soma* is sandwiched, so to speak, between a physical external environment and the Organized Being's faculty of animating principles. The laws of Nature governing those physical phenomena that meet up with the earlier theorist's mathematical definition of a signal are studied by and belong to physics, physiology, chemistry, and anatomy. These provide the empirically known in regard to the phenomena *but not in regard to a real explanation of signals and signaling*. For such a real explanation we must turn to the other side and look at the question from what is properly called a ***psyche-somatic*** theory of signaling. Signaling is representation (*repraesentatio*) in the appearances of *soma*, and it is bound to the principle of thorough-going reciprocity between *soma* and *nous* because each of these is merely a logical division, not a real division, of the over-all phenomenon of being a human being. What can be *correctly* said of signaling and signals must accord with this principle.

It is perhaps very clear by this point that we are inquiring into the logical essence of signals and signaling. It has just been explained that both are mathematical in their Natures. However, this is no license to take arbitrary liberties with their definitions because they are those most special of mathematical objects, namely, objects that stand squarely at the horizon of possible

experience. This means nothing less than that, as mathematical objects, *they are principal quantities* of what Slepian called "facet B" (the "mathematical world") [Wells (2011a)]. The unity of rational science and empirical science depends totally on such quantities. Once one realizes this, the inattention that philosophy – and, particularly, metaphysics – has rendered to these concepts can rightly be called unfathomable. Neither "signal" nor "signaling" is a technical term in either Blackburn's *Dictionary* or Mautner's *Dictionary*.

Have the special sciences stepped in to fill this breach? It doesn't require a very long survey to find that the answer is no, they have not. What we find instead is a free-standing weed patch of definitions consisting of incommensurables. Mathematics, as represented by Nelson's *Dictionary*, does not define either term at all. Isaacs' *Dictionary of Physics* provides no definition of signaling and only the narrow and *ad hoc* electrical engineer's definition of signal:

> **signal** The variable parameter that contains information and by which information is transmitted in an electronic system or circuit. The signal is often a voltage source in which the amplitude, frequency, and waveform can be varied.

Clugston's *Dictionary of Science* scarcely has a broader scope for signal and, again, no definition at all for signaling:

> **signal** A variation of some quantity with time in a way designed to convey information of some sort, for example a voice. In a broader sense, 'signal' is often used to mean the useful part of an experimental measurement, in contrast with noise.

Biology, as represented by the Thain and Hickman *Dictionary of Biology*, does not define either term at all, although it does not hesitate to list "signal recognition," "signal region" and "signal transduction" among its technical definitions. Finally, Reber's *Dictionary of Psychology* offers up six "usages" for "signal" but no definition or "usage" for "signaling," although it does offer a definition for "signaling system":

> **signal** **1**. n. Most generally, a sign[29] that serves to communicate something. **2**. n. More specifically, an agreed-upon event or object that functions as an occasion for some action. **3**. n. A stimulus, particularly as in signal-detection theory. **4**. n. In neurological work, any event that is transmitted along neural pathways. **5**. n. Any transmitted event, e.g. a radio signal. **6**. vb. To indicate or denote something. adj. *signal*.
>
> **signaling system** A term often applied to the communication system of nonhuman species. It is preferred in these contexts to *language*. See also *semiotics*.

It is obvious that all the above definitions are merely nominal definitions and that none of them offer a *Realerklärung* (real explanation) of the idea of a signal. The first dictionary definition above can be subsumed under the second (as a special case), and the second definition is subsumed under Reber's definition 5 by a reference to information theory. The Reber's set of definitions covers the current usages of the word "signal" in science, and these definitions cannot be measured against one another save by means of metaphors or similes.

This leaves entirely too much ambiguity in the usage of the ideas of signal and signaling, and it is for this reason that these merely mathematical usages cannot suffice, nor can we suffer the ideas to be taken for granted. But to produce a *Realerklärung* of "signal" and of "signaling" requires that an applied metaphysic be developed in order to provide the necessary continuity we must demand between a special science and its real foundations in Critical epistemology.

All of the dictionary definitions refer in some way to the phenomenon of cognition, either

[29] Reber's defines "sign" as "an indicator, a hint, a clue."

directly or indirectly, by the linkages they set up between the idea of signal and the ideas of communication or transmission. This is merely the connotation that a signal conveys information, as was said earlier, and this in its turn makes the idea of signal an idea of data representation. In any physical-natural science, to invoke the ideas of "communication" or "communication system" lacks objective validity because the dead-matter objects of physical-natural science do not contain any notion of cognition in their fundamental principles. For example, it is absurd to say that one neuron cell "communicates" with another in the brain because this *means* the latter cell in some way "understands what the first cell is saying to it" or it presumes that some physical event (e.g. a neurological action potential) *denotes a purpose* for the "receiving" cell or *serves a purpose* of the " transmitting " cell. But this is vitalism in an insidious form, and it is no less ludicrous to anthropomorphize a biological cell in this way than it is to say that a house's thermostat *knows* the house is cold and its *duty* is to turn on the furnace. A scientist can employ teleological thinking to provide himself with an initial problem orientation, but to stop with teleological metaphors and not pursue the question until the metaphor is replaced by objective understanding congruent with the fundamental principles of the science is child's logic of the sort Piaget documented in young children:

