The Trace of Intentionality : Conceptual Graph Semantics and Phenomenological Reduction as a Scientific Theory

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Scholars should be like liquid. What I mean by this metaphor is that researchers should engage like liquid molecules, neither floating around with no mutual contact nor locked into solid paradigms. The community of phenomenological researchers is a good example: phenomenology has spilled out from its roots in Husserl's philosophy into existential and hermeneutic thought, into social science and cultural studies, into Analytic philosophy and the philosophy of mind, and into cognitive science and mathematics. The vectors of this divergence have been researchers who, like members of fuzzy sets, belong only to some degree to academic communities committed to nurturing a particular set of terminology, paradigms, canonical texts, and methodologies.

Critics of reductive science tend to assume that reductionism implies a kind of metaphysical rigidity, a methodological dogmatism, which constrains rather than liberates thought. While this may be true in certain specific circumstances, there are aspects of reductive analysis which, on the contrary, help to loosen the molecular bonds between distinct researchers and research communities. Reductionism posits inter-theoretical links between distinct and differently-scaled theories, while simultaneously accepting that distinct theories, whose topics of interest range over objects belonging to a particular scalar spectrum of phenomena, will likewise use terms and concepts crafted for those topics and scales. Reductive analysis allows theories to situate themselves relative to other theories while maintaining a distinct lexicon and methodology. Reductive analysis also allows theories to be incorporated, to be introduced as "modules" within other theories, so that theoretical progress can be made by the synrhesis of preexisting theories. Theories belong in a combinatorial space of theoretical possibility, and therefore of new lines of research which nonetheless originated in existing lines. Theories are therefore united in a continuous but flexible mesh, and any given scholar can pull the strings in one direction or another. This kind of interrelationship is not dependent on a reductionist paradigm, but the possibility of some theories acting as causal or physical-constitutive grounds of other theories can provide canonical inter-theory relations which ground the entire theory network. In the absence of well-established reductive lines, theories (and by extension the scholars which craft them) can seem more like gasses than liquids in their relationships to each other — and perhaps more like solids than liquids within their internal communities of researchers.

While both reductive paradigms and these inter-theoretic networks are well-established in mathematics and the natural science, I think it is fair to critique the humanities and social sciences for less carefully balancing the independence and interdependence of theories: humanities science (using this to mean the combination of humanities and social science) tends more often to yield theories which are more isolated from their peers but which, therefore, do not exist in the same combinatorial space of possibility. This isolation can give theories leeway to develop their own terms and methods, but it can also obscure ontological relations between components of distinct theories. Considering that nuances of language, consciousness, and experience belong to all social and human phenomena, it seems reasonable that phenomenology, cognitive science, and linguistics and the philosophy of language are disciplines which spread across the human sciences. Since all human reality involves acts of judgment and language and the experiential episodes which support them, it seems that these disciplines can, perhaps in consort, provide something like a reductive base. This does not mean that phenomenological, neurological, or linguistic terminology (for example) should be an intrinsic part of political or cultural theory — promoting formal models of voting patterns or lyric poems, any more than quantum field theory is part of botany. But political ideology or cultural trends can be seen as emergent phenomena generated by vast numbers of individual linguistic and cognitive acts.

Developing a multi-scale, loosely integrated multi-theoretic network however requires more than just identifying certain canonical disciplines. Reductive analysis requires institutional and technological commitment, and a motivation amongst researchers to identify conceptual methodological trends across theories, and to collectively build a multi-theoretic infrastructure. Natural sciences at all scales share a basic metaphysics about the proper methods and scope of science in general, so that for all their differences there is a sense of compatibility which drawn botany and quantum mechanics, say, closer to each other than either is to Astrology. But there is also a common methdological interest in quantitative models, in mathematics, in experiments, and in the technologies which support the pursuit and reporting of research — statistical and data management tools, solving equations, computer simulations, textual and graphics tools, etc. There does not exist a similarly rich practical research infrastructure in the human sciences. It is hard to find a humanities equivalent to Matlab, Octave, Latex, PLoS/One, or the Millenium Problems. One could argue that these analogies are imperfect because humanities science is much less reliant on quantitative methods. But technological infrastructure can evolve around qualitative as well as quantitative research strategies. To take one example, an important subset of humanities science involves nonverbal cultural artifacts, and implicitly or explictly embeds this nontextual content within scholarly documents. This suggests a role for technology analogous to how Latex is used for embedded mathematical equations within research texts; but while numerous projects exist which envision this kind of technology, the community of humanities scientists does not appear to have prioritized the development and consolidation of these projects.

More generally, quantitative methods can have a role in humanities science even if they are not intrinsic to most particular research strategies. For example, I think it indisputable that internet searchers are now an important tool for finding humanities research articles, particularly those which bridge distinct theories. And, of course, search engines rely on quantitative methods to classify and statistically represent individual documents. Such technologies are not typically considered part of "philosophy of science" or "humanities methodology", partly because the methods typically used to quantitatively model documents rely on linguistic content and structures generally, rather than on any theoretical or methodological details specific to humanities or scientific research. However, one can envision document analysis methods which are indeed more sensitive to documents' argumentation and theoretical structure, and, in any case, the sheer volume of research associated with many theoretical perspectives calls for quantitative methods simply to provide a better understanding of this research in its totality. For example, it would be impractical to read every article published in a year about, say, the Functionalist Theory of Mind, and indeed the attempt to master this volume by narrowly focussing on this one theory can obscure the relations which exist between this theory and others, whether overlapping or competing. It is of course useful to identify the exceptionally competent and influential scholars who can provide an exposition of a theory — such as, to take one example, Jaegwon Kim's [3]. Certain qualities in a text — its conceptual clarity, the detail of its citations, the degree to which it and its author is cited by others — can suggest that it acts as a kind of prototype for the theory it advocates. But it would be good to back up these impressions with more rigorous measurement. What is the evidence that Kim's *Philosophy of Mind* is a good representative of Functionalist argmentation within this range of theories? Is there some dimensionalization of a collection of articles in this area where Kim's centrality can be formally demonstrated? Are the intertextual links of citations and mentions sufficient to demonstrate centrality, or are semantic and rhetorical details (which are computationally harder to extract) needed as well?

Taking this example further, I think it would be interesting to contrast phenomenological and functionalist theories of mind by contrasting a work like [3] with a text like David Woodruff Smith's [4], one grounded in phenomenology but sufficiently informed by Analytic philosophy to make a comparison to *Philoso-*

phy of Mind significant. But — even given a detailed, technologically enhanced cross-reading of these two texts — the implications of such an analysis would be extended given a kind of meta-analysis which situates the respective texts within larger theoretical contexts; which demonstrates the degree to which [3] is representative of functionalism in the Philosophy of Mind, and [4] representative of English-language or "Analytic" phenomenology.

As someone who often finds phenomenological analysis to be rigorous and persuasive, I hope that phenomenology emerges as one perspective which is considered part of a core methodology, or set of methodologies, spread across the human sciences. At the same time, I recognize that bridging distinct theories often requires technological or research "infrastructure" developments as well as raw argumentation. With this in mind, I am particularly interested in extending phenomenological research and methodology with Conceptual Graph Semantics (CGS). One virtue of CGS is that it operates and applies at different levels: at once theory and technology, metatheory and mathematics. Conceptual Graphs can certainly be used as models of semantic phenomena, but they are rigorous enough to be developed as mathematical systems or used to provide model spaces for mathematical theories, such as in modal logic [2]. Moreover, CGS allows for a kind of self-referential or self-applicative development of theory; documents and research articles can themselves be annotated with CGS structures, and technologies, such as the Cogitant software package, can be employed to build and visualize conceptual graphs. Since they were initially designed to capture semantic structures and to model language acts, there is no reason why conceptual straphs cannot also model mental states, propositional attitudes, and other structures which are compatible with language and semantics. One the other hand, CGS can also model the rhetorical structure of documents and inter-theory relations, and therefore can be applied to Phenomenology on several distinct levels.

