5 THE CORE THESIS OF LIR: STRUCTURE AND EXPLANATION

Abstract This chapter represents a transition between the theory established in previous chapters and applications of it in philosophy and science. It describes the core thesis of LIR and shows how it can function as a new methodology for talking about specific areas and theories of reality. It begins with a statement of the thesis and the two-level framework for analysis to which it leads, presented as a metatheory, and aspects of intertheoretic relations and part-whole relations are interpreted following the LIR axioms. The second part of the chapter deals with the structure of reality as defined by LIR both ontologically and metaphysically. This is the basis for subsequent analysis of particular philosophical and scientific theories and provides an introduction to discussion of the specific structural realism of LIR. The final Sections position LIR in relation to the on-going philosophical debates about the analytical/synthetic distinction and explanation and *their* relation to the LIR structuralist conceptions.

The ubiquity of hidden assumptions and definitions of classical logic pervade virtually all the aspects of interest to this study. For example, if one accepts the categories of LIR and NEO as applying to reality, they must apply to the conceptual as well as physical structure of reality as well, including relational structures, theories, including, especially the existence of real contradictions and inconsistencies at macroscopic levels of the real world. I will therefore highlight below the dynamic aspects of structure, without, at the same time, doing what would be just as incorrect as ignoring them, namely, discarding the commonsense notion of structural stability in the everyday world. My goal will therefore be, in the spirit of my logic, to maintain the necessary equilibrium between the different key notions in all of the above areas.

My conception of categorial ontology is also non-standard: since LIR theory is based on energy, there will be an additional hurdle to overcome: the age-old questions of form and the primacy of form – geometry and statics as opposed to matter (energy) and dynamics obtrude themselves on my thesis, blocking it as it were. I address these issues in some detail in Chapter 6, but to begin to remove some of the blocks, I have constructed my argument here, in Section 5.4, around two approaches, namely, *Gestalt* theory and catastrophe theory, in which these issues are discussed. This discussion will, I hope, further assure readers of the

links that LIR has to other philosophical and metaphysical systems, and that a dialogue is possible.

5.1 THE CORE THESIS OF LIR

The logical and categorial concepts of LIR have now been developed to the point where I can make a first statement of the core thesis of this book: LIR as a formal (categorial) ontology gives us a way of talking about dynamic opposition as a part of theories of science and philosophy; the grounding of LIR in the physics of energy insures that I am talking about reality. Looking at a theory from the ontological standpoint means that one can *say*, for example, that some entities are neither entirely the same or different, and then relate this to the real opposing processes instantiated by or constituting the entity and its antagonistic dual to see what this means in reality.

In my view, progress in explanatory power may be possible when it is realized that reality both *has* the metaphysical structure proposed by LIR, and *is* actually something that should be understood as the extant domain described by NEO, whose categorial features fit the objective for a formal ontology defined in Chapter 3. In other words, according to LIR, reality instantiates the material categories of Energy and T-states and their major category features, as well as the formal categories of Process, Dynamic Opposition and Subject-Object.

I propose that the logic of/in reality could accordingly make contributions to scientific and philosophical theories, in two closely related ways:

- The theories currently used to describe the domain are themselves based on classical logic. Thus, these theories might be compared and reconstructed according to the principles of LIR, that is, their terms analyzed according to the above categories, and rules provided for the formation of the T-states involved.

- LIR can demonstrate that the (extant) domain that the theories in question aim to describe, reality itself, has been misconceived as a reality that follows the principles of classical logic and has been, accordingly, often misrepresented by classical ontologies importing or embodying these principles.

My claim is that LIR and NEO can achieve both of these objectives, in particular through the application of their ontological predicates and the category

of Dynamic Opposition. However, I have implied a concept of what constitutes structure in the metaphysics of LIR. In order to position my thesis correctly as a logic and an ontology, prior to showing how it can be applied, I thus need to further characterize the kinds of analyses and explanations that can be made and the relation between metaphysics and ontology in general that yields a picture of the structure of the reality to which LIR applies. In the process, we will also see that theories such as *Gestalt* theory and catastrophe theory prefigure in part the principles of LIR. These points will be useful the more specific applications that follow, e.g., in physics and biological science.

As I have shown in Section 4.3, LIR is in one sense a scientific theory and, to the extent that its physical postulates or underpinnings can be disproved, it could meet Popper's criterion of falsifiability. There are problems with the Popper approach, but the idea is still useful in many cases. In another sense, however, LIR is a metatheory that proposes analyzing the extent to which other theories adequately represent the non-separable properties of real phenomena. In this regard, LIR suggests a new criterion of falsehood. Any theory whose argument depends on the absolute independence of the entities or interpretations under discussion may be biased in favor of one other, resulting in errors or omissions. For itself, LIR avoids this trap because it *assumes* the existence of a counter-theory with which it is necessarily in a dialectical relationship. Reality, for LIR, includes the existence both of LIR and anti-LIR and their conjunction.

My preferred conception of a scientific theory, as mentioned in Chapter 3, is the 'semantic' one, which sees theories as models or structures. These are extra-linguistic and in my terms dynamic entities as opposed to the syntactic conception as a set of statements or formulas governed by first-order predicate logic. LIR treats the relationship between theories and the world not only as an isomorphism. Real systems and their theoretical models are not totally independent entities, and the PDO provides an element of a formal and physical structural relation between them.

My approach is an unfamiliar one. This often makes it necessary, as well as desirable, to refer in a particular area of application to theories with which I do not agree fully or wish to refute but are very well known. It is from the opposition, if you will, of LIR with the other theories that *their* valid aspects can best be illustrated,[1] as well as the possible contributions that the LIR approach can make.

[1] There is an interesting example here of the application of NEO to theories. A dialectical view of Batterman (*op. cit.*), suggests that a range of striking phenomena arise at singular asymptotic limits for the relation of two theories. The properties of systems at the limit values, he argues, cannot be derived from the more fundamental theories; instead, they require one to make use of a special-case theory involving elements of both the original two.

5.2 A TWO-LEVEL FRAMEWORK OF RELATIONAL ANALYSIS

The most general description of reality is that it consists of entities and the physical and relational structure in which they find themselves. In linguistic terms, one looks at semantics and syntax, in philosophy at parts and wholes and so on. This division brings with it what is often referred to as a tension between the structure and its elements, and I see in this 'tension' an expression of the instantiation of the PDO outlined in this book, namely, that elements and structures share, to a more or less actual or potential extent, one another's properties, both physically and also epistemologically, in the sense of alternating perspectives.

In the sense of the core thesis indicated above, there will be two types of tools that will be necessary to deal successfully with the two parts of the core thesis. For the structure of theories and their inter-relations, in particular reduction, the PDO will be used as a metatheoretical methodological principle for looking at the relations between entities in a domain of dualities or dichotomies, between either classes of entities or two individual terms. For the structure of reality as revealed by physical and biological science, PDO will be used as a quasi-natural law within the language of the scientific theory itself. I define a systematic normative framework as an outline of some clearly formulated set of requirements and rules, in this case of LIR itself.

Examples of the entities are the following:

Object Level [2]	***Meta-Level***
Data of Theories	Theories
Theories	Meta-theories
Becoming	Being
Element	Set or Class
Matter (-energy)	Symbol
Facts	Meaning
Part	Whole
Individual	Group
Semantics	Syntax

[2] Two-level frameworks are also used in the analysis of set theory and foundational notions of truth and existence in mathematics. To avoid paradoxes, one must move to the meta-level and use model theory or remain at the object level. The meta-level has additional resources that enable the removal objections to the founding of mathematics by set theory, although constructions at both levels are equally abstract. The details of the argument are not relevant; my point is that working between two levels, in the "higher" of which new notions can be incorporated, is a similar process in both real and abstract domains (Muller 2005).

It is clear that any implied separation between these subjects and those of science is arbitrary, since individual – group relations are studies by social and biological sciences. Another kind of relational structure is the relation between process or events and the explanations of those events.

Let me now suppose that I want to explore the relation between object level and meta-level entities. I therefore state the following theorem:

Theorem 5.1: Object level and meta-level entities are contradictorially related by Axiom **LR5** of Functional Association

To prove this, for example, in the case of matter and symbols of matter, I need to show that a symbol is both really and phenomenologically part matter and *vice versa*. That symbols are partly matter/energy is guaranteed by the process of the emergence of signs and symbols in the course of human evolution. Symbols therefore reflect the underlying dynamic opposition that was in operation at that level. Pictographic languages, such as Chinese, illustrate this rather directly, and the origin of some letters in Western alphabets in natural objects can still be detected.

But in what way does matter have the properties of symbol? This requires a different point of view, from what I might call a higher level of perception at a correspondingly higher level of reality. At this level, matter-nature is perceived as signs having intrinsic meaning.[3] This idea is a recurrent theme in art, poetry and religion. In fact it is in general the symbolic aspects of matter that are at a higher level of reality than the material aspects of symbols.

Individuals, as part of a group, contribute their individuality to it. But the group instantiates aspects of group psychology and this becomes part of the individual. What is the 'group part of the individual' is something instantiated at higher, more intuitive level, but not the less real for that.

At all levels of reality, I will assume that there is a conflict or opposition between epistemological elements and the energetic processes to which they correspond. I may and in fact always will focus on one or the other aspect, but there is present a contradictional relation, one aspect is actualized while the other is potentialized. This is the most significant isomorphism of natural laws[4] at different levels of reality.

In other words, I apply the category of Dynamic Opposition to entities at the two levels. I then find in the physical domain, the same distribution of entities

[3] An excessive example is Pamuk's (fictional) description of the Turkish Hurufis who saw messages written in letters constituted by human features (Pamuk 1996).

[4] The question now arises whether this defining set of principles constitutes a new physical law, a law of nature. Their operation must be and I believe is consistent with existing physical laws. These principles might also be considered as being outside the domain of laws *per se*, including boundary conditions at real boundaries and interactions and constraints of the kind that Cat has called *anomic*. I will return to this question in Chapter 6 in the discussion of causality.

into Separable and Non-Separable; with and without the equivalent of an energetic relationship. In the latter, the actualization of one entity potentializes the other, in the former not. Such two-tier systems of phenomena (of perception, reality, meaning, etc.) have of course been proposed frequently. But my thesis is that only the antagonism within and between levels that is capable of explaining or rationalizing their existence and non-epiphenomenality for all logical elements that are not equivalent to those of binary logic. LIR mediates the relations of both horizontal and vertical transitions, and the *relations* themselves can be seen to be at different levels of reality. The next two sub-sections will discuss two examples of the application of the above framework.