> STEI (5½) told us spontaneously that the name of the moon "*isn't in the moon*. – Where is it? – *It hasn't got a place*. – What does that mean? – *It means it isn't in the moon*. – Then where is it? – *Nowhere*. – But when you say it where is it? – *With the moon* (returns to the first stage[30]). – And where is your name? – *With me*. – And mine? – *With you*. – But when I know your name where is it? – *With you when you know it*. – And the name of the moon? – *With it*. – And when we know it? – *With us*. – Where is it when it's with us? – *Everywhere.* – Where's that? – *In the voice*." [Piaget (1929), pg. 77]

It would appear from this that little STEI ascribes an ontological import to names not all that dissimilar to how a quantum physicist regards the idea of "virtual photons" in quantum electro-dynamics theory. Piaget's example is not merely a cute anecdote. The alleged magic power of names was something ancient man took very seriously; one did not "speak of the devil" because then he *would* appear. And is not a thing that can be both nowhere and everywhere indeed magic? As Shakespeare put it, what's in a name? Answer: whatever you wish whenever you wish it.

Yet, at least with regard to signals and signaling, this character of nominal realism does serve to provide a clue to the perspective and Standpoint from which their appropriate Critical applied metaphysic is to be sought and developed. Let us take an adult look at stage one of childish nominal realism. When the child says the name of a thing is "with" the thing, what he is doing is nothing else than making an association between an insubstantial thing (the name) and a substantial thing (the object so named). *This is Slepian association*[31] *between a facet B object* (the name as a principal quantity of mathematics) *and a facet A object* (the physical thing so named).

The *Realerklärung* of signaling, and that of signal as well, must be a practical explanation (because all root meanings refer to actions). In particular, it must correspond on the somatic side of *psyche* to the concept on the noetic side. This tells us that the particular applied metaphysic we require is the applied metaphysic of *psyche*, known as the sensorimotor idea [Wells (2011c)]. But there is still a significant amount of work to be done in developing the applied metaphysic

[30] Piaget documented three stages of nominal realism in children from 5 to 10 years of age. "During the first stage (5 to 6) children regard names as belonging to things and emanating from them. During the second stage (7 to 8) names were invented by the makers of the things – God or the first men. In the case of the first men, the child generally supposes that the men who gave the names are those who made the things . . . During the third stage, which appears about the age of 9 or 10, the child regards names as due to men of no particular identity whilst the name is no longer identified with the idea of creation." [Piaget (1929), pg. 63]

[31] see Wells (2011a)

because *the Standpoint required to explain the somatic associations of* psyche *differs from that by which the sensorimotor idea was developed for the noetic associations*. The sensorimotor idea was developed for the noetic context from the theoretical Standpoint of Critical epistemology. When we come to consider the *appearances* of phenomena of *soma*, an empirical special science is grounded in human *judgments* of Nature (the world model the scientist builds). Every empirical science is uncertain to some degree in its findings, a point that skeptics tend to ride to exhaustion.

This *judicial* character of materialism found a spokesman in Santayana, who announced to one and all that "in natural philosophy I am a decided materialist – apparently the only one living" [Santayana (1923), pg. vii]. Santayana wrote,

> A philosopher is compelled to follow the maxim of epic poets and to plunge *in media res*[32]. The origin of things, if things have an origin, cannot be revealed to me, if revealed at all, until I have traveled very far from it, and many revolutions of the sun must precede my first dawn. The light as it appears hides the candle. Perhaps there is no source of things at all, no simpler form from which they are evolved, but only an endless succession of different complexities. In that case, nothing would be lost by joining the procession wherever one happens to come upon it, and following it as long as one's legs hold out. Every one might still observe a typical bit of it; he would not have understood anything better if he had seen more things; he would only have had more to explain. The very notion of understanding or explaining anything would then be absurd; yet this notion is drawn from a current presumption or experience to the effect that in some directions at least things do grow out of simpler things: bread can be baked, and dough and fire and an oven are conjoined in baking it. Such an episode is enough to establish the notion of origins and explanations without at all implying that the dough and the hot oven are themselves primary facts. . . If he begins in the middle he will still begin at the beginning of something, and perhaps as much at the beginning of things as he could possibly begin.
>
> On the other hand, this whole supposition may be wrong. Things may have had some simpler origin, or may contain simpler elements. In that case it will be incumbent on the philosopher to prove this fact; that is, to find in the complex present objects evidence of their composition out of simples. But in this proof also he would be beginning in the middle; and he would reach origins or elements only at the end of his analysis.
>
> The case is similar with respect to first principles of discourse. They can never be discovered, if discovered at all, until they have been long taken for granted, and employed in the very investigation which reveals them. The more cogent a logic is, the fewer and simpler its first principles will turn out to have been; but in discovering them, and deducing the rest of them, they must first be employed unawares if they are the principles lending cogency to actual discourse[33]; so that the mind must trust current presumptions no less in discovering they are logical – that is, justified by more general unquestioned presumptions – than in discovering that they are arbitrary and merely instinctive.
>
> It is true that, quite apart from living discourse, a set of axioms and postulates, as simple as we like, may be posited in the air, and deductions drawn from them *ad libitum*[34]; but such pure logic is otiose, unless we find or assume that discourse or nature actually follows it; and it is not by deduction from first principles arbitrarily chosen that human reasoning actually proceeds, but by loose habits of mental evocation which such principles at best may exhibit afterwards in an idealized form. . .