My agenda in this paper is to sketch a theory of scientific reduction and inter-theory relationships in terms of conceptual graphs, and then to show that phenomenology and phenomenological reduction, itself modelled by conceptual graphs, can be seen under this construal as a kind of scientific reductive analysis. It is important to emphasize that "phenomenological reduction", which can also be called the "bracketing" or "suspension" of the "natural attitude", is on the fact of it significantly different from a scientific reduction of phenomena into component or causal parts. While we can speak of "reducing" complex mental or experiential phenomena into particular semantic or cognitive units, such a strategy for organizing phenomenological research — even if it is largely sympathetic to phenomenological philosophy — ia not automatically a kind of *phenomenological reduction*, or the introspective stance that this bracketing proper involves vis-a-vis our own mental states. I do believe that these two notions of "reduction" can be connected, but I believe this connection must be spelled out carefully, which I will try to do using conceptual graphs as a theoretical domain (but without actually drawing these graphs themselves; I assume that comments I make in terms of hypotethetical graphs can be unproblemmatically extended to actual graphs if such demonstration were deemed useful).

Before developing this argument in the context of phenomenology, however, I will sketch a view of scientific reduction in terms of CGS. This will not be a detailed theory, though I believe that a formal account of reductive analysis in terms of Conceptual Graphs — analogous to how reduction is often defined in terms of formal languages within the Philosophy of Science — would be both useful and intuitive. Here I will make only general remarks in terms of concept-types highlighted by reductive theories in contrast to those constituting accounts of higher-level phenomena subject to reductive analysis. Nor will I offer a detailed introduction to Conceptual Graph Semantics; readers may consult [5] [**?**], etc. The key points are that CGS graphs are rich qualitative structures, in contrast to the types of graphs most commonly studied in mathematical graph theory. Simple mathematical graphs are just sets of vertices together with a relation linking some vertex pairs. Additional structures defined on this relation then yield directed, weighted, labeled, and indexed graphs, so that edges between two nodes may be directed (distinguishing source from target nodes, so that the edge-relation is not necessarily transitive), weighted, labelled (thereby defining multiple edge-types), and/or ordered (with some or all edges assigned an "index" relative to other edges with the same source-node). Conceptual graphs support all of these constructions as well as "hypergraph" structures in which individual nodes can be replaced with "nested" graphs, although not all CGS models make use of all of these graph variations. The crucial further property of conceptual graphs is that the set of vertices is divided into concept-nodes and relation-nodes, with the basic CGS structure defined by a pair of concept-nodes linked by a relation node (though more complex relations can apply between more than two concept-nodes). A given node is intended to model an *instance* of a concept or relation, whether generic or particular, rather than concepts or relations themselves; however, each node is assigned a concept or relation *type*. These types are understood to form a partially-ordered set or lattice, so that some concepts and relations are subtypes of others, such as *horse* and *mammal*. The idea that concept-types and relation-types can be grouped toghether based on more abstract concepts or relations which they mutually extend, will prove in my account to be important in applying CGS to modelling reductive explanation.

1 Conceptual Graph Models of Reductive Explanation

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In lieu of a detailed theory of CGS reduction, I will summarize an example of reductive analysis in terms of hypothetical conceptual graphs. Suppose we write down a typical explanation of the phenomenon of transparency like so:

> Transparency is the ability of some substances to allow light to pass through them. For example, a glass window allows sunlight to enter a room. The glass molecules in a window-pane are arranged in a lattice structure which varies very little from place to place, so that light passes through the pane at the same rate regardless of where it enters the pane. In addition, the glass molecules do not themselves absort light, so the color of incoming light is not altered as it passes through the glass. The net result is that the collection of light waves leaving the pane shows little distortion from the collection entering the pane, making objects on one side of the pane visible from the other side almost as if the pane were not there.

My point is not to offer a definitive explanation of transparency, but to use this paragraph as a case study for conceptual patterns within reductive explanation in general. Imagine therefore that this paragraph is modelled as a conceptual graph, and that the graph is partitioned into sections reflecting the reductive direction. Certain concept-nodes therefore represent macro-scale or everyday-familiar objects or phenomena (transparency, a glass window, a sunlit room), whereas others represent a "reductive base" (glass molecules, light waves, lattice structures). With these nodes identified, the next question is whether there exist identifiable structures that render a conceptual graph Γ as an example of reductive analysis; in particular, whether there exist relations between and across concept-nodes grouped into a "macro-scale" subgraph and a "reductive base" subgraph.

I want to be careful not to develop an overly formalized theory of reduction, as if suggesting that all reductive explanations must be representable in some specific graph format. Therefore I propose merely to formally represent an idealized reductive structure, with the understand that actual explanations may depart from this structure to some degree, but that their similarity to this structure governs why they are perceived to be successful analyses, that is, that they are perceived to have explanatory merit and also to represent reductive relations between distinct scales of phenomena. With this ideal structure in mind, then, suppose a graph Γ models a reductive explanation. Let $\Gamma_{\mathcal{M}}$ represent a subgraph whose concept-nodes belong to a "macro-scale" and $\Gamma_{\mathcal{B}}$ a subgraph whose concept-nodes belong to a "reductive base", using m and b to represent sample nodes from these sets. Let $\mathcal{R}_{\mathcal{M}}$ and $\mathcal{R}_{\mathcal{B}}$ represent the set of relation-nodes restricted to $\Gamma_{\mathcal{M}}$ and $\Gamma_{\mathcal{B}}$ respectively, and let $\mathcal{R}^*$ represent the set of relation-nodes between concept-nodes so that they form pairs $m \hookrightarrow b$.

With this structure defined, consider a model Γ of the above paragraph explaining transparency. It seems clear that concept-nodes for “glass window” and “pane of glass” should be assigned to a $\Gamma_{\mathcal{M}}$ partition and “glass molecule” and “light wave” to a $\Gamma_{\mathcal{B}}$. It might be argued that some of Γ's content does not belong to a reductive explanation per se but is used instead to motivate or demonstrate the explanation. In particular, the use of a glass window to illustrate transparency could be replaced by some other example, so this part of Γ is arguably not intrinsic to the reduction and therefore can be excluded from an analysis of its explanatory structure. I contend, however, that although *this* example may be replaced by a different one, the reductive explanation would be difficult or impossible without the use of *some* example, simply because we need to create a conceptual separation between a phenomenon to be reductively explained and the reductive explanation itself. By analogy, if *heat* is *defined* as thermomolecular kinetic energy, then it would be circular to describe thermomolecular kinetic energy so as to *explain* heat. The idea that molecular motion *explains* heat demands that we recognize one conceptual representation of heat, or that there is a concept “heat” present in the everyday, macroscopic “lifeworld” which is distinct from the concept heat as understood by a physicist. The fact that the “lifeworld version” of *heat* can be reductively explained in terms of thermomolecular kinetic energy is *why* this latter concept can be introduced as the *definition* of heat as a distinct concept for natural science.

Similarly, undertaking reductive explanation for transparency suggests that there is a “lifeworld” concept of transparency which will be understood as distinct from some micro-scale phenomenon which explains it; and example such as the transparency of a glass window then allows the explanation to isolate this lifeworld phenomenon as its topic. Reductive explanation presupposes (or introduces) a conceptual distinction between a phenomenon insofar as it is presented as a topic *prior to* explanation and then as a physical system or reality which is modeled by some theory, which the explanation describes. The idea of this distinction is admittedly subtle from a philosophical point of view, since we need to get a handle on which the pre-reductive concept actually is, if it is not just whatever conceptual picture emerges from the explanation. If reductive *explanation* is not reductive *definition*, then the explanation does not actually *define* the pre-reduced concept, which leaves open the question of how we actually should define this concept. If heat qua life-world concept is not *by definition* thermomolecular kinetic energy, then how should we define it? Perhaps as a psychological phenomenon — the human experience of heat as thermomolecular kinetic energy acting on sense receptors? That is, should “lifeworld” heat be defined as the psychosomatic effects of “physical” heat, thereby distinguishing the lifeworld from the physical world as a collection of psychosomatic phenomena which is a kind of subset of the physucal world, one in which many physical concepts have a dual form as sensory impressions? Unfortunately, this account has an ambience of Psychologism, as if any objective analysis of the conceptual structure of the lifeworld is simply an analysis of psychological reality as one part of nature. Certainly psychology is a valid science, but the objectivity of this science is not the same as the objectivity of conceptual relations insofar as they are experienced and embedded within a shared, human lifeworld. Alternatively, we can gain a handle on lifeworld concepts epistemically: I can believe that the pan is how without believing that the pain has high molecular kinetuc energy; I can know what heat is without knowing what thermodynamics are. Lifeworld concepts are not intensionally substitutable for their macroscale counterparts. On the other hand, the idea that conceptual differentiation requires nothing else than different propositional attitudes — so that two people with different beliefs about heat have two different heat *concepts* — seems overly generous. Defining lifeworld concepts epistemologically makes them too diffuse, whereas defining them psychologically is too narrow.