5.2.1 Mereology

My framework involves two levels and several kinds of entities. Since LIR refers to the non-separability of some pairs of those entities, that is, their alternating actuality and potentiality, some horizontal and vertical part-whole relations may exist that require explicit attention. As might be expected, the classical theory of part-whole relations closely mirrors classical binary logic. One of its key axiomatic principles is that of asymmetry: two distinct things cannot be part of each other. Every object is distinct from its proper parts, and standard first-order logical language with identity is used for its formalization.

This simple theory runs into the same kind of difficulties as does the individuality of quantum entities, and for the same reason: it is a restatement of the standard theory of classes or sets as wholes and their elements as totally separated members of those wholes.

Standard part-whole theory, like classical logic, also contains some non-classical 'cracks'. The existence of parts that interact with the whole is accepted, despite the absence of discussion of that interaction and the difference between such cases and those in which no interactions exist. Parts may not be parts '*simpliciter*', and so on. One speaks of 'non-well-founded' relations of parts and wholes in set theory that involve membership circularities or closed loops. These cases suggest that the standard meaning postulate for 'part' is far too restrictive.

LIR states that the relation of parts to wholes may be dynamic, that is, that parts and wholes can share one another's properties, in the sense that aspects of the whole are potentialized in the parts, and aspects of the parts are potentialized in the whole. Any implied circularity is not perfect; for real entities the loop is never totally closed. The PDO applies as it does to classes and their members as laid out formally in Appendix 2. Specifically, it applies to a theory that includes an object level and a meta-level, and states that the parts that constitute the content of the object level share properties of the meta-level as a whole. At the level of physical individuals and groups, the situation is the same: the group has some of the

characteristics of the individuals that comprise it, and the latter have or have internalized aspects of the group.

Even where there are no interactions of this kind, classical part-whole theory and binary logic do not fully apply, as the following discussion about problems of compositionality will show. It is already more or less accepted that standard binary logic cannot apply to a part-whole relation involving real entities in the temporal and modal world. The classical part-whole relation betrays, so to speak, its origins in mathematics. In non-classical extensional mereology, the notion of sum, which is the essential principle of compositionality, is modified or absent. In its place there is a combination of two different relations between parts and wholes.

The two relations differ primarily insofar as the applicability of classic extensional mereology (CEM) is concerned. The central idea of CEM is that of a *sum* as the essential principle of compositionality. The problems that are incurred with this notion in trying to handle the parts of entities that change in time are well-known. A typical strategy is to do two things (Bottani 2001): (1) show that in the normal temporal and modal world, the absolute part-whole relation, on which CEM depends, is neither true nor false for certain pairs of things; the absolute, a-temporal part-whole relation is the usual dyadic one – A is a part of B; and (2) define a triadic relation – A is a part of B at time T. Thus, even if CEM refers to the absolute relation, its essential principles apply to real processes, that in LIR include all apparently static objects, sometimes referred to as 'continuants', as well as people.[5] One retains the universality of CEM to all entities, and thus the intuitive concept of inclusion, but not its exhaustivity. The implied necessity in this picture of modifying standard binary logic to include temporal and modal aspects has been recognized by Simons. However, the limitations of such modifications were outlined in Chapter 1. Further, it is not clear how the two relations exist concomitantly.

The LIR view is that the absolute and non-absolute part-whole relations indeed have different logics, but that the interactive relation between part and whole that depends on PDO is not captured by them, given the classical conception of identity. The NEO categorial division into separable and non-separable process entities thus adds an additional dimension of 'non-classicality' to mereology as it does to logic.

5.2.2 Inter- and Intra-theoretic Relationships

Relations between theories and the data or observations they contain, as well as relations between theories, have been studied extensively. The following

[5] In LIR, continuants are regarded as processual entities, and there is no epistemic cut between continuants and processes.

are among many the many subjects that might usefully be addressed by LIR: contradiction and opposition within theories; reduction; and theory change.

In Chapter 1, I mentioned the LIR view of the definitions of reduction of Kistler and Batterman. The dialectical view of Batterman (2002) offers an interesting example of the application of NEO to theories. It suggests that a range of striking phenomena arise at singular asymptotic limits for the relation of two theories. The properties of systems at the limit values, he argues, cannot be derived from the more fundamental theories; instead, they require one to make use of a special-case theory involving elements of both the original two. Theory change is another subject with an extensive literature, and I will return to it in Chapter 6. Here, I will discuss the perhaps less familiar topic of conflict or opposition between theories.

I assume, first of all, that it by now an accepted fact that real empirical data can be inconsistent, and that it is not irrational to accept inconsistent theories (Bueno and da Costa 2007). It is also clear that since nothing is absolutely certain in science, all theories are fallible and subject to revision. Further, most simply, a theory in which there is an inconsistency between it and specific observations should be rejected, pending further experiment. Contradictions that are internal to a theory, or exist between two theories can be handled, Priest suggests (2002), by an adjunctive paraconsistent logic, and this is acceptable in LIR as well, since the Axiom of Conditional Contradiction reduces to paraconsistent logic for non-dynamic relations.[6]

By *opposition* between theories I refer to the real, polemical interactions between holders of opposing views that may or may not be partially or (almost) totally incompatible. Such interactions are horizontal (intra-level) in my framework and can be viewed logically as instantiating the PDO as first one and then the other protagonist prevails in the argument. My reason for preferring LIR to some form of independence friendly logic (IFF) such as those proposed by Hintikka is that I believe such opposition is not a 'game'. There are two principal possible situations: (1) the players are solely in a survival mode, in which case the applicable logic is classical binary logic; (2) they are in a collaborative and/or partially irrational mode. Here, the possibility for emergence of an included middle position should be included in the logic, and it is in LIR.

Béziau proposes a "Logic of Confusion" to describe how different, incompatible viewpoints, including theories, may be put or handled together, using a paraconsistent discussive logic based on that of Jaskowski (Béziau 2001). This construction is successful, in my opinion, and Béziau looks forward to the extension of this logic of confusion to one in which is neither paraconsistent, nor paracomplete and in which implication is anti-deductive, perhaps in my sense of negative implication.

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[6] Priest states, flatly, that reality itself is inconsistent. LIR says that reality is contradictory, but it is consistently so! Note that as phenomena approach, asymptotically, absolute non-contradiction, they also approach consistency.

In this strategy, a real-world situation is taken as the basis for theoretical analysis, which does not yet tell us much about our arguing philosophers or logicians. LIR will not answer the question of who wins the argument or if anything of value comes of it, but sees it as an example of the structure in and of reality that makes it, also, logical.

I propose the logic of/in reality, together with its PDO and associated ontology, as a metatheoretical scheme that can deal with scientific theories and their data, and with inter-theoretical relations, where those relationships involve some kind of real, structural or structuring interactions. Theories are today more generally viewed as classes of models, rather than classes of statements or propositions (the 'non-statement' view), and the model-theoretical or structuralist standpoint is more easily accommodated by the dynamic structuralist aspects of LIR, those that are derived from the dynamic structure of energy.

Like any good empirical theory that makes an appropriate representation of a field of experience, by this definition, LIR offers a structural model of at least part of reality. The fact that PDO holds between two theories is not intended to imply that it exhausts the relations between two theories, for example of reduction or emergence. That fact would, however, offer an element of *compatibility* between *some* theories. I wish to emphasize the 'some' because there are many situations where the degree of interaction is too weak.

The distinctions between inter- and intra-level reduction, like other distinctions, often become dichotomies. It is accordingly useful, and very much in the spirit of LIR, to look at the two types of reductionist activities as interactive. Wimsatt (2007) places the emphasis where it should be, namely, on how science is done. In this approach, an intra-level reduction is a successional one: when a new theory reduces to an old one, it is thought to replace it. The entities and relations involved are at the same level. This is reduction of theories in the physicists' sense. An inter-level reduction involves articulation of a lower-level mechanism, the operation of which is sufficient for the emergence of the higher-level system property; mechanisms and properties are at different levels. It is in this type of account that explanations and new predictions become available. This is reduction in the philosophers' sense, where the less fundamental reduces to the more fundamental.

The principles of LIR could be stated in the same terms as many of Wimsatt's heuristics for fundamental problems in philosophy and science:

- Look for robust tendencies (e.g., toward identity or diversity), and for conditions under which those tendencies are likely to be realized, rather than for absolute positions.
- Study context-sensitive inferences rather than ones that are context-free, along the lines of Aerts' analysis of non-classical contextuality, in which both system and perturbation have an internal relational structure (Aerts et al. 2002).

- Rather than looking for universal theories or principles which are foundational to all the elements of a given domain, look for the conjoint application of robust principles which may be heterogeneous in application, but complement each other to give a better fit to the details of the situation.

For LIR, I seek no more (and no less) than the status of *a* such a robust principle. Whatever universally applicable characteristics LIR may have, it would be counterproductive to make their establishment the central goal of any discourse. This will I hope be apparent in my treatment of complementarity in the next chapter.

Reduction*ism*, understood as a metaphysical doctrine that denies or discredits the explanatory and/or causal power of higher level entities or phenomena still has its advocates, as we will see later in this book. I will not enter into this further area of polemics here. I would say simply, with the chemist Roald Hoffmann (2007) that vertical understanding, corresponding to classical reductionism and horizontal understanding are involved in any scientific or philosophical undertaking, and human beings mix up the two modes of explanation. The process is a typically dialectic one and the rules of alternate actualization and potentialization of LIR apply.

5.3 ONTOLOGY AND METAPHYSICS IN PARALLEL

In Chapter 3, I began to discuss the relation between ontology, as the study of being, what is, and metaphysics as a universal discipline that is concerned with the fundamental structure of reality as a whole. Metaphysics therefore includes ontology and science, as well as the status and validity of metaphysics itself, as proper subjects of study. The LIR approach emphasizes the *relations* between the structure of reality and the role of the ontological elements in that structure, the fundamental dualities, recognizing that the relations between the elements also define a dynamic process of alternating actualization and potentialization.

The metaphysical world-view that is implied by the PDO is compatible with the metaphysical revision that has been "engendered by quantum mechanics" (Redhead 1995). I do not have to have a prior 'orthodox' concept of reality in order to define the best possible active role for what I observe, namely, that dualities are present at all levels of reality, starting with that of the quantum field. The dualities in question have a kind of part-whole relation to the world, but one need not assume that at the end of this analysis, one will have captured all the essential aspects of the world. I will not have, as a consequence, a 'Theory of Everything' (at which I was not aiming in the first place), but I will have a framework that can evolve in parallel with further development in the physical understanding of our universe.