[32] "into the midst of things"

[33] Apparently without recognizing it, Santayana has just described the method Kant used to tease out the transcendental acroams of Critical epistemology. The transcendental Ideas are *both* regulative laws of pure Reason *and* acroams of Critical metaphysics. That they are both is because Critical epistemology is the science of human understanding, judgmentation and reasoning: the laws of this science *can be* none other than the laws of the phenomenon of mind in action.

[34] "to any desired extent"

> In the tangle of human beliefs, as conventionally expressed in talk and in literature, it is easy to distinguish a compulsory factor called facts or things from a more optional and argumentative factor called suggestion or interpretation; not that what we call facts are at all indubitable, or composed of immediate data, but that in the direction of fact we come much sooner to a stand, and feel that we are safe from criticism. To reduce conventional beliefs to the facts they rest on – however questionable those facts themselves may be in other ways – is to clear our intellectual conscience of voluntary or avoidable delusion. . . To reduce conventional belief to the recognition of matters of fact is empirical criticism of knowledge.
>
> The more drastic this criticism is, and the more revolutionary the view to which it reduces me, the clearer will be the contrast between what I find I know and what I thought I knew. But if these plain facts were all I had to go on, how did I reach those strange conclusions? What principles of interpretation, what tendencies to feign, what habits of inference were at work in me? For if nothing in the facts justified my beliefs, something in me must have suggested them. To disentangle and formulate these subjective principles of interpretation is transcendental criticism of knowledge. . . The only critical function of transcendentalism is to drive empiricism home, and challenge it to produce any knowledge of fact whatsoever. And empirical criticism will not be able to do so. . . Thus, transcendental criticism, used by a thorough skeptic, may compel empirical criticism to show its hand. It had mistaken its cards, and was bluffing without knowing it. [Santayana (1923), pp. 1-5]

Materialism on the empirical side of science might be said to be a *duty* expected of a scientist. For how otherwise are the rest of us to trust what he tells us? But this materialism, if it is to be honest materialism, must be a skeptical materialism in the positive sense of being what we call *open-minded* in science. Ideas and postulates of ultimate beginnings, ultimate endings and ultimate simples, if conceived to be material things, lie so far beyond the horizon of possible human experience that we can call them nothing but transcendental illusions, and propositions concerning them are always formally undecidable because beyond the horizon of possible experience their *Existenz* is a *super*natural *Existenz*. Scientific materialism prides itself on banishing the supernatural from its doctrines, all the while playing at occult quantities and super-natural prejudices. It is in*deed* bluffing without knowing it.

How, then, is scientific empirical knowledge possible and what degree of holding-to-be-true can be achieved for it (given that empirical *certainty* is *practically* unreachable)? To answer these questions we must look to the source of those *conceptions* we call scientific ideas. And what is this source? Santayana's discourse quoted above is peppered with adequate clues: belief; presumption; habits of mental evocation; habits of inference. All of these are products of human *judgmentation*. There noetic representation has its *mental* source in the process of reflective judgment, and this capacity for knowledge representation is understood with *practical* objective validity from the *judicial* Standpoint of Critical epistemology.

This, then, illuminates for us the correct Standpoint from which we make our reconsideration (*Überlegung*) of the sensorimotor idea of *psyche*. The sensorimotor idea from the judicial Stand-point is the epistemologically proper applied metaphysic for objects of *soma*. The theoretical Standpoint is the Standpoint for ontology, but the judicial Standpoint is the Standpoint for the human being's power of Self-organization in harmonizing objective and subjective knowledge. Signals and signaling are accidents with regard to *nous-soma* reciprocity and so they are not thing-like. Rather, they are *efficacious* constructs. The principle of formal expedience of Nature is the governing acroam of reflective judgment and the process of judgmentation in general, and it is quite clear that efficacy and expedience are notions very closely akin to each other. Two sequels ("The applied metaphysic of the somatic code" followed by part II of this paper) undertake the development of the applied metaphysic of the *judicial* sensorimotor idea and its application.

VII. References

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