With respect to our case-study explanation, a glass window is introduced as an example of transparency. At least from a rhetorical point of view, the point of using an example for a less-obvious concept is that some situation is more familiar; we make the concept "transparency" more familiar by associating it with the situation of sunlight entering a room through a window. Rhetorically the situation is presented as if it itself does not need further elaboration; simple directing listener's attention to the situation is enough to capture the semantic contribution which the situation is supposed to make, as an everyday-world example of transparency. These rhetorical patterns are not automatically indicative of cognitive processes, but the rhetoric here certainly seems to suggst a *presumption* of mutual understanding: that all participants in the process of conveying an explanation can associate the idea of a sunlit room to real-world situations and to cognitively hone in on the specific feature of that situation relevant to the explanation. So as to have a label for future discussion, I will refer to such invocation as *copresumptive*, a *presumptive activation* of "background knowledge" which is assumed to be shared within a language community or amongst participants in a collaborative process of cognitive exploration. This copresumptive structure is obviously distinct from any assumptions made about microscale concepts, since the explanation would be pointless if everyone were equally familiar with the latter as with the former. Therefore heat and transparency qua lifeworld concepts are different from their microscale counterparts because there is a copresumptive familiarity with the lifeworld but not the microscale versions. This does not philosophically *explain* these conceptual differences, but it does illustrate problems in psychological or epistemological attempts to account for them: in copresumptively assuming familiarity with the lifeworld concepts of heat or transparency I do not believe that we are treating these as psychological concepts — as if we were attending a conference on the neuromechanics of heat sensation — or as mere names for positions in propositional attitudes, as if our collective everyday notion of "heat" were just a name for what people think heat is who do not know about thermomolecular kinetic energy. It is implausible that the mental states of physicists who know this theory quite well are significantly different vis-a-viz everyday-world situations like being careful when handling a hot pan or sipping from hot coffee.

Instead of pursuing compact definition of lifeworld concepts — like heat as molecular kinertic energy, psychological sensations responding to molecular kinetic energy, or components of propositional attitudes directed (knowingly or not) to molecular kinertic energy — the presumptive familiarity of lifeworld concepts reflects their connection to common relational networks between concepts. The copresumptive stature of the concept heat is our belief in collectively understanding situations linking heat to concepts such as the capacity of hot things to burn and cause pain, that fact that heat is used to cook most foods, and so forth; similarly, transparency is connected to the fact that light renders objects visible, that it can be difficult to navigate a dark room, that indoor places are usually lit by artificial sources inside or by sunlight from outside. These latent networks endow concepts like heat and transparency with a practical significance, a place in what we might call *operational* networks whose fundamental structuring principle is the pursuit of practical ends: I want to remove the pan from the oven; I realize it will be hot; therefore I use oven mitts. I need to walk through a room; I see sunlight entering through a window; therefore I know I do not need to flip the light switch. These operational networks are built of connections many of which have the form x is true, therefore I can do y. We presume each other's experiences with concepts in the context of similar operational networks; for example that we have all sometime navigated through a room by virtue of sunlight, and been aware that the light in the room was originating from ourside and entering through glass windows. So these kinds of networks should be seen as latent conceptual graphs "activated" by the specific Γ representing our case-study explanation. The relations between concept-nodes for a glass window *allowing* light to pass through, and by implicit extension that a sunlight room *allows* objects inside to be seen, that this visibility *makes it possible* to navigate through the room, etc., have a distinct "operational" character. So the portion of Γ devoted to setting up the motivating example is one whose relation-nodes tend to be of an identifiable, "operational" variety.

Identifying these kinds of connections between concept- and relation-types is one goal of `CGS`. Since these types belong to type heirarchies, certain inter-concept-type and inter-relation-type connections exist by virtue of conept- and relation-types which inherit from a common more abstract type in the hierarchy. Given for example relations r_1 and r_2 there is guaranteed to be a relation $r' \preceq r_1, r_2$ because of an assumed "universal relation" which is the least element among the relation types as a partially ordered set. The greatest element relative to this $\preceq$ ordering is therefore a binary operation defined between any two relation types. This relation provides a way of grouping relation types which are similar to some degree. For example, it may be that a relational system include a general "operational" relation-type, whose more specific relation-types would includes those of *allowing to*, *being able to*, etc. On the other hand, we should not assume that all interesting groupings on relation-types or concept-types can be captured simply by moving up the type hierarchy. The situation here is analogous to type hierarchies in computer programming languages, and the need for some system — such as annotations, multiple inheritance, or interfaces — to provide meta-information about some type which cannot be conveyed from its sequence of ancestor types alone. In the case of "conceptual C++", the analogy is rather close: even without the language extensions proposed for concept-C++ as a distinct language, C++ multiple inheritance is often used to indicate that a particular datatype exhibits characteristics of a particular type of concept, often by declaring a specialized template class as a base class for the type in question. Instead of a simple type hierarchy, C++ clases thereby stand within a complex lattice with two different partial orders relating types to one or more base types as well as generic and partially and fully specialized templates. Because CGS supports are usually defined with simpler concept-type and relation-type lattices, I will suggest a different mechanism for grouping concept- and relation- types.

As an example, consider the idea that many concept-types are such that their instantiations, or the fact of their instantiation, suggests some sort of numeric measure or quantification. For example, the concept *red* appears to involve the fact that given a red-instance there is some way to quantify this instantiation, for example in terms of a frequency of light waves or in terms of the RGB vector of computer graphics. Such concepts seem to carry within them a set of "axes" such that instantiation of the concept indicated a point or region within a dimensional system spanned by some of those axes. Suppose we define *axiatropic* concept-types as ones which carry some such kind of dimensional structure. It may be possible to introduce "axiatropic" as one distinct concept-type and assume that all axiatropic concept-types are somewhere beneath this point in the hierarchy, but we could just as well define the notion of "axiatropic" as a label or annotation applied to some concept-types, regardless of the structure of the type hierarchy. Other examples of useful "annotations" could then include the idea of "operational" relation-types sketched earlier, or the idea that certain concept-types have an experiential or "qualitative", "what it is like" aspect. Concept- or relation-types may also have these aspects to varying degrees. I will refer to these aspects as *valences*, so a type may have an experiential valence, an operational valence, etc. In lieu of grouping types in terms of a hierarchy such that $t \prec t'$, with t a concept- or relation- type, assume a set $\mathfrak{V}$ of valences ν such that $t \triangleleft_\alpha \nu$ where α represent a weight $\alpha \in (0, 1)$. Similarly define *concept-valances* and *relation-valences* as weightsi defined on concept-nodes and relation-nodes, inherited from their types. By weighting valences the degree of ν can range over the nodes in a graph Γ, and subgraphs can be measured in terms of ν based on a function such as the average of α given $n \triangleleft_\alpha \nu$ for $n \in \Gamma' \subset \Gamma$.