The role of categories in ontology, independently of the formal mathematical uses to which they can be put, is essential in defining LIR as a conceptual structure that has additional explanatory power. In a categorial realist conception, as suggested by Thomasson (2004), "providing a system of categories can be seen as a, or even *the* central task of metaphysics". I believe a robustly realist position is made more plausible by the principles of LIR, since they improve our ability to discern intrinsic divisions and above all changes or movements in physical reality. For my purposes it is not necessary to decide for an ontological or metaphysical reading of the term 'category', and both can be used as they complement one another.

Von Bertalanffy questioned the concept of categories as a 'Western', ultimately bivalent concept, based on Whorfian reciprocal relation between language and world-view. I will not take a position on this issue here, but I feel that LIR naturalizes the debate on the cultural relativism of categories, as it provides a basis for understanding the differences in cultures in the same dialectical terms as other phenomena. I simply agree with von Bertalanffy's conclusion (Von Bertalanffy 1969) that "they (categories) must, in a certain way and to a certain extent, correspond to 'reality' – whatever this means in a metaphysical sense."

Seibt's definition of ontology is as an explanatory theory of truth-makers of sentences, and the project of ontology as a theory of truth-makers is a prudent one. It is distinguished from metaphysics by being metaphysically neutral, that is, ontological theories specify what makes sentences of the theory true without being committed to any particular theory of truth. Ontology in this sense is best compared with semantic theories of inference, which discuss patterns of formal and material inference. Such categorial inferences are the phenomena that ontologists try to explain by devising a description of the truth-makers for the sentences involved in them.

As one reads through the scientific literature, the terms ontology, ontological and ontological theory are found relatively frequently. However, there is rarely any reference to a process of drawing the categorial inferences regarding the most general entities of the domain that are the 'data' of an ontological theory. I can only conclude that 'ontological' is generally used as a synonym for what is *metaphysically* real. In the dynamic logic of/in reality, an inferential phenomenon is, exactly, a phenomenon, that must be characterized in the same way that all phenomena are by its dynamics as a process, by itself and in subsequent interactions.

The fact that Seibt founds ontology ultimately in agentive experience and intuition is a reason to look closely at the similar founding of LIR in experience as well as physics and being. I recall the reference to experience in the presentation of the axioms of LIR and in relation to the LIR definition of processes in Chapter 3. Because everything in reality is logical in the LIR sense of incorporating relations of dynamic opposition, the experience of those relations is also logical, and logic and experience become interchangeable terms. Further, in the epistemology

of LIR, intuition is not something accidental and purely irrational, but is also linked contradictorially to knowledge in the usual sense.

My hope is that by the end of this book, I will have established the LIR system as 'serious metaphysics' in the sense that Bloomfield (2005) has given to this term. I have the same negative reaction to attempts to study the characteristics of 'possible worlds' that bear only hypothetical relations to this one, and I much prefer to focus on how things actually are.

I thus agree with a critique of a metaphysics that

> garners 'putative' knowledge about the nature of reality, our actual reality, by attending to worlds which are logically consistent but which are nevertheless impossible given what is actually true. Attending to these actually *impossible* worlds yields metaphysical 'knowledge' that is actually founded on ignorance.

My criticism of the philosophers who espouse such positions is that they accept a definition of a possible world as one that is *not* logically contradictory. The thesis of this book is the exact opposite. The real world is only possible because it *is* conditionally logically contradictory, that is, partly inconsistent, as pointed out in Chapter 3. A world that is totally non-contradictory is an abstract entity.

The metaphysical prescription is clear: one should stick to a discussion of those possibilities, or better, potentialities, which relate to the actual world – reality. This is the way to carry out the basic task of serious metaphysics, namely, to learn about the nature of the single truly real and actual world.

From a pragmatic standpoint, there is much to be gained in developing the ontological and metaphysical approaches in parallel. In formal terms, metaphysics can be an investigation into the reality and adequacy of a conceptual structure for a scientific theory TH (whose source is an ontology as a theory of truth-makers for TH, i.e., also a description of a model structure for TH) as well as a description of the entities of reality and their behavior. Advantage can be taken jointly of both ontology as a semantic level of interpretation and the LIR metaphysics of material categories in an interpretation in terms of the laws of physics. I claim that a complementarity exists between, for example, inference viewed from the two perspectives. The relation I propose can be seen as an example of the fundamental principle of LIR, since when the ontological aspects of a theory are actualized, e.g., the theoretical character of its constructs, the metaphysical and physical aspects is potentialized and *vice versa*. At the same time, it formalizes another example of agentive intuition, namely, that of 'looking at something from two points of view'.

I should repeat that it is essential not to confound, confuse nor conflate the ontological, metaphysical and logical standpoints. Ontology and metaphysics themselves are not totally separate nor the same but 'inform' each other not only heuristically, in what I might call a transdisciplinary spirit, although this is also a highly desirable goal, but also as models of reality, dialectically.

I will speculate further here and suggest that in fact logic in reality, metaphysics and the ontology that I have developed from them can be seen, non-metaphorically, as a triad, each member of which is the included middle of the other. If one concentrates on the interaction of the logical and metaphysical aspects of, say, the process of implication, as in my logical calculus, an ontology emerges, and so on.[7]

The philosophy of LIR is transdisciplinary, and any contribution it could make to research on reality – in physics, ontology and metaphysics – will require many interactions with other disciplines at both specialist and generalist levels. But it is a novel theory, and the discussion in this book should be seen only as a prolegomenon to the much deeper analysis that is required to take into account the enormous weight of prior work.

5.4 THE STRUCTURE OF REALITY IN LIR

I assume that reality, the domains of which all theories try to describe, has some logical and categorial as well as physical structure that can be further articulated beyond the bare establishment of the categories as the ontology of LIR in the previous chapter. Thus, the most important task at this point in my development is to insure that the structural characterizations of reality in LIR are sufficiently dense.

In previous Sections, I have referred to structures at various points, but the concept or 'structure' of structure – conceptual, mathematical or physical – has been left undefined. The description of reality in terms of levels also has left undefined the structure of the processes occurring at a particular level. I will begin this discussion by defining the conceptual structure of reality as it emerges from my LIR theory at this stage. This concept of structure will be the basis for the discussions of structural realism in science in Chapter 6 and cosmological structure in Chapter 7. It is important to distinguish three broad but certainly not totally independent definitions of structure: (1) as an object consisting of some physical parts – a building; (2) the relations of those parts to one another and to the rest of the world; and (3) a mathematical description of that set of relations. It is the relational description of structure that I will emphasize in what follows.

Seibt has suggested[8] that the structure of LIR, as a metaphysical metatheory, is in a sense as abstract as structures in mathematical category theory, that is, the structures have themselves other formal theories and real phenomena as their instantiations. Above, I have shown that the PDO is a theoretical, formal function that is to be interpreted *realistically as designating real properties of phenomena*.

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[7] I have adapted this idea from the 'trialectic view of reality' of Craciunescu in which each member of the triad of epistemology, poetry and metaphysics can be the included middle of the other two (Craciunescu 1999).

[8] Seibt, Johanna (2005, private communication).

In this section, I claim that the PDO categorized in LIR/NEO defines a non-mathematical structure of reality that matches the structures of the domains of application in philosophy and science to be addressed. In my view, there are both physical and conceptual structures to be described, for example, the structure of explanations in the context of LIR to be discussed in Section 5.5 below. LIR is also a *physical* theory about real relations, that is, antagonistic ones, that is an instantiation of the largely abstract theoretical structure referred to above, and its output are physical descriptions about at least certain aspects of reality. For example, at the microscopic level, structure is described by the physics of the uncertainty principle, which has an interpretation in LIR/NEO as a case of dynamic opposition.

I therefore need to look further at the 'organizational' structure of reality established by the categories of NEO; the structure of reality as prescribed by LIR; and the structure of the domains of application.

5.4.1 The Categorial Structure of Reality in LIR

The formal ontology of LIR, New Energy Ontology (NEO), like any other category theory, is an abstract theory about what there is in the world, and it is an abstraction from empirically gained knowledge, and in particular knowledge about its dualities, as indicated in Chapter 4. In the standard view, categories are supposed to reflect the most basic divisions among entities and are accordingly supposed to represent the most basic part of the structure of the world, arrived at by a systematic analysis of its objects.

I do not wish, at this point, to get into the discussion of whether Energy, for example, or Process, is in some sense more or less basic than, say, Existence, Becoming, Sense, or Essence, all of which are categories that have been claimed, in one system or another, to be the 'most basic'. What I see in category theory that is relevant to the core thesis above is some of the 'machinery' of the categorical approach that allows one to see the domain of application of LIR and NEO.

The relations between categories are as important as the categories themselves in defining the structure of the world. There are two ways in which these relations can be described, the first being part of formal, mathematical category theory and the second the more classical informal concept of links between categories.

5.4.1.1 Morphisms and Functors

In category theory, a morphism is a function between two objects in a category that defines the relationship between them, how the structure of one can be 'mapped' onto the structure of the other. In non-technical terms, a morphism guarantees that the two objects have, in some important respect, a similar structure

and form. In category theory, the nature of the objects or entities in a group of categories is irrelevant. What characterize a category are its morphisms. In the NEO category of Energy, there is a classical identity morphism that maps Energy on to itself. If one takes two objects in the category of Non-Separability, say, the pair of a theory and its contradictory theory and another pair such as genotype and phenotype, the contradictorial aspects of the first map on to the second, no matter how disparate.

A functor is a morphism or function between categories that insures that the morphisms within them are preserved.[9] An example from NEO is a function (functor) that 'goes' from the set of processes within the category Process to the category Subject-Object and preserves the structure of Process in the sense that the actualized aspect of a process is a subject and a potentialized one an object. Again without going into technical aspects, the existence of these properties is an indication that my categorial scheme is valid.

The functors, at least informally, operate as might be expected: everything in Energy maps to Process; Process maps to Separable and Non-Separable; Non-Separable maps to Subject, Object and Subject-Object; and Subject-Object (recalling that 'subject' and 'object' refer to actualization and potentialization as agent and patient respectively) maps to T-states. This defines a kind of hierarchy and justifies my calling the relations functors.