With our case-study explanation, the "macroscale" segment Γ_m of the graph has a strong "operational valence", using the terminology I've been exploring. The kinds of conceptual relations invoked in this part of the graph orient concepts in terms of practical actions and situations, such as walking through a sunlit room. The explanation proceeds from talking about a *glass window* to talking about a *pane of glass*, switching attention to an object which is still macro-scale and everyday-familiar to some degree, but less clearly situated within everyday contexts. Most people encounter windows on a daily basis, but deal with "panes of glass" quite infrequently. It is true that windows *are* panes of glass, but in typical cases we engage with them under the guise of "window", not "pane of glass". Although any window concept-instance is also a pane-of-glass concept-instance, these two concepts are not identical. The window-concept is more likely to be instantiated in operational-oriented networks: our engagement with *windows* typically takes the form of opening or closing them, opening or closing binds or shades, etc. Engaging with panes of glass is more narrowly concerning with fitting a pane into a window-frame, or needing to repair or replace a pane which is broken. Pane-of-glass engagement is therefore more typically directed to the strictly material and geometric properties of panes of glass as physical objects, rather than the operational properties of windows as components of certain familiar day-to-day actions (like opening and closing the windows) or activities (like spending time in a sunlit room). Windows and panes of glass are therefore disclosed within experience in different cognitive modalities. This phenomenological notion of "disclosure" can be modelled with my proposed `CGS` notion of valences, with an "operational" valence applying more strongly to windows, and a "macro-object" valence applying more strongly to panes of glass. Having transitioned between these two valences, the explanation can then exploit the fact that with our attention focused on a hypothetical pane of glass, we are more attuned to its material and geometric properties. The pane-of-glass concept suggests a certain typical physical dimension — in particular, most panes of glass are rectangular solids with small thickness relative to dimensions of width and height, so we tend to focus on these two larger dimensions. The concept therefore sets up an axial structure, in which locations on or inside the pane correpsond to points in the dimensions spanned by these axes.

Thereby cognitively attunded to this kind of dimensional structure, we are thereby prepared to visualize patterns identified relative to these dimensions, such as a lattice structure between glass molecules. We are also primed to recognize individual glass molecules as occupying points within the axes of the pane's edges, althoguh we understand that the size of the molecules relative to the pane itself is so vast — on the order of billions or trillions — that we recognize any visualization of a "single" glass molecule as provisional. Nonetheless, we believe that we can in theory zoom in on the space spanned by the pane edges until we achieve a resolution in which individual molecules, even if they cannot be "seen", can nonetheless be individually accounted for as causal agents or units of phenomena to be described. In particular, we can consider individual molecules interacting with individual light waves, and we can also consider light passing between the gaps shaped by the well-ordered lattice structure between the molecules. Here the concept- and relation-types take on valences which are distinct from the macroscale concepts operating earlier in the explanation. Here phenomena are more likely to be discretized — individual glass molecules and light waves; spatial relations are more preeminent and, within them, relations which can be described in terms of geometry or symmetries (like lattice structures) are emphasized; and interaction between concept-instances tend to be modelled quantatitively (like a molecule absorbing particular photons depending on their frquencies). These interactions themselves are canonically discretized; at sufficiently fine-grained scales it is assumed that physical change and physical interactions emerge from discrete units of physical influence, which are localized and propagate within space and time. A black object left in a sunlit car becomes hot because of a synthesis of distinct micro-scale events, with individual photons carrying a physical influence which passes through the car's windows, strikes the object's surface, gets absorbed by a molecule there, and contributes energy which becomes manifest as heat.

The premise of physical change and causal influence being "discretized", and fundamentally reducible to discrete, spatiotemporally located physical influence, is perhaps the key hallamrk of scientific explanation in contrast to reasoning which is considered non-scientific, or more perjoratively "pseudo-scientific". Appeals to "magic" or "divine intervention" are suspicious, at least to those of us who generally accept the scientific world-view, precisely because they suugest the presence of causal influences between phenomena without also identifying a vector of physical influence which could be assigned a spacetime trajectory which carries that influence from the site of the origination of a cause, to the site of its effect. Astrology is suspect, for example, because there is no evident mechanism whereby astronomoical configurations could cause psychological effects here on earth, via physical influences whose propagation can be tracked through spacetime. This does not apply to all astronomical phenomena — for example, we are well aware of the danger of solar flares to electrical grids; but the carriers of these forces, such as gamma rays, have a well-understood manner of propagating through the intervening space. Failure to account for the micro-scale, discrete structure of causal influence is a clear indicator that a certain theory or explanation is not properly scientific, or at the very least is scientifically incomplete. Of course, this problem afflicts many theories of consciousness, because it is hard to see how rich, detailed qualitative structure of experience can be assigned a properly "discretized" causal foundation. It is difficult, that is, to understand how the precise feel of colors or tactile sensations can be directly associated with collecitons of spacetime localized micro-scale events, such as neuron firings. Although we can readily grasp *correlation* between these levels of explanation — that there can be a causative link between, say, neuron-firings and rich color sensations — it is hard to acceot intuitively that rich color sensations are *nothing other than* neuron firings, because the concepts associated with the latter, like electrical signals and ion channels, are so much different in character from qualitative concepts like the color of red qua sensation.

Although I do not want to minimize this problem — this mountain to climb, for a genuinely physical explanation of consciousness — I think we need to be wary of an all-or-nothing approach to explaining consciousness. By examining a case-study reductive explanation in terms of hypothetical conceptual graphs, I want to call attention to the *conceptual structure* of this kind of explanation, rather than focussing principally on the metaphysical picture underlying the ontological status afforded to the macro- and micro-scale obejcts and phenomena concerned. I will have some further comments about the transparency case-study, but for the time being I'd like to shift attention to the structures whcih may be apparent in reductive analyses of consciousness and conscious experience.

2 Perceptual Manifolds and Mereological Structure

When conceiving a theory of consciousness which would be structured in rough analogy to our transparency example, the obvious challenge is identifying the truly micro-scale phenomena to serve as a reductive base; the units of perception or experience which would qualify as perceptual "atoms", or micro-scale objects analogous to the glass molecules and light waves. In particular, too-simplistic accounts of putative perceptual atoms will not pan out. Perceptual entities which are *too* atomic, in terms of those indicators which generally suggest "atomicity" in the perceptual domain, may actually bear less of this "atomicity" than their superficially more complex peers. For example, at least from the vantage of phenomenological reflection it seems erroneous to construe as perceptual atoms a speck of color which has minimal visible expanse — so that if it were any smaller it would be just beyond the threshold of visibility — or an extremely brief tone of sound. Because such barely-detectable visual or auditory elements are atypical, we can argue that they are actually harder to imagine and more attention-grabbing when they do occur, so that are not especially good candidates to posit as perceptual "atoms". It could be replied that such miniscule precepts are attention-grabbing mostly when they stand out in contrast to their surroundings, such as a speck of color against a different color or a brief tone against silence. But insofar as perceptual elements are situated within a continuum of similar elements it seems that the fundamental perceptual structure is the continuum itself, not some portion of it except insofar as that portion does indeed exhibit some contrast.

Similarly, it seems that perceptual elements which are geometrically or descriptively simplistic — such a monochrome perfect square — are similarly atypical and attention-grabbing. A square is "simple" insofar as it requires only one dimension to fully describe, but perhaps this geometric notion of simplistic is not sufficient for a notion of *perceptual* simplicity. We need in effect to qualify our intuition that complex systems have more "degrees of freedom" than simple ones, and that this definition presents a technique for measuring and quantifying complexity. Nonetheless, it seems intuitively true that perceptual elements can be more or less complex, and that more complex percepts are composed of simpler ones. At the same time, our attention tends to migrate between different perceptual scales, so that we focus on smaller parts one moment and larger wholes the next — now an arriving subway, not one car, now the opening doors. Wholes are experienced to varying degrees as unities which move and are disclosed as individuals, then as collections which serve as cognitive containers for disparate parts. This varying strength of part-whole relation can be captured by using weighted mereology in lieu of a binary mereological system. Suppose we then have a collection ${}^{\mathcal{W}}\mathfrak{M}$ of entities or "mereons" m, and a weighted relation $m \sqsubset_\alpha m'$ to mean that m is part of m' to degree α. I will assume that these are "perceptual" entities, though I will make a few points about mereological systems in general, so use the generic word "mereon" as an abstractly understood part of a mereological system.

The point of a mereological system is to describe part/whole relations, but also to identify the wholes in themselves — that is, to identify which collections m correspond to a distict mereon m'. In addition, the structure of such a system permits an analysis of the *internal structuration* of wholes; to identify details such as how many parts they take on, the complexity of these parts, and how tightly couplend they are to the whole. In a weighted mereological system it is understood that wholes vary in the degree to which thay may be treated as individuals, or are "coherent" as individual, sensibly posited as individuals in some context. A robust mereological system therefore models the *individual coherence* and *internal structuration* of its elements or "mereons"; we could say that mereons are situated within a two-dimensional "IS/IC" scale combining these attributes. While mereons with less internal structuration will tend to have greater individual coherence, these two dimensions can vary separately: a complex whole can have significant internal structuration and also be coherent as an individual, or operate as a singular entity in many contexts. The individual coherence of a mereon is potentially captured by how strongly its parts belong to it: given the set m such that $m \sqsubset_\alpha m'$ we can consider the set α of associated weights. At the same time, weighted parthood suggests not only degrees of part-whole coupling but also the relative importance of the part to the whole. For example, it is understood that the United Nations is a less compact geopolitical entity than the United States, which can be conveyed by asserting the grater coupling of individual states to the United States, compared to individual nations in the United Nations. This suggests that degrees of part-whole coupling is definitive for the whole's coherence as an individual. On the other hand, the example of Puerto Rico — which could potentially become an independent nation in the future — shows that relative weak coupling of at least some parts to the whole does not undermine the coherence of the whole. In this case the part is less *important* to the whole, precise because of weak coupling, and therefore contributes less to the individual coherence of the whole.

Whether a relatively weak coupling $m \sqsubset_\alpha m'$ indicates the relative lack of importance of m to m', or instead the relative diffuseness of m', must depend on the precise case, perhaps on the distribution of the weights α associated with the set of $m \sqsubset_\alpha m'$. The proper interpretation of this distribution must be considered a product of how mereology is intended to model a semantic or conceptual system, rather than formally part of mereology itself. In any case, let us assume that a system ${}^{\mathcal{W}}\mathfrak{M}$ is equipped with an IS/IC measure defined for all mereons, which presumably relates to part-whole relation weights in some statistically meaningful way. Whereas complex wholes, whether with strong or weak individual coherence, are associated with relatively high *internal structuration*, mereons with low IS measure tend to function more as atomic parts within larger wholes; however, we need not assume that there are perfectly atomic units with no internal structuration at all. In addition, just as high IS measure does not fully quantify complexity — for example because mereons with high or low IC measure exhibit different "sorts" of complexity — nor does low IS measure by itself perfectly correspond to greater "atomicity", or should mereons with the lowest IS measure necessarily be considered as atoms in the context of a mereological system. Insofar as ${}^{\mathcal{W}}\mathfrak{M}$ systems are intended to model aggregative or compositional networks where simpler parts and merged into complex wholes, we need to be able to recover from the system a relative scale of containment or nesting. The high-level elements of this scale would tend to be ones which are complex but also coherent as wholes; that is, with high IS and IC together on an IS/IC scale. Assume that a ${}^{\mathcal{W}}\mathfrak{M}$ system has defined a *multiplicity* measure μ which tends to be proportional to both IS and IC, but with potential statistical deviation between μ and IS/IC. The low-level elements on this scale — those with low multiplicity — are not necessarily those with lowest IS. A perfect monochrome square or perfectly sinusoidal tone may have little internal structure from a mathemtical point of view, but actually seem to be *more* complex, qua percepts, than more random counterparts.

This psychological phenomenon could perhaps be captured by statistical deviation between μ and IS at low ends of the scale, according to the parameters I am envisioning here. Why low IS at low measures correspond to greater μ — although at larger measures there should be a proportionality between multiplicity and internal structuration — can be accounted for with various additional parameters. Perhaps very low IS mereons stand out from the norm, being outliers within an IS/IC scale, and this tends to raise their μ measure. Perhaps symmetries, lack of randomness, or the presence of certain critical features, like right angles, tend to elevate μ. Whatever the details, the internal structure of mereons can be captured to some degree, but not entirely, by the system of their parts. A gradually varying color hue over some region, or an increasing pitch, may not have clearly demarcated inner parts, but still have internal structure. Within a ${}^{\mathcal{W}}\mathfrak{M}$ system the IS of a mereon will derive to some degree from its parts, but in addition by some further internal variation which can potentially be quantified, or modelled according to some equation, such as equations used to generate gradients or diffusion patterns in computer graphics. We can thereby distinguish *discrete* and *equational* IS, and observe that mereons whose IS measure is more "equational" should also exhibit less multiplicity; the degree to which a mereon's internal structure derives from some continuous variation reinforces the possibility that the mereon can be perceived or function more as an atomic unit. In other words, if mereons can be regarded as *quasi-atoms* to the degree that they have low μ measure, then quasi-atomicity is dependeng not only on low IS but also on the proportion of IS which has this "equational" aspect; percepts which have more equational structure (like a gently varying color region) may actually be more "atomic" than entities whcih have less inner structure but which have more contrast relative to their surroundings. If a ${}^{\mathcal{W}}\mathfrak{M}$ system therefore has this kind of multiplicity μ measure which roughly corresponds to IS/IC but can deviate at the low values, so that there exists a single μ which orders mereons from the more quasi-atomic to the more evidently complex, then the low- μ mereons can be called "quasi-atomic" and the system called a "quasi-mereological" or ${}^{\mathcal{Q}}\mathfrak{M}$ system.

Whereas standard mereologies can be modelled with lattices, i.e., partially ordered sets with a maximal element, ${}^{\mathcal{Q}}\mathfrak{M}$ systems are better suited to a CGS-style graph structure, in which the mereological "part of" relation is only one relation type among others. For example, Computer Aided Design (CAD) programs often use similar graph structures to create complex graphics, such as realistic three-dimensional scenes. Any given element in a scene is defined by several different structures, including surface geometry, surface coloration, internal incadescence, and external lighting. Each of these details contribute to the visual appearance of an element, such as its color pattern. The factors contributing to this appearance are therefore, in many systems, grouped as nodes in a graph, with each of the nodes connected to some central node representing an "element" — potentially a geometry node, a node describing a surface color pattern, etc. — contributing to its final rendering. Mereological relations such as one element being part of another, or two elements bearing some relation which makes them jointly part of a larger whole — such as physical contiguity or being physically attached via some medium — are only some of the connection-types between nodes. The set of relation-types is more general because individual nodes do not only represent distinct "mereons" but can also represent, say, equations describing patterns such as color gradients or light diffusion. Given a ${}^{\mathcal{Q}}\mathfrak{M}$ system we can models these connections by supposing that in addition to a set m of mereons there exist a set $\mathcal{Q}$ of equations, with an equation q having a dimensional structure δ_q spanning its parameters. We can then say that mereons m may possess such structure $\delta_q \ll m \rightsquigarrow q \lll m$, so that $\ll$ and $\lll$ represent relations — between a mereon and a set of dimensions, and an equation defined within those dimension, respectively — separate from $\sqsubset_\alpha$

and also contributing to the internal structuration of m. In an abstract sense equations $q \lll m$, or at least the structural formations which they represent, are "parts" of m; the distinction here can be compared to Husserl's constrasting dependent and independent moments. So ${}^{\mathfrak{Q}}\mathfrak{M}$ systems in this sense have two different "parthood" relations, here labelled $m \sqsubset m'$ and $q \lll m$, designed to capture "independent" and "dependent" parthood, assuming "parthood" in the latter case is understood abstractly.