Regarding the morphisms within all the categories, the mappings, it may be a consequence of the theory that they look very much like the axioms and ontological predicates themselves. If one takes two processes or T-states, etc., *X* and *Y*, then there is either a substantial contradictorial interaction between them or there is not. If there is, they belong in the sub-category NSC of the category of Dynamic Opposition. Within NSC, the single morphism or 'mapping' must be interpreted as the relation of dynamic opposition itself. This is true also of the category of Energy, in which the function of self-mapping, which is a standard operation in category theory, involves the same principle, but it is clearly non-classical in that it includes a self-duality. These results, which may be considered anomalies, arise in my opinion from the fact that category theory was designed to handle objects, including processes or events, whose major characteristic was their absolute identity.[10]

The above discussion further defines NEO as a categorial system, albeit a non-standard one. In principle, given five categories, there are twenty functors corresponding to the ten mapping relations and their inverses. Only some of these, however, are important enough to be discussed as such. The point of this exercise is that the set of functors between the five categories of NEO define a conceptual

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[9] I accept the concept of preservation here, in contrast to its use in propositional logic; truth preservation is not directly applicable in LIR.

[10] This picture nevertheless leaves place for the categorial features of both exhaustivity and exclusivity: an entity either instantiates contradiction or it does not. There is no partial contradiction. Similarly, to say that something is the same and/or different is exhaustive.

structure that in and of itself is a structure or structuring of reality in which dynamic opposition is operating in several different ways at the same time.

In his discussion of closed categories and toposes, Lawvere (1994) develops a categorical refinement of Hegelian opposition and defines an 'adjoint functor' that "is a precise realization of the allegedly nebulous notion of *unity-and-identity-of-opposites*". With these tools, he appears to resolve some of the problems I have addressed, for example, the relation between the subjective and the objective. Also, given two categories U and P, where U is a neighborhood of P, a new category B (I am simplifying somewhat) can be obtained that depends on a binary relation of 'interlocking' of sub-categories. Lawvere believes the system of adjoint functors expresses the objective dialectical relations at the heart of a given field. Since logic is the study of what is universal, one arrives at what he calls the objective logic of the field. Similarly, Magnan and Reyes (1994) state that in this way, classical logic appears as a particular presentation of the objective logic of the category of constant sets. Their search is for an objective logic of the universe of graphs that is richer, and they also suggest that universals of the mind may be expressed by universal properties in the theory of categories.

There categorial constructions seem to me to lack dynamic reality, despite references to them as models of becoming; the phenomena that are treated are, again, limited to simple processes. Perhaps too concisely, I could say that they lack any metaphysics. The reliance on the set of non-contradictory identities of classical logic is replaced by another set of abstractions, and this new instar of the ancient idea of the unity and identity of opposites does not suggest explanations of real change.

Classical propositional logic can be axiomatized in category theory, truth table semantics defined and the soundness and completeness of models proved. The classical functions 'true' and 'false' can be defined as categorical functions (arrows). Intuitionistic and modal logics can also be defined categorically, and even theories in various fields can be seen as being equivalent to the existence of specific functors between particular categories. I believe some forms of categorial construction can be, with suitable modifications, useful for formalization of the categories of LIR. Dynamic systems (evolutive sets), which are what LIR is primarily concerned with, can also be represented by functors. The morphisms in the category of such systems preserve the evolution and the morphisms between them are morphisms between functors, called natural transformations. From this standpoint, my categorial approach does not look too outlandish. It *naturalizes* (in the usual definition of bringing into science) the intuition behind the formal categorial concept of natural transformations.

5.4.1.2 Ontological Links

The LIR view should be contrasted with the integration made by Smith that shows a correct intuition although it retains the concept of entities essentially abstracted from their real-world dynamics. Smith (2002) explores an ideal notion of form as mathematical structure, which embraces logical, phenomenological and ontological form. Form "seems fundamentally mathematical." The formal entities referred to by Husserl as manifolds can be considered as complex states of affairs or partial possible worlds representable by forms of theories. Smith's semantics correlates the four Husserlian levels of form (expression, thought, meaning and object) and thereby integrates logic, phenomenology and ontology. This neo-Pla-tonist integration is interesting, but the logic involved is standard. In my view, it thus excludes the dynamic, contradictory properties of form, and thus does not adequately describe the real aspects of entities and processes.

Smith has listed the ontological links among entities in the different categories *assumed* in Husserl's ontology as predication, qualification, formation and representation and goes so far as to suggest that the Husserlian categories of Fact, Essence and Sense are themselves largely defined by such links (Smith 2004). These fundamentally different links entail a complex structure in the category scheme. An ontology is not a catalogue or list of objects or processes *per se*, but a general framework (= structure) for giving a suitable organization to such catalogues and lists. I note, however, that most ontological frameworks assume sets of independent entities, whereas my fundamental thesis involves the non-separability or non-discreteness (but not indistinguishability) of processes or events.

If I now look again at my list of major categories, I can also state what, in each case, is the link of the category to the entities in it:

	Link
Energy	Equivalence
Process	Change
Dynamic Opposition (SC and NSC)	Qualification
Subject, Object and Subject-Object	Representation
T-state	Formation

To give one example, the formation of T-states requires the involvement of entities in the sub-category of Non-Separability (NSC). In the example of Smith, rather than a sequence or hierarchy of categories, one finds a matrix of moderate dimensionality, 2×2 where formal and material categories link or apply to entities in different ways. The structure of my categorial scheme consists of the indicated five categories, but they are *not* mutually exclusive or intended to be exhaustive. The structure involves links between all of the categories taken two to five at a time, rather than a simple 2×3 matrix of two formal and three material categories. Nevertheless, the resulting conceptual structure is not unlike the one above defined in terms of functors. I consider that my conceptual structure can be used as a *grid* to

be placed over the phenomena being considered to help develop aspects that can provide additional explanation and predictions of their evolution.

I claim that NEO is an ontology rich enough to capture the essential types of entities of reality. As a theory of change or becoming, I suggest that it is 'deep' enough in the Whiteheadian sense to determine what it is to be an entity at all, that is, to be, namely, something instantiating the fundamental principles of dynamic opposition, which in turn define, in the metalogic of LIR, what it means to exist. These could also be called modes of becoming, defining ways in which entities become the entities they are.

5.4.2 The Structure of the Domains of Application: Set Theory

My claim was that the structure of reality matched the structure of domains of application. While this will become more apparent in discussion of specific domains, to insure that LIR can be talked about formally, I need to provide a *formal* account of the structure of reality, that is, of the processes and other categories whose entities constitute reality in my view.

The standard, 'classical' language for discussing structure is that of mathematical set theory, of which the components are elements, pairs of elements, etc. and structural relations, in particular of sets to sets. A major problem being currently addressed within this framework is the indistinguishability of particles at the quantum and atomic level. Seibt has studied this problem from an ontological standpoint; the metaphysical development I will follow here is that of Krause (2005), because of its relatively facile translation into LIR terms. As I did in Chapter 1, I will state a standard view and then the significant conceptual differences with the LIR theory.

Definition of Set

The Cantor definition of the concept of a set is "a collection into a whole of distinct elements of our intuition or thought". This definition already comes into conflict with the principles of LIR, and, from my point of view, begs several questions.

D1: In the LIR approach, neither elements of thought, nor any other elements, can be considered as totally distinct. Non-separability and asymptoticity apply also to the concepts of whole and part, such that part and whole are also related contradictorially.

Definition of Structure

In a typical semantic approach, structures are set-theoretical constructs, that is, *mathematical objects* of the form $\mathbf{A} = (A, R)$ where A is a non-empty set and R is a binary relation on A. Physics requires higher-order structures of the same kind. In set-theoretical terms, a relation R is always constructed from the objects it relates.

D2: The objective of the analysis is completely different. The relation between two elements is grounded by the Axioms of LIR and the PDO, and I want to show what this implies for the real structure of a process. In other terms, given two sets A and B, axiomatically a bijection *f* from A to B exists such that substitution of B for A always entails similarity. In other words, they have a similar structure since only one reality relation exists at this meta-level, that of dynamic opposition.

Quasi-set Theory

A relational structure in the usual sense is a collection of sets (or quasi-sets) and the relations among them. Krause introduces the concept of quasi-sets in order to define relational structures where the relations involved do not depend on the particular objects being related. Quasi-sets are collections of elements of which one cannot say that they are identical to or distinct from one another. Formally, this is equivalent to saying that classical identity in its sense as indistinguishability does not apply to the objects in the domain. In still other terms $x = y$ and $x \neq y$ are not well-formed formulas in the logic of this theory.

D3: In LIR, entities are, by the fundamental axioms, *both* the same and different, both distinguishable and indistinguishable. This seems to me perfectly consistent with the interpretation of Krause for quantum cases. I need to distinguish in some more formal way between macroscopic process elements involved in an 'active' process and objects for which the dialectics are 'frozen' (cf. Appendix 1) that is, subject to an input of energy, they are to all intents and purposes in the 'classical' part of the LIR theory. This is similar to the quasi-set situation, for such 'M' (macro) elements that *are* distinguishable, the set-theoretical description has a classical part.[11]

I thus arrive at a concept of structure, also, as an entity in the category of Process, described by a theory of non-standard sets, NSC-sets involving either a

[11] This is again similar to the contextual concepts of Aerts. It should be considered the rule rather than the exception that macroscopic systems as well as quantum systems have classical and non-classical parts.

pair or a triple of non-separable elements, A and P, the binary reality relation Rl_B and the ternary reality relation Rl_T A, P and T. The NSC-set is like the quasi-set in that it is an entity that is a collection of something of a kind, although it cannot be regarded as a collection of (1) well defined and distinct objects; (2) indistinguishable objects; or (3) entities, process or other, with invariant properties.

The relational structures of reality in LIR are ones in which the involved relations (the NSC-relations) do not depend on the particular elements being related, and the issue of having an effect, described by the relation, without some individual causing the effect does not arise. Process elements are and are not individuals. However, if, as Krause shows at the quantum level, permutations of electrons or atoms are not observable, it literally 'makes no difference'.

In this sense, NSC-sets instantiate, like quasi-sets, the ontic sense of structural reality, the Ontic Structural Realism (OSR) of Ladyman and Ross (2007)[12] that all that exists are structural relations with the only relata being other relations. Descriptions that refer to any process of change (if I may be permitted a locution that is redundant in my own terms), *ipso facto* describe the logical if the not the total phenomenological structure involved.

D4: It is important to restate, for clarity, one essential respect in which LIR and its categorial ontology differ even from quasi-set theory: the relations of membership (of elements in a set) and inclusion (of sets in other sets) are not primitive except for ideal, non-spatiotemporal entities; part and whole share one another's properties in the LIR mereology (see above). Thus in LIR it is not only that quantum and certain non-quantum elements are separable non-individuals in the sense of being distinct and indistinguishable, and that elements are non-separable from the whole of which they are parts, it is that the parts *actually instantiate* aspects of the whole and *vice versa*.

5.4.3 The Metaphysical Structure of Reality in LIR

The structure of LIR as an ontology is thus one of a general but systematic framework. Its 'outputs' are ontological structural descriptions that are about the categories and their internal and external relations, as shown above. But LIR is also a *physical* theory about real antagonistic relations, and its outputs are also physical descriptions about at least some aspects of reality, subject to measurement as indicated in Section 1.7. LIR, in my view operates as both a meta-theoretical, general regulative principle of science and a law that can be internalized in the language of a given scientific theory proper.

[12] Cf. my discussion of Structural Realism in Chapter 6.

At the mental level, the structure of a reasoning process is given by LIR as a 'psycho-physics', in which the elements are the lower-level neuro-physiological substrates. However, this does not require *total* knowledge of the nature of those substrates in the same way that the elements of quantum physics do not need to be based on a final conclusion as to the 'ultimate' constitutive nature of the photon or electron. One thus has a metaphysical energetic picture of the structure of reality with potentialities as carriers from the lowest physical level to higher ones throughout nature. It is a restatement of the insights of the later Russell of propositions as "psychological occurrences" (Stevens 2006).

The question remains as originally posed by Lupasco (1967) "What is a structure?" The answer he gave was that structures are also dynamisms, not to be objectified and reified. Whatever rules one uses, "in order for these rules to generate a veritable structure, they must obey these logical laws or conditions necessary for its existence." Thus, using the method with which we may by now be familiar, one finds three types of structure, or rather, Lupasco said, *structuring* (*structuration*), one embodying primarily bonding forces and homogenization, another primarily heterogenizing forces and a third at a T-state between the two. Any individual structure is never rigorously actual, that is absolute in any sense, given the nature and logic of energy. It is a dynamic structuring that is always functionally associated with an antagonistic and contradictory potential structuring.

Lupasco made the following link between structure and form: the energetic dynamisms that constitute all matter and all existence, and the systems they generate, are

> pure structural forms, containers of containers, structures of structures, subject to an essential and ineluctable chain of transformation. There is therefore no such thing as a full and static form; devoid of a present, going always from past to future, or even inversely, temporality is immanent to form.

Every form, every system, all matter, in a word, is thus in LIR terms a real process.[13]

The structure of real processes involves the change of an energetic entity and its opposite or antagonist from a state of subjective actuality to one of objective potentiality or T-state. Structure is thus defined by the sub-category of Non-Separability. The values (degrees) of actualization and potentialization or T-state are logical in that they depend on this syntactical structure as well as being context-dependent.

What does this mean for a structural model or explanation? Does it make sense to consider them, also, as dynamic forms, subject to potentialization and the actualization of their contradictions? I think the answer is yes and no. As formal objects *qua* their meaning, the structural descriptions of LIR as such, like

[13] Lupasco designated all such processes as 'non-ontological', which meant everything that was becoming, experience and logic. He used ontological to refer to being, which for him consisted only of affectivity (affect).

all propositions, belong in the category SC of separable, in this case non-spatio-temporal entities, the data of standard inference; however, considered as processes capable of change, they are from this point of view in NSC. I would include in the list of structural models those displaying a sequence of argumentation in which the advantage oscillates from one antagonist to the other.

The structures of all elements or entities in this non-separable category gain their explanations from LIR as a metaphysical but also physical theory. The elements *are* process structures, in the 'NSC-set-theoretical' sense and their deterministic dynamics is that described using the non-Kolmogorovian probability language proposed in Chapter 1. The criteria for applying this concept of structure-as-process, given a process of two elements are those indicated above as the requirements for application of the two-tier framework for analysis. Another way of saying this is that a 'structuring' seen externally is a kind of form; looked at internally, it consists of the processes themselves. Metaphysical structural explanation is a matter of picking out the elements in the category of Dynamic Opposition and showing what is involved in the operation of the PDO. Being very general, I can take as 'examples' the structure of existence – life and growth *vs.* death – and the structure of the universe – the increase of negative energy, the probable cause of the current expansion *vs.* the decrease of normal and dark matter-energy. After this it gets easier!

I will now mention two other theories of the structure of phenomenological reality, indicate their strengths and weaknesses and develop the LIR concept of structure based on the categories of NEO in relation to them as well.

5.4.4 Figure Versus Ground: Gestalt Theory

Two of the most discussed aspects of structure in reality that have been formulated as dichotomies in both ancient and modern philosophy are form *vs.* matter and figure *vs.* ground, in which the concept of form also plays a key role. Their analysis will illustrate how the concepts of LIR play out in relation to terms between which a relation of opposition is generally accepted. I will discuss the second of these first.

Gestalt theory was collated and formulated as a broadly interdisciplinary theory providing a framework for analysis of a wide variety of psychological phenomena and processes (Lupasco 1967). Its basic concept is that of an interacting figure, a form or process in a foreground that stands out against a background or 'ground'. Applications were also seen in non-individual reasoning processes, for example group dynamics. Köhler showed the existence of physical and psychological *Gestalten* with properties *similar* to the perceptive or phenomenal, in an attempt to establish an isomorphic relationship between phenomenal and physiological processes. The Gestalt psychologists determined empirically that one never perceives isolated elements that are somehow combined or associated into perceptions and objects and that, further, any modification of either figure or ground

modifies the entire ensemble – a form. This amounts to a psychological exemplification of non-separability applied to sets and their elements (see Appendix 2).

The figure-ground duality as a structure in reality is easily incorporated into LIR, and without going further into its historical development, I can put the original positive contribution of Gestalt theory on a sounder theoretical basis. According to the fundamental principles of LIR, structures or forms cannot be reduced to syntactic assemblies that can be manipulated by substituting, for the organicity of the structures, that is, their dynamic stability, systems of simplified relations between terms. This would represent a reification of connections, characterizing terms only *via* positional values that negates *a priori* all the phenomenological characteristics of structures, including, in particular, the dynamic phenomenological shifts in perception that take place between figure and ground.

The Gestaltists did not show *why*, by virtue of what principle, interactions between figure and ground should exist and behave the way they do. In LIR, both figures and their related grounds are sets or classes. If one agrees that a set or a class is always a duality of sets or classes, one identifying and the other diversifying, linked by dynamic, structural interaction (contradiction), one can see that the adjunction of one more identity or diversity can modify their union. The psychological data reported by the Gestalt psychologists provide an illustration of the dynamic logic of the contradictory. Seeing that figures and grounds are related contradictorially, that is, alternately actualizing and potentializing one another, relates them to the processes of which they are the physical and logical consequence. Elements never just "come together" to generate an isolated form. Rather, since every element is itself a form, it is apprehended in the form in which it is included, and every form distinguishes itself as a form, in relation to the form that surrounds it, on which it appears, which constitutes a ground, which is also a form.

5.4.5 Form Versus Matter: Catastrophe Theory

Another ancient argument is whether form, geometrical position, or matter is more fundamental in the universe. In the last half of the 20th Century, Thom and Petitot developed a theory of morphogenesis, the origin of form, in terms of a relatively small number of topological graphs of geometric singularities, called catastrophes. In this theory, form is the most fundamental aspect of the phenomenological universe, that is, what is accessible to human perception.

Catastrophe theory (CT) abductively permits the classification and prediction of the singularities of the morphogenesis of a system, even without knowledge of the underlying dynamics or that of its macroscopic evolution. Petitot showed that in addition to providing a method for modeling phenomena studied in the natural sciences, CT was able to constitute an objectivity of phenomena of social sciences (humanities), language and thought. Petitot said that CT 'purified'

phenomenology from the quasi-mystical Husserlian vision of essences, brought back to it the mathematics that Husserl had refused to accept and transformed its philosophical task into a scientific program. CT thus had the right to be considered the first synthesis of geometry[14] and phenomenology and a serious option for the naturalization of phenomenology.

The reason that it is essential to discuss CT at this point is that it constitutes *a direct challenge to the fundamental principle of LIR, namely, its grounding in the irreducible and oppositional duality of energy*. If form is in part as fundamental as CT claims, then, in the spirit of LIR, a proper theory should not exclude, either matter (energy, force, substance) or form, but show how the two work together.

CT, however, was an attempt to be "the creation of a theory of morphogenesis *in abstracto*, *purely* geometric, independent of the substrate of the forms and the nature of the forces that create them." CT is to a certain extent a local theory of the most general possible undifferentiated substrate, in which one can see a resurgence of the Aristotelian scheme of *hylomorphism*, matter aspiring to form. The resistance of biologists to CT was supposed to be due to the underlying idealism of this concept and the tradition in physics of the ontological primacy of energy (force) over form, whereas the CT position is that "there is no reason to think that force has in principle a deeper ontological status than form."[15]

This principle is constitutive for CT, as it rehabilitates *formal* causality beyond material causality and affirms that for all reality, the morphological-structural order is constrained by a mathematics, by Platonic ideas – laws of form – that nature is 'obliged' to realize. However, and we will see here the rationale of this long excursion into idealism, Petitot insists that this principle, and thus presumably CT, "is only valid *locally*, the integration of local accidents into a global structure giving back all their rights to the real and specific internal dynamics, unreduced, i.e., to 'matter'. Matter often imposes additional constraints, but the macroscopic global appearance, form in the usual sense of the term, comes about by the aggregation of a great number of local accidents, and the statistics of these local catastrophes, the correlations that control their appearing in the course of a given process, are determined by the topological structure of the internal dynamics. "It is by the topological richness of these internal dynamics, their more or less integrated character, that is explained, finally, the almost infinite diversity of the appearances of the external world."

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[14] This is not the only attempt at the geometrization of human concepts. Mazzola, in his 'geometric logic' of music indicates that the Yoneda 'revolution' in mathematics achieves this, but he also explicitly states that this categorial approach is based on an 'absolute' logic derived from the three fundamental classical axioms (Mazzola 2002).

[15] The intuition that form is fundamental goes back to Plotinus and Plato, and I see it as defining a type of personality or mentality that is simply the opposite of those who seem satisfied with a view of matter (or matter-energy) as fundamental. The concept of form as fundamental, in the LIR view, is wrong only if it is considered to be *exclusive*.