The fact that the apparent (such as visible) properties of a perceptual elements can be derived from several distinct structures — geonetry, surface color, lighting, etc. — demonstrates why human (and animal) vision is so remarkable, and why simulating human perception is so difficult. A good example is the problem of translating bitmap images into three-dimensional scenes, which involves image segmentation as well as converting two-dimensional color variation into three-dimensional geometry. At the same time, this problem provides a clear and practically useful case study of algorithms which attempt to model human perception, since we can judge how well a given 3D Reconstruction appears to capture the three-dimensional reality which yielded a two-dimensional image. In addition, the human process of comparing two-dimensional and three-dimensional versons representation is itself a kind of human perception, which can be used to study perception in general, particularly because in this domain there are detained mathematical representations of the perceptual elements in question. The translation of a bitmap image into a `CGS` graph Γ, one using concept- and relation-types formalized by 3D modelling languages, is therefore a plausible example of `CGS` representation of human perception in general. Γ nodes may thereby provide a model for a ${}^{\mathfrak{Q}}\mathfrak{M}$ system in which the parameters I have suggested, such as IS/IC and μ measures and dependent and independent parthood relations, can be defined. Equation noes attached to mereons proper provide quantitative structures which can help define the quantitative parts of these measures, including the α weights for $\sqsubset_\alpha$ relations. In other words, graph structure as well as equational details provide a space of statistical variation which can refine IS/IC, μ, and α measures, particularly if these measures are used in 3D Reconstruction algorithms which are then tested against human feedback. This research strategy suggests an avenue in which quantitatively analyzable elements (Γ nodes in conceptual graphs based on 3D Modelling languages) can serve as proxies for perceptual entities in general, and also in which a notion of "atomicity", or a scale μ wherein low-dimensional entities by this measure can be considered "quasi-atomic", can be statistically defined. In other words, even if there is no obvious sense in which there are perceptual "atoms" akin to chemical atoms molecules, we have nonetheless an intuitive sense of the phenomenological existence of percepual "quasi-atoms" and also a research strategy for testing these intuitions against quantitative data.

Having plausible candidates for perceptual "quasi-atoms" does not guarantee a reductive theory of perception. Even granting that a notion of quasi-atoms refined in the special case of perceiving computer-generated graphics can serve as proxy for perceptual atoms in general, and that the aggregative patterns modeled by CGS graphs in 3D Modelling are sufficiently similar to perceptual complexes in general that these graphs can be case-studies for CGS reconstruction of general perceptual manifolds, we still have merely defined an aggregative structure for perception, not a reductive analysis of larger-scale objects in terms of smaller-scale ones. However, this aggregative system can provide a foundation on which further reductive structures can be defined. In light of the discussion up to now, I will assume it plausible that there exist perceptual quasi-atoms and that conscious experience can be analyzed in terms of perceptual manifolds whose elements are aggregates of these quasi-atoms. My point is *not* that the fragmentaiton of perceptual manifolds into quasi-atoms is by itself a reductive theory of perception (and by extension, potentially, consciousness in general). Instead, I skectch a reductive theory in terms of larger-scaled patterns in the relation between this aggregative structure and actual cognition and awareness. In synthesizing temporally unfolding manifolds of perceptual elements into a unified, temporally unfolding conscious experience, different "parts" of the manifold are experientially and cognitively emphasized to different degrees. I will try to make this point in terms of hypothertical conceptual graphs.

Suppose we have an aggregative space of perceptual "mereons" related in terms of a CGS structure Γ. The nodes and relations within this graph can be considered similar to those found amongst elements in 3D Modelling graphs, so that mereological relations are included along with representation of perceptual patterns, such as color gradients. Perceptual elements are recognized as aggregating into larger wholes, and the grounds for identifying such wholes are partly perceptual and partly cognitive; in some cases there exist perceptual details which motivate the recognition of a whole (such as a repeated perceptial pattern), and in other case wholes are represented as coherent individuals by virtue of their being cognitively identified, particularly as instances of some concept-type. Graphs representing basic perceptual relations can therefore be seen as embedded in larger graphs which include cognitive identifications. Morever, most consciousness is engaged not merely in observing situations but of interacting with our immediate environment, pursuing specific ends; so the basic structure in a typical experiential episode is my *attempting to do*, *desiring to do*, or *being in the process of doing* some task. We can therefore imagine a general graph structure Γ partitioned into *operational*, *cognitive*, and *perceptual* components $\Gamma = \bigcup \Gamma_{\mathbb{O}}, \Gamma_{\mathbb{C}}, \Gamma_{\mathbb{P}}$. Suppose I need to walk to another room to check a piece of information in a book. This planned activity involves a series of smaller tasks — say, walking into the room, checking to see if it is dark, turning on the light if so, finding the book, searching within the book for the desired content, replacing the book on the shelf, leaving the room. These tasks are associated with cognitive descriminations: checking if the room is dark, finding the book from a shelf with others, etc.; and these cognitive processes require perceptual details in turn, such as visually locating the light switch or checking the color of books on the shelf to help single out the one I desire. These cross-relations, operational-to-cognitive or cognitive-to-perceptual, represent relation nodes connecting the above Γ partitions.

The interrelationships between $\Gamma_{\mathbb{O}}$, $\Gamma_{\mathbb{C}}$ and $\Gamma_{\mathbb{P}}$ are such that accurate analyses of cognitive-perceptual processes must go beyond simply dividing larger wholes into constituent parts. If $\Gamma_{\mathbb{P}}$ rerpesents a total perceptual manifold at a given moment in time (itself something of an abstraction), then we experience different parts of $\Gamma_{\mathbb{P}}$ with different degrees of attentiveness and clarity. The temporal unfolding of perception can perhaps be modelled by considering formal processes which replicate perceptual experience to some degree — for example, by analyzing how a person goes about developing a 3D reconstructio of a 2D bitmap. Such an analysis requires a proper software environment — as far as I can tell, one which is more sophisticated than existing tools in this domain — but assuming a software component can be designed which supports image segmentation and then allows individual segments to be separately translated into 3D model components before integrated into a larger 3D scene graph. The sequence of which segments are worked with in which order can therefore shed light on the order of where attention is directed when encountering the scene in real life. Another strategy may be to track eye movements as someone looks at a 2D photograph, or how someone navigates through a 3D scene in an interactive viewer. However imperfect these analyses may be, their possibility at least suggests that the phenomenological reality of the temporal unfolding of perception, and the dynamic skittishness of attention, are not beyond formal analysis. We can of course also analyse these processes more intuitively, using hypothetical introspections and situations, but this latter kind of analysis need not be seen as lacking potentially more formal subsequent research possibilities.

The hypothetical situation I have mentioned here involves getting a book from the other room. Consider then as I enter that room, and the sequence of tasks I outlined: turning on the light, walking toward the bookshelf, etc. If say I find that the room is indeed dark, I may be dimly aware of the bookshelf outlined against the light from a curtained window, but I recognize the need to turn on the light switch against the wall. Since this task is preconditioned for the main task of finding the book, I do not attend to the bookshelf closely at first. This attentional "passivity" would be difficult to capture by treating the perceptual manifold through the vehicle of a photograph, where perception of a bitmap image is used as proxy for perception while actively engaged in the scene. Even if the photograph is a credible simulacrum of a perceptual manifold — of a graph $\Gamma_{\mathbb{P}}$ — what is missing here are the associated $\Gamma_{\mathbb{C}}$ and $\Gamma_{\mathbb{O}}$ structures which situate $\Gamma_{\mathbb{P}}$ in cognitive and operational contexts. When I first enter the room, my attention is on the amount of light in the room — not directed at any perceptual entity in particular, so therefore more of a cognitive or "" attentional focus, but still involving perception in a kind of higher-order fashion (perhaps expressed in the simulated context of 3D navigation by the act of a viewer increasing the overall light in a scene so as to better see its contents). Recognizing that I need more light, I turn my attention to the light switch and then on the knob itself, thereby focussing lower in scope until I can engage in a single physically and operationally compact unit, the light switch which in one motion can complete one task, namely turning on the lights. This "scoping" of perceptual attention is thereby directed and framed by a specific operational and cognitive context — needing to turn on the lights and knowing that flipping the loght switch accomplishes that goeal. That act completed, I may then direct my attention toward the bookshelf, but first as a single entity insofar as I need to orient myself in the room so as to walk in that direction, and only then focussing closer in to the books themselves. As I scan the book-covers trying to identify the specific book I am looking for, I therefore become more attentive to the perceptual differences between each one, such as the color or color-pattern of their cover.

Suppose I am searching for a book with a maroon cover, and there are other books with red or purple colors. Whereas I may see each of these books prior to my actually directing attention on them, and so therefore are to some measure conscious of their specific colors, the distinction between these colors only become cognitively preeminent for me when I actually need to use this distinction so as to single out one book in particular. So perceived perceptual difference, such as between colors, is "perceived" to different degrees and in different ways. There may be a passive perecption of these differences but, in terms of a more active perception where differences are cognitively recognized or components of cognitive judgments, this mode and degree of awareness varies according to lines and scales of attentive focus. This variation needs to be accounted for when introducing dimensional structure to model perceptual qualities, such as color. We can associate color-concepts with quantitative measures, like light frequencies or RGB graphics; however, even if this provides a quantitative handle on a hypothetical point of "raw sense data", it is also to some degee an abstraction. A perceptual quality like color is both a perceptual and a cognitive concept; the concept of being red in the sense of having this particular red appearance, and the concept of red as a distinguishing feature which can potentially single out an object from others or from its surroundings. Even if most experiential episodes involve both of these modes simultaneously, they nonetheless play distinct cognitive roles: the passive perception of color which serves primarily to demarcate color contrast and so segement visual regions, and the cognitive identification of colors as discriminating features of objects which bear them. In this latter sense the degree of contrast between distinct colors, insofar as this contrast is cognitively recognized, varies according the amount of attention focused on objects in question. The contrast between red and maroon, for example, is more cognitively pronounced when I am looking for a maroon book when there are red ones nearby, as compared to when I passively perceive the books together as I first start walking to the bookshelf. So whereas color space can be associated with dimensional structures which quantify the degree of contrast between colors as well as colors themselves, these dimensions themselves, insofar as colors are cognitive concepts, are supplemented with further dimensions that modify the theoretical measure of color-difference in terms of degrees of attention.

Suppose $\widetilde{\mathcal{D}}$ is a general dimensional structure modelling colors (like an RGB cube), and say $\mathcal{D}_R$ and $\mathcal{D}_M$ are similar dimensionalizations of red and maroon as regions in this space. We can similarly dimensionalize color differences, for example by assigning a measure $\mathcal{D}_R \ominus \mathcal{D}_M$ as the average distance between red-points and maroon-points. More generally, let $\ominus$ be a distance metric on $\widetilde{\mathcal{D}}$. This single measure, however, cannot properly dimensionalize color-difference as a *cognitive* phenomenon because it fails to account for degrees of attentional focus. If Δ is a dimensionalization of perceptual *location* — such as the axes of a bitmap image — then the $\ominus$ metric on $\widetilde{\mathcal{D}}$ has to be assessed relative to location, in terms of which locations are attentional focal points. Here the dimensional structures are complicated: even granting the deliberate oversimplification of treating perceptual locations as if perceptual manifolds were just $\mathbb{R}+^2$ surfaces, attention can focus over a greater or lesser area. Whatever axis structure is used to span Δ, we can propose a scalar field $\sigma(\Delta) \rightarrow (0, 1)$ which assigns to "points" $d \in \Delta$ a measure corresponding to the "degree of attention" invested at these points. The "shape" of this field will be constrained by how attention directs at contiguous areas, concentrated more on smaller regions (corresponding to fine-grained focus), or spread out more diffusely on larger ones. Quantitatively modelling the "shape" of the field representing degrees of attention depends on a proper dimensional structure representing an axiation of perceptual location, or, as Jean Petitot points out, this amounts to a "fibration" of perceptual space as a topological system [**?**]. Assuming these dimensional structures are well-defined, and that we have a map from perceptual locations onto color points $\Delta \rightarrow \widetilde{\mathcal{D}}$, then color-difference needs to be defined between *localized* color values, or between pairs $(\widetilde{\mathcal{D}} \times \Delta) \times (\widetilde{\mathcal{D}} \times \Delta)$, so that the nonlocalized difference $\ominus \subset \widetilde{\mathcal{D}} \times \widetilde{\mathcal{D}}$ is adjusted by the values of $\sigma(\Delta)$ defined at the location-points within the respective $\widetilde{\mathcal{D}} \times \Delta$ pairs. The proper color-difference metric is therefore ""; $\ominus$ altered or "convoluted" by the σ field. Similar comments can be made for other difference or distance metrics for dimensionalized perceptual qualities. $\ominus_\sigma$

Because perceptual details are situated in larger cognitive and experiential contexts, we have to be careful not to regard formal models of perceptual manifolds as definitive represents of actual perception, either as it is actually, consciously experienced, or in its cognitive role. This does not mean that developing such formal models is a quixotic exercise, but rather that the force of the model is its representation of how the cognitive and experiential interpretation of perceptual details *departs from* the base model. To formalize this idea itself, suppose $\Gamma_{\mathbb{P}}$ is a conceptual graph representing a perceptual manifold. Assume that the structure of this graph does not model such effects as attentional focus; in other words, it models a perceptual situation as a passive given, as if it were extracted from a photogtaph. Features in the graph may vary in importance depending on how large or complex they are, but importance is not assessed relative to different potential intentional stance viz-a-viz the $\Gamma_{\mathbb{P}}$ contents. As I have suggested, such graphs do not occur in isolation; I introduced this notation in the context of operational and cognitive, as well as perceptual, partitions of a larger Γ. Suppose we can refine this model by representing additional stuctures, due to these other (sub) graphs, which are superimposed on the concepts and relations in $\Gamma_{\mathbb{P}}$. Write $\Gamma_{\widetilde{\mathbb{P}}}$ for this more complex graph "convoluted" by $\Gamma_{\mathbb{C}}$ or $\Gamma_{\mathbb{O}}$ structures. One example of this convolution was suggested above, namely for the tendency of color-differences (and differences between other perceptual qualities) to be more or less clearly experienced, and more or less accounted for within cognitive judgments and discriminations, depending on attentional focus and the cognitive and operational context which motivates the selection of this line of attention instead of other possible ones. The fundamental *intentionality* of consciousness ensures that perceptual manifolds, qua experiential and cognitive phenomena, are not undifferentiated aggregates of perceptual features — indeed, are not even differentiated only by mereological relations and compexity or "IS/IC" measures among the "mereons" of perceptual manifolds as aggregative systems. Instead, perceptual manifolds evince a further, second-order differentiation and articulation via the "convoluting" effects of cognitive and operational context.

The analysis of experience into perceptual manifolds as aggegates of "quasi-atomic" perceptual mereons, then, is not *the* reductive analaysis of conscious perception; it simply lays the groundwork for the real reductive analysis, which is identifying the "convoluting" effects of cognition and task-oriented, directed attention as they operate on perceptual experience. Here "reductive" does not mean reducing a complex phenomena into simpler parts and then assuming that all explanatorily significant concepts are defined amongst the kinds of entities found among these similar parts; in other words, a process of showing how properties and relations amongst "reductive base" entities bear the full causal and explanatory burden of observed properties and relations amongs the "macro-scale" entities. The kind of reductive analysis I have sketched in this section is a more nuanced kind of reduction because the primarily weight of explanation is borne by *systemantically observable* alterations in formal models within the reductive base by which the contextual effects of the macro-scale phenomena can be "traced" within the micro-scale, which here means the fine-grained scale of quasi-atomic perceptual features. This kind of reduction theorizes a kind of feedback loop between scales in which the micro-scale constitutes the macro-scale, via aggregation and wholistic synthesis, but the macro-scale simultaneously provides contextual effects that may be "traced" within the micro-scale, as alterations of convolutions of its properties and relations. Although it may strain our experimental and theoretical resources to quantitatively model these convolution effects, I do not believe that such quantitative analysis is more difficult than building formal, partially quantitative models of perceptual manifolds itself, that is, in their base, non-convoluted structure. If it is possible to build conceptual graphs mixing relational and dimensional modelling — for example by defining dimensional structures on certain graph-nodes and/or concept-types — then these structures provide a basis for further "convolution" modelling. To the degree that computational phenomena and problems such as 3D scenes, Virtual Reality, and 3D Reconstruction, can provide formal models of perceptual manifolds, then they can also provide an architecture for building formal models of cognitive and operational contexts whose effects can be "traced" in perceptual models.