In my view, the CT approach is a 'textbook' example of the reduction of heterogeneity to the non-logical status of accident. Even for those who are not familiar with the ideas of this book, the above separation into local and global regions in which different principles apply may look suspect. Energy is not an 'undifferentiated substrate'. LIR undercuts the exclusivity of the CT approach since neither form nor matter-energy need be considered primary in the sense that matter-energy also has structure, = form, given by antagonism. It is in fact what I designate as the *foundational differentiation* of the effective quantum field that is the origin of form and everything else.

In a later paper, Petitot and Smith (1997) claim that it is *separation* that accounts for phenomenal reality and *discontinuities* that serve as a central organizing principle of the phenomenal world.[16] The authors appear to be maintaining the principle of bivalence as a total exclusion or disregard, with the laudable objective of coherence, of one of the terms of a dichotomy or duality. According to my categorial scheme, the Petitot-Smith approach would be applicable only to phenomena in the category SC. Indeed, most of the examples used in the paper refer to simple, macrophysical changes of phase.

Thom thought that the principal epistemological and ontological interest of CT was to go beyond the antinomic disjunction between a mathematically determined physical being and linguistically described phenomenological appearing (*apparaître*) and then reconcile them by integrating catastrophic infrastructures into the mathematical determination of phenomena. CT proposes that one can postulate that these infrastructures constitute an objective correlate of the qualitative linguistic descriptions in sciences, which are founded in "things themselves". The consequence is that one could go beyond the division of the subjective and the objective and convert this 'central problem' into a scientific one. In his reworking of Thomian idealism, Petitot (1988) asks how,

> if one adopts the standard doctrine of objective explication by invisible entities (forces, atoms, fields, etc.), governed by principles and laws capable of being defined mathematically from the geometry of space-time, can one 'redescend' from such an objective, mathematically determined reality to visible morphologies?

The answer based on LIR is that one *cannot* using the standard doctrine of forces, etc., because it excludes the key antagonistic principles which allow differentiated entities to be built up by and from them. Most importantly, the principles of LIR provide for what Petitot described as "reciprocal interactions between an entity and its environment that allow for 'emergence' (Petitot put emergence in scare quotes) of morphologies by self-organization of material substrates." From this point of view, one does not need to speak of the appearing of phenomena or manifestation as irreversible processes that the laws of physics, interpreted as in this book, cannot describe; the observable discontinuities of a phenomenon do not

[16] I note that these authors claim no causal predictive or explanatory power for their theory.

have to be separated from its physical objectification, and the relative continuity of its existence.

If the separation proposed by Petitot and Smith exists, how can the phenomenon, in its appearing, not be degraded to a "simple subjective-relative appearance? How can a realist doctrine and an ontological conception of the 'semiotic constraints of the perceptive organization of the real' be reached?" Petitot proposed that a transcendental objectivity of pure manifestation can be constituted by identifying manifestation and morphology. A geometrico-topological analysis defines, for every spatio-temporal process, 'factors of phenomenological invariance' that play a fundamental role in their verbal description and consequently the linguistic organization of our vision of the world. "Can one not admit that these factors derive from the real properties of the objects of the external world, and manifest the objective presence of formal entities linked to these objects, and of which one can say that they are carriers of signification?" Given the correlation between manifestation and meaning, the synthesis between phenomenology and objectivity permits the foundation of meaning in phenomenological objectivity. If one admits this, CT can permit a geometric modeling of ordinary verbal thought that can "replace *semantic* intuition, with its immediate subjective character, by *geometric* intuition, that spatializes its object, and distances it from the thinking subject."

Now, one can perfectly well construct an idealist metatheory of transcendental objectivity, but it unfortunately tells us nothing about the real world. I have shown that the separation of subjective and objective leads to category errors, and this discussion is a further example, that also shows the consequence of separation of geometry and energy. Petitot also makes the statement that the factors of phenomenological invariance, the catastrophic infrastructures of phenomena, consti*tute "third terms – up till now totally missing – between description and explica*tion, between appearing and objectivity (Petitot-Cocorda 1985)." These third terms, however, cannot be dynamically included middle T-states, as there are no dynamic or even complementary interactions between the opposites involved, as I claim there are, for example, between appearance and reality.

Petitot's major project was to reformulate the Husserlian phenomenological reduction to lived experience in terms of critical reduction to phenomena by reinterpreting the original giving intuitions in terms of transcendental esthetics and schemes. For this, a mathematical formalization of categorial intuitions is essential, resulting in a new conception of the relationship between mathematics and reality. The development of mathematics realizes an authentic dialectic of concepts which transcends them and this dialectic insures a schematizing function which makes the Kantian *a priori* historical and diversifies it in regional ontologies. If catastrophe theory can pretend to be implicated in a constituting fashion in experience, it is because it is based on mathematical theories which instantiate and resolve problematic dialectic concepts (Hegelian syntheses suggested by Lautman as "Ideas"). The impression that one retains from these conclusions of Petitot is that of arriving back at real phenomena after a lengthy detour. If phenomena

themselves instantiate dialectics, then they (the dialectical relations) can be considered as ontologically constitutive, and the dynamic view of dialectics in LIR provides physical explications of them.

There is an assumption by Petitot that his *theory* could be the source of objectification of the virtual aspects of phenomena. It is possible that Petitot really means that an objective phenomenal reality precedes intrinsic mathematical reality, but then he should say so, and provide adequate characterization of those 'virtual aspects'. My criticism of CT is not that it possesses a transcendental signification in its own terms for the constitution of a morphological-structural ontology, but that a link to real phenomena is not made.

A major objection made by Petitot against logic is that *it* is inadequate to give an adequate account of real phenomena. On closer inspection, it would appear that the logic under attack is classical, exactly that which, in contrast to LIR, is absolute, idealized and abstract. If so, it never had the capability of providing an adequate description in the first place.

In his dynamic structuralism of language, to explain denotation, the relation of description between language and external reality, Petitot-Cocorda (1985) postulated a phenomenologically real, non-linguistic *third term*, the state-of-affairs. Is this to be considered as an included middle in the sense of LIR? I think not. Petitot proposes this term for constraints imposed by the physical world, leading to catastrophe theory as a synthesis between phenomenology (appearance) and physical objectivity (reality). This synthesis makes possible the mathematical definition of "factors of phenomenological invariance" as objective formal entities. In LIR and NEO, the approach to states-of-affairs is not to seek invariants in them. An invariant is by definition excluded from being a part of a reality in which elements undergo change. The phrase used by Cassirer of "invariants of experience", as well as the one above, are for me oxymorons. I mention the Petitot program[17] simply as reflecting another view of general relativity as geometry, excluding a functional dualism of the LIR variety.

In order to complete the general discussion of the methodology of application of LIR, since LIR is proposed as theory of explanation, I must also look at what *this* means and to what extent LIR can answer 'why'-questions. The theory of explanation itself is an area of current philosophical debate, and it is therefore appropriate that I define (explain!) what I mean by explanation, that is, *its* elements or structure.

[17] As a further indication of the exclusive role of geometry, Petitot quotes Deleuze to the effect that the *a priori* of his structuralism is *topological* and not logical.

5.5 WHAT IS AN EXPLANATION?

The key questions to be asked in this connection are "What is an explanation?" and "What are explanations of?" Answers to these questions developed over the last half-century tended to focus on linguistic aspects of explanation, explanation as a set of propositions of some kind. The necessity of relating explanation to an underlying theory of real phenomena has now been recognized, but attempts are still made to restrict this to a purely formal operations of deductive inference, dependent on a standard first-order, consistent logics or neo-classical inconsistent logics. In the last few years has it become apparent that such approaches provide only partial insight into what really constitutes an explanation, namely, a description of both why and how a phenomenon is observed.

5.5.1 Two General Failures of Explanation

In both philosophical and logical texts, one is struck by the frequent similarity of the forms of argument used and of the description of the difficulties encountered by the respective theories. I will characterize these, for brevity, as 'both-at-once' and 'spontaneity'. The common property of such attempted explanations is that they are in fact nothing but descriptions of phenomena, lacking a detailed characterization of any underlying set of principles or mechanisms that could entail the changes involved. Some ancient and current examples serve, as much as anything, to show the persistence of the problems and difficulties.

5.5.1.1 'Both-at-Once'

The idea that the world instantiates situations which can be described as two opposing things existing at once is mentioned in the Diamond Sutra in Buddhist Scriptures (ca. AD 350) – neither a thing (dharma, for which some ten meanings have been given), nor a non-dharma. The Jains (Stcherbatsky 1962), however, also in the first half of the 1st millennium, made similar statements positively, taking what might be called the first real dialectic position. The nature of reality, they said, is permanent and impermanent at the same time, finite and infinite, particular and universal. They realized that a being with absolute identity would be unrelated to all others and could not exist, but without some identity, it would be indistinguishable from everything else. Many authors use this construction when they are unable to provide a satisfactory explanation of the phenomenon under study. However, no explanation is given of how such states of

affairs might be instantiated, and the phrase ‘both at once’ can only be understood metaphorically.

Barel (1987) developed a concept of paradox as contradiction, an entity being at the same time digital and analog, discontinuous and continuous, and *as a metaphor*, particle and wave. The part of a phenomenon is at the same time smaller and larger than the whole, and inversely. An intuition of intermediate states is present, but it remains too arbitrary to be useful.

A related expression that is often used is ‘fusion’. One senses here a sincere, not to say desperate desire to understand and explicate a phenomenon, but almost no serious meaning, even in conceptual, philosophical space, can be given to fusion (or mixture). Superficially dynamic, it actually describes only a simple stochastic process. It may imply an interaction between two terms or elements that fuse, but it fails to give an adequate picture of the rationale, content or consequence of the change involved.[18]

A relevant example for this study is the view of quantum mechanics developed by Bohr. In his Copenhagen interpretation, to explain problems of quantum measurement, he saw that quantum entities had to be described as both continuous waves and discrete elementary particles at the same time. He avoided contradiction and paradox by defining a concept of complementarity, equivalent to ‘both (A and not-A) at once’. This interpretation is now generally conceded to be inadequate, but totally satisfactory replacements have not been developed, as I will discuss shortly.

In summary, although the phrase ‘both at once’ fails as explanation, it points towards situations in reality that can are targets for better explanation, whether in philosophy or science.

5.5.1.2 Spontaneity

In work in process ontology, philosophy and metaphysics, dealing with quantum reality, life, consciousness, and emergent organization, there still regularly appear in the argument points of admission of impotence. Whether the authors regard teleology or chance as fundamental, they postulate some arbitrary kind of ‘spontaneous processes’ and/or underlying idealized structures as the basis for order in the universe throughout ascending hierarchies of complexity. New laws and properties accompany emergent processes, but no foundation or underlying cause is suggested for their existence. I note ‘chance as spontaneity’ in Peirce; Bohm’s underlying unity; Varela’s autopoiesis; the ‘creative spontaneity’ of Rescher; Popper’s propensities; Kauffman’s spontaneous computational ‘order for

[18] A recent example (Miller 2006) is the search for a ‘bridge’ between two traditionally opposed hypotheses about how we infer the mental states of others: simulation theory (mirror activity) and theory of mind (use of abstract rules). It is suggested that rather than being mutually exclusive, the theories may describe “two processes we can mix together”.

free' plus evolution and Salthe's 'autonomy' to name a few examples. These issues are important, since the invocation of spontaneity is directly linked to critical metaphysical problems of the underlying existence of continuity *vs.* discontinuity and determinism *vs.* indeterminism in the universe, as well as the importance of cause in scientific theories.

Peirce (1998), for example, shows here again the combination of a correct new intuition, that metaphysics cannot require that all the details of phenomena are determined by law ("Now, metaphysics has always been the ape of mathematics") and a, from my point of view, classically false one, namely that the variety in the universe is arbitrary and "*This variety must be attributed to spontaneity in some form.*"

An interactive Internet project proposed by the authors of the encyclopedic Principia Cybernetica Web (PCP) attempts to answer fundamental philosophical questions, and the site is organized as a complex network of mutually dependent concepts and principles. The authors' intention is to ground philosophy in change and development, rather than static concepts of matter, substance or mind, but they see evolution as the expression of a blind variation and selection process. The universe 'self-organizes', resulting in the 'spontaneous emergence' of more and more complex organizations. What is provided is hardly more than an idea. Spontaneous emergence is no more grounded here than in far less sophisticated models from Aristotle on. These remarks do not apply to the concept of spontaneous symmetry breaking (SSB) in statistical mechanics and quantum field theory. In the former, SSB can be described as a change in the order of a system due to instability under small statistical perturbations. In the latter, 'spontaneous' refers to a situation in which a member of a set of symmetric physical states is conceptually selected as a ground state, in which case symmetry, conceptually again, is said to be spontaneously broken. The basis of the term is not in question here.

Even Husserl fell back on spontaneous beliefs as the basis for transcendent intuition, that which places us in contact with the causally connected individuals that constitute the domain of natural realities. In his idealist system, it is the source and foundation of our belief in the world and nature.

I thus restate what I consider the failures of spontaneity and simultaneity as explanations:

- The absence of an explanatory mechanism for the apparent co-existence, frequent or occasional, of opposing or contradictory elements
- The lack of physical grounding of critical concepts of evolution and emergence, and recourse to one of spontaneity, above the quantum field level

The problems are, in my opinion, unfortunately quite general. They also occur in discussions of the relatively new disciplines that that appeared in the last twenty-five years or so, namely, cognitive science, complexity science and systems

science. These sciences accomplish a number of important tasks in breaking down artificial barriers between the classical disciplinary divisions in and between the natural and social sciences. Their openness to social and political problems and humanistic intuition are congenial to me personally, but I feel that most lack sufficient fundamental physical grounding to be adequately rigorous or explanatory.

5.5.2 The LIR View of Explanation

My claim is that something like a logic of reality is required for explanation that includes the antagonistic or contradictory aspects of the phenomenon under study. If LIR were only a restatement of the intuition of the prevalence of conflict of opposing forces in the world and of cyclic phenomena in nature and human affairs, it would not have much new explanatory value. The essential addition of LIR is the demonstration that this intuition has a scientific basis, grounded in the physics of the universe that can be formalized as a logic or logical theory. In my view, a theory that did not take into account the *existence* of constitutive dynamic opposition at cognitive levels would in my view already be likely to be incomplete or misleading, and in any event not provide a satisfactory explanation of the phenomenon. To say that a trend toward reductionism in philosophy or science is frequently, or always, followed by one toward anti-reductionism is nothing more, as it stands, than an astute observation. In LIR, most of the explanations will be metaphysical ones, with application to metaphysical problems, but in some cases, the explicit definition of the PDO may have applications in science *via* suggestions of directions of research.

Any explanation has two components, what is to be explained, the *explanandum*, and the explanation or *explanans.* The *explananda* are the phenomenal or conceptual elements or entities ***e***. By an explanation can be understood an act of explaining, *EA*, or the piece of information conveyed under the act, *EI*. In fact, both are necessary for explanation, something that results in a change in the state of knowledge (hopefully an increase) of its receiver. One also can and should differentiate between causal explanations, which refer directly to a (clearly) physical event, and conceptual explanations, which are based on abstract relationships. These would include relations defined by classical logic. Even in these latter cases, it is necessary to maintain the proper order of *explanans* and *explanandum* such that former provides the basic concepts used in the latter. Both types of explanations involve act and conveyed information, but the validity of causal explanations depends further on the causal relation itself.

Assuming a certain degree of background knowledge B – well-recognized theories, laws and ‘facts’ from other disciplines, the essence of my explanations in the context of LIR will causal ones be a situation description S of

phenomenon in terms of the categories of NEO.[19] An explanation is usually said to be successful if there is a relation of logical entailment, in this case a deductive one, between [S, B] and ***e***. I have shown, however, that classical logical entailment is tautological in real situations. Thus one must be satisfied, in my view, with explanations that will never be *completely* satisfactory. This is a well-recognized weakness of theory, which has been recognized by Bueno and da Costa and is one of the justifications for their concepts of quasi-truth and partial structures in quantum phenomena, but LIR gives this weakness itself a further theoretical basis. The term explanation can refer both to relationship between a theory and a phenomenon and between the description of the situation and a phenomenon. In the latter case, it would be more reasonable to call it an expanded description.

There is one sense in which my categorial structure is open to criticism: it states that essentially everything is a process and instantiates actualization and potentialization and subject and object entities. I disagree. It is true that LIR is doing its explanatory work in the 'thin' sense of explanation that *metaphysical* theories can afford: structural description. I argue, however, that further structure is given to my explanations by the different way in which I have defined structure as process, that is, including the "quasi-empirical" reality values as its elements. I suggest that there is a net gain in explanatory power once it is seen that all five categories of NEO involved in a description of a phenomenon, and their interrelations, are categories of real forces at work in them and not abstract classes of some kind.

There is a further implication of LIR as 'experimental metaphysics' to use Redhead's term (Redhead 1995): the method of valid argument in current philosophy itself embodies tautological assumptions of classical logic. I do not wish the validity of my argumentation and explanation to be judged by such standards, exactly as I refuse a definition of logic as excluding the real world. I accept the consequence that efficiency will be the only criterion of the value of my approach. I will claim, non-defensively, that the consideration of dynamic opposition as fundamental, with regard to statements about laws of nature,[20] provides a new and at least as satisfactory basis for ascribing validity to my logic as to proceed along the lines of a proof-theoretical justification of the laws of classical logic (Dummett 1993). I do not need to consider logic as concerned *solely* with the validity of forms of argument, represented by propositional inference schemas, requiring a notion of truth under interpretation. I do *not* take truth for granted and I *do* inquire into the meaning in reality of the notion of truth, as in Section 2.3. The pattern of inference I will use in discussing particular theories is the one defined by LIR,

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[19] Hung (2005) describes a theory of projective explanation to describe explanations in science, among other reasons to include the role of the observer. An observer characterization O describes the mental constitution of the observer including his perceptual frameworks, beliefs, etc. It would be perfectly congenial to a metaphysical discourse such as this one to include myself as O. This would give logical status to my own prejudices.

[20] There are several key issues revolving around the existence and domain of application of laws of nature – 'scientific laws' – with which I will deal in Chapter 6.

namely, from some reality values of actualization, potentialization or T-state to other such values.

5.5.3 Explanation and Metaphysics

One debate about the nature of explanation can be readily approached using the concepts of LIR. As summarized by Bird (2005), Explanations can be further placed in two categories, subjectivist and objectivist, with the following characteristics:

- Subjectivist (S-explanation): explanation = act of explaining and what is provided by that act; anti-metaphysical – explanations are not natural objects and do not constitute part of the way things are; typically, incomplete; the relation between *explanandum* and *explanans* is syntactic.
- Objectivist (O-explanation): explanation = natural phenomenon independent of subject; deals with the way laws and facts relate metaphysically; typically, complete; relation of semantic entailment.

Hintikka and Halonen have championed formalized S-explanations as being most significant, but their theory has been severely criticized by many authors, for example, of not distinguishing an explanation from the act of providing one, as I have done above. In their defense, they say that they do consider dependence relations required for the derivation of the *explanandum* from a background theory, but are suspicious of attempts to posit metaphysical causal powers to back up such relations of dependence. As evidence, these authors point to explanations made in ordinary usage (e.g., of beliefs) that are accepted by people who do not observe causality playing any role in them. This is probably true, but it does not mean that causal processes are absent.

Sintonen (2005) mentions that the major contributor to a theory of explanation, Salmon (1998), finally embraced a two-level or two-tiered view in which relations of statistical relevance (the first level) are to be accompanied and substantiated by causal relations, and it is only at this second level that explanatoriness emerges.

A full discussion should await my development of the LIR view of causality, but the following claims are already possible using the LIR concepts in hand:

1. The two-tiered view of Salmon exactly fits the LIR two-level framework of relational analysis: the movement from actualization to potentialization at the phenomenal level is dependent on statistical considerations, and explanatoriness is the T-state emergent as a consequence of the causal relations also present.
2. Causality seems clearly essential to explanation, and if causality poses problems for formalization, one is well advised to move away from formal approaches, e.g., those that emphasize deduction as the primary feature of the explanatory process. Deducibility is metaphysically too weak to support an account of explanation.
3. In LIR, *subjectivist* stances can be given their proper value by bringing them 'home' to a metaphysical framework as real, dynamic phenomena. On the other hand, problems with *objectivist* stances can be answered by re-introducing the subject making the explanation, at least, when the explanation does not involve 'explaining' why some proposition or theorem is true, but why, and how, some phenomenon has occurred. Such real-world explanations are bound to be incomplete S-type explanations, but this is acceptable, as there is greater assurance that they are *relevant* in the sense of relevant logic (Chapter 1).