The kind of "feedback" reduction I have hereby sketched is admittedly different from both typical scientific reduction and from the phenomenological reduction or *epoche*. I believe however that it bears some similarities to both, and arguably can serve as a bridge between them. In the last section I will explore this possiiblity.

3 Phenomenological and Scientific Reduction

There were several characteristics of the case-study reductive explanation from the earlier section which I will consider, by way of making a comparison with the reductive analysis sketched in the previous section.

- HYPOTHETICALS Explanations do not typically refer to "actual" example objects or phenomena (when the do they might better be described as "demonstrations" or as explanations clarified via a demonstrations. Instead, they describe typical, hypothetical cases — an imaginary glass-lit room, an imaginary situation of entering a room to find a book, etc., referring to the two examples I have used here. As I considered earlier, the ability of the example to set up a provisional conceptual network based on the presumptive familiarity of participants with the kind of situation described, is presupposed by the explanatory process and is not itself explained. This further implies

- PARTICIPATION Explanations are seen to be participatory processes, in which the nature of this participation can be studied in part by rhetorical, discursive, and dialogic theories, in addition to formal models of scientific analysis. The point is not that rhetorical structures (for example) *take the place of* scientific-analytic ones, but rather that some parts of scientific process involve cognitive interactions which can be more concisely modelled using theories in the domains of rhetoric, discourse analysis, or dialogic semantics.

- VALENCE Earlier I discussed a theory of relation-type "valences" which tend to distinguish types of relations typical among concepts posited as part of the macro-scale phenomena to be explained, in contrast to those among micro-scale entities. In the case of reductive explanation of macro-scale *physical* phenomena in terms of such posited objects as molecules and photons, the macro-scale relation-types tend more to be operational and situational, whereas the micro-scale relation types are quantitative and spatial. When modelling explanations via (hypothetical or actual) conceptual graphs, I argued that this general typology of relations can be captured by "valences" defined on relation-types within the relation-type hierarchy which is a formal component of CGS environments.

- PARTITIONS In the first section I proposed a segmentation of a graph Γ describing the case-study reductive explanation into a macro-scale and micro-scale or "reductive base" components $\Gamma_{\mathcal{M}}$ and $\Gamma_{\mathcal{B}}$; in the section section I divided graphs represent a total cognitive/experiential episode into operational, cognitive, and perceptual segments $\Gamma_{\mathbb{O}}$, $\Gamma_{\mathbb{C}}$, and $\Gamma_{\mathbb{P}}$. As I will discuss, the analogy is imperfect, because $\Gamma_{\mathbb{P}}$ is not a "reductive base" in the second analysis analogous to $\Gamma_{\mathcal{B}}$ in the first explanation. However, there are certain similarities between them, which I will consider shortly.

- ATOMICITY In the first explanation, molecules and light-waves were introduced as elements of a "reductive base". In the second analysis, I argued that it was possible *after analysis* to identify the *least complex* perceptual features as "quasi-atoms", but stipulated that these entities were not complete atomic or not without some internal structuration. However, it is rare that physical reductions themselves go "so far down" to a purely "atomic" level, or even what such a level would be; even the tiny "strings" of String Theory have vibrational patterns and, therefore, some inner structure. Relative to a given explanation, objects on certain scales may play the role of de-facto atoms (whether what physics itself would call an atom, or a molecule, or subatomic components), but even here these quasi-atoms are neither fully undifferentiated or purely isolated; atoms for examples can be imperfectly visualized as self-contained solar-system like aggregates of nucleons and electrons, but in some contexts (such as analysis of electroconductivity) the electrons do not properly belong to individual atoms but instead flow between them.

There are some obvious disanalogies between the two analyses. In the case of the transparency explanation, the transition from macro-scale, "lifeworld" operational concepts to micro-scale, less-familiar, scientifically posited entities, was part of the explanatory process, part of the cognitive transition achieved insofar as the explanation is understood and accepted. In the case of perceptiual manifolds, the lifeworld, operational, macro-scale phenomenological totality of consciousness is *itself* the phenomena to be explained, and the transition to an emphasis on fine-grained perceptual detail is not only part of the explanatory process — part of the participatory setting or the "metalanguage" with which the explanation itself is carried out — but rather is the actual line of reduction by which a reductive base is defined.

The distinction here can be captured more systematically by contrasting the reductive base notion $\Gamma_{\mathcal{B}}$ exemplified by the glass-molecules-and-light-waves level, and the perceptual manifold model $\Gamma_{\mathbb{P}}$. In the former example, $\Gamma_{\mathcal{B}}$ was assumed to model a domain of entities which are the *physical constituents* of $\Gamma_{\mathcal{M}}$ entities, such as sunlight and glass panes. In the latter analysis, perceptual quasi-atoms are also assumed to be constitutive of experiential manifolds, though this is presented as an experiential rather than physical constitution, in the sense that any experience of an aggregate perceptual context is necessarily an experience of its fine-grained components. On the other hand, there are different kinds of experience and different degrees of experiential activeness or passivity. There is a *sense*, for example, that my visual perception of a book's cover includes perception of its title, but this latter perception may be more or less passive; if I am actively concerned with identifying the book, then I may be specifically aware of its title, but if I am simply scanning all the books on the shelf looking for one with a maroon cover, I may not actually be aware of all the title, even if that information is available to me visually. The fact of having passive perception of contents which convey some information is not the same as actually being aware of the states of affairs whcih this information conveys; this is the crux of the distinction between perception and cognition. The *perceptual* manifold as a unified whole "contains" perceptual parts, but cognition and experiential awareness acts a filter which screens many of these parts, if we were to make a list of thoser perceptual details which are actually used in cognitive judgments during particular experiential episodes. We can still consider active, cognitively engaged conscious experience as a kind of macro-scale phenomenon — analogous to a $\Gamma_{\mathcal{M}}$ — which is composed of constituent smaller-scale ($\Gamma_{\mathcal{B}}$) parts, but here the manner by which $\Gamma_{\mathcal{B}}$ mereons unify into larger wholes is complicated by the distrinction between active and passive perception. Here the macro-scale is not just a collection of micro-scale entities, the way that a pane of glass is a collection of glass molecules; rather than macro-scale is an *aggrgative system* in which additional parameters (such as activity and passivity) are superimposed on the basic mereological hierarchy.

This extra complication certainly alters the degree to which reductive-base properties carry explanatory and causal weight within the explanation. Insofar as a pane of glass *just is* a set of many glass molecules, it is imprecise to say that micro-scale properties of glass molecules "cause" macro-scale properties like transparency. Glass-panes and many-glass-molecules are two different descriptions of the same system on different scales, just as descriptions of the front and back of a house, or the house while it is being built and after it has weathered decades of winter storms, are different descriptions of the same "system" at different spatial and temporal locations, respectively. We expect that the language and conceptual frames appropriate for describing the basement of a house are different from those appropriate for describing the living quarters or the roof — not because of some mysterious difference between these levels but because they are different spatial parts of one object. If we can accept the analogy of *scale* as a *dimension*, akin to space and time, then we make a similar point with respect to the different descriptive mechanisms of the glass-pane and the glass molecule. These descriptive difference are cross-scale but "intra-object", so that talking about a window and about glass windows are ways of talking about two different scales or reality within a glass pane, but are both talking about *the same* glass pane. The glass molecules