Some authors seem to have an intuition of a correspondence or other relation between S- and O-explanation. LIR provides a basis for establishing a contradictorial relation between them that will enable both forms to be applied complex situations, for example of debate about explanations!

5.6 THE ANALYTIC/SYNTHETIC DISTINCTION IN LIR

As a further introduction to the methodology of LIR and as an illustration of how some of its concepts can be applied, using the framework suggested above, I will look at the relation between sentences and reality that is implicit in the analytic/synthetic distinction. The reason that this philosophical issue is introduced is that it is critical to much further discussion of applications of LIR for which standard notions of language, truth, inference and the logic of propositions must be 'translated' into the physical or metaphysical conceptions of LIR.

In Chapter 2, I discussed the LIR conception of truth as the truth of reality, that is, of the status of real processes tending toward non-contradiction or contradiction. This is in contradistinction to a concept of truth as the truth-value of sentences. However, for my applications of LIR to philosophy and science, I will be presenting a theory, consisting of sentences. Now, when I write a sentence, I want you to believe it's true. If you can't or won't, you should at least believe that I believe it's true. In both cases (I omit some pathological ones) the truth basis of

my sentence is at issue, and I would like to be clear in what sense I want the truth-value of *my* sentences to be understood, and what meaning I wish them to have.

This discussion, I believe, is essential because LIR statements look like what are termed *synthetic* statements, that is, ones whose truth depends on matters, in particular, contingent facts about the world, to which I have ascribed a certain dialectic *structure* (see Section 5.4). Such statements are distinguished from *analytic* statements that are true by virtue of their meaning alone.

Meaning arises from the syntax and rules of the language used. Quine believed this distinction could not be made since sentences depend both on the conventions of language use and facts about the world. In addition, this definition of meaning is both circular and non-naturalist, in my terms; it lacks a link to reality. Because there is no principled way of distinguishing cognitive processes involved in analytical or synthetic statements, Quine's view has been called 'holism', since there is no way of selecting which of the causal relations involved in psychological states are also involved in the determination of meaning.

Naturalistic theories of mental states define their meaning in terms of their psychological causal relations to other mental states, such as both beliefs and behavior. This is the causal-role theory of content in cognition. If one assumes that analytic sentences exist, meaning must be something separate and distinct from other factors, but some way is still required for making this distinction. The way to do this while avoiding circularity is to have some other, non-semantic, syntactic characterization of the internal psychological states. I do not believe, however, that such structural relations need to be defined as immutable and independent of spatial and temporal location for human beings. Such distinctions *only* are valid for systems like computers, where there is total separability between software and hardware.

My claim is that LIR provides support to a naturalistic, causal-role theory of mental content and a naturalistic means of drawing the analytic/synthetic distinction. This is because LIR *always* defines a real relation between the intensional notions or aspects of a phenomenon and the extensional ones. Kaye (1995) claims that his causal role theory of content identifies the meanings of representations in the brain with the causal relations of representations that are determined by their structure and by the structure of cognition. Despite the incomplete knowledge of the details of the causal relations within our mind/brains, LIR defines the operation in them of dynamic opposition as a structural or better structuring principle. It is possible to say, now, that an analytic statement is true in virtue of the causal relations resulting from its syntactic structure and, as well, the causal relations that it stands in by virtue of the structure of the cognitive system that contains it. The consequence is that an absolute distinction between analytic and synthetic statements does not need to be fully maintained, without going to the other extreme of having to deny variations in content for different psychological subjects.[21]

[21] This means that there is not a single rigorously identical concept that all subjects must share.

In conclusion, analytic claims can provide insight into external reality, but only if coupled with a non-semantic theory that provides some basis for explanation of the coincidence between our concepts and the properties or real phenomena of the world. By starting from the side of the phenomena, LIR permits progress in this direction.

5.6.1 The Inferential Role Description

The causal role theory of mental content is a functional role theory in that it identifies content with the *role* of a representation in cognition. Here, I wish to analyze an inferential role account according to which the meaning of a mental term is identical to the role in the totality of inferences that the individual makes. In defining such a categorial account in my system, one would first need to identify the inferential role of the scientific terms one wishes to interpret with LIR or NEO and then show that the definitions of the categories in LIR fit these inferential roles in the scientific language and thus adequately capture the content of the scientific concepts involved. As a model that may help in understanding the relation between LIR and NEO, I have selected the example of the term 'perception'

1. The Scientific Term: 'Perception'

2. The Scientific Concepts: About 30 from the light source to the conscious thought and resulting behavior ('Action').

3. The Inferential Roles of 'Perception' in the Language: The inferential roles of this term relate to the meaning to me of perception, that is of all the inferences I make such as, for example, how (1) physical stimuli become mental information; (2) mental and physical states can affect 'Perception'; and (3) an analysis of 'Perception' is essential to my theories, etc.

4. The Interpretation of 'Perception' with LIR/NEO: 'Perception' is a set of processes of processes, etc., in which an inflow of energy in a first step actualizes, in a system of chemical and electrochemical gradients, depolarization (excitation) of nerve cells which is followed by the actualization of their re-polarization (inhibition) and the potentialization of excitation, followed by further similar post-synaptic transmissions which eventually become the trace that is the conscious percept.

5. The Definitions of the (Relevant) Categories in LIR:

Process:	Change
Subject-Object:	Agent-Patient/Actual-Potential

Energy:	Effective Quantum Fields
T-state:	Emergent Included Middle

6. The Fit of the Definitions of the Categories to the Inferential Roles of 'Perception': The categories assign meaning to all aspects of the mental representations that constitute, for me, my patterns of inference-making about 'Perception', e.g., that it can lead to new notions or that I may be overloaded and make erroneous judgments and arguments.

7. The Capture of the Content of the Scientific Concepts of 'Perception' by the Definitions of the Categories: In the concepts of 'Perception' we have: energy in micro- and macro-physical, chemical and electrochemical form; dialectic of excitation-inhibition; changes at surfaces; a subject-object relationship between the energy and the perceiver; plans and ideas as T-states.

Kaye has criticized the inferential role account of mental content as circular since a characterization of truth conditions seems required for analysis of the semantic assignments that in fact are or involve truth conditions themselves. LIR undercuts this objection since I use the concept of dynamic opposition to delineate the extension of a concept syntactically. My inferential role semantics do not only involve or exist as truth conditions, but 'reality' conditions. Thus I claim that besides causal-role theories of content, the notion of inference is available to me as a meaning naturalist and scientist as well as to formal ontologists.

The LIR approach thus permits a clarification of the 'role' of the causal and inferential role descriptions respectively. In this example, I see another instantiation of the LIR two-level system of analysis: the causal role theory is itself synthetic; the inferential role theory analytic and they are in a contradictorial relation *vis à vis* the data – the phenomenological representations. The categorial inferential role theory serves in my view as form of control mechanism to check, as in the American expression 'reality check', that one has successfully modeled and/or ontologically interpreted a term or a process. From this, it is not too far fetched to suggest that the performance of philosophy is a dynamic and dialectical process itself, in which one oscillates between analytic and synthetic approaches, each serving as a control of the other.

My choice of perception as the object of the mini-analysis above was thus not entirely arbitrary. Causal theories of perception (Boyd 2002) as well as of knowledge in general have had a role in defending scientific realism and insuring that scientific findings and terms have philosophical as well as scientific relevance. I will return to the LIR version of scientific realism in the next chapter.

5.6.2 The Syntactic – Semantic Distinction – and Conjunction

Placing semantics in the group of object levels and syntax (structure) in that of meta-levels corresponds more or less to standard practice. What however might be the consequences for their 'working' relation in LIR?

To answer this question I must first recall the notion of structure in standard logic. Structure for a well-formed formula in first-order predicate logic (FOL) is like a line in a truth table of sentential (syllogistic or term) logic: both yield, syntactically, that is, by virtue of structure alone, values of truth or falsity. A structure in FOL consists of a domain and the assignments of (1) objects in the domain to names of the logical language; (2) properties or sets of objects in the domain to one-place predicates in the language; and (3) multiple relations or objects to multiple predicates. The relation of their respective definitions of implication also links semantics and syntax, but the discussion centers as usual on the preservation of truth-values with which LIR is not directly concerned.

The lines of the 'reality' tables of LIR are like the above structures as they were (axiomatically) defined in Chapter 1. On the other hand, the metaphysical structure of reality was developed from the considerations of the semantics of LIR in Chapter 2. Instead of well-formed formulas that are true or false as above, both LIR viewpoints yield the real state of the system, its values of actualization, potentialization or T-state that describe its elements. For me, this functional relation between syntax and semantics is a further reflection of the relations of the underlying physical reality. All of the pairs of phenomena listed thus have structural or syntactic and semantic aspects, as will be seen in the various applications in the following chapters.

By this time, it should be clear that the LIR semantics is far removed from semantics as traditionally conceived, that is, as a ruled correlation of uninterpreted symbols with bare, non-structured objects, with or without 'temporal parts'. In the dynamic view of Peruzzi (1994) "What exists is real interaction, schematized in patterns on whose symbolization syntax operates". I will refer to this article on several further occasions.

The existence of what I consider functional links between syntax and semantics is also illustrated by systems using standard logics for work on the categorial structure of natural language. Categorial grammar analyzes *linguistic* syntax and semantics in terms of type theory and the lambda calculus (van Benthem 2003).

The purpose of such exercises is to provide a perspective on parameters for linguistic description, needed for explanation in linguistic frameworks. Categorial derivations are made that consist of binary assertions of the form:

- Expression *E* has syntactic category *C*
- Term τ has semantic type *a*

As shown by van Benthem, the two viewpoints work in tandem, so that parsing a string of words with syntactic categories produces a description that uses correlated semantic types. He further indicates that the application of categorial logic and categorial grammar to language could have further 'naturalistic uses'. The assignment of reality values to phenomena *via* the conceptual and logical structures of LIR is a development in this direction as well.

What I have now defined is a concept of the structure of reality that does not depend on any transcendental notion of human experience such as that present in Heidegger or the neo-Kantian phenomenology of Petitot. I have also established a framework for analysis that is broadly applicable to dualistic entities in philosophy and metaphysics. In the next chapter, I will provide a preliminary outline of a potential LIR philosophy of mind and phenomenology, as well as defend new interpretations of the major philosophical issues of causality, determinism and continuity. Combined with critical changes in the standard conceptions of time and space in Chapter 7, they will be the basis for a contradictorial view, in Chapter 8, of emergence and the related problems of life and evolution.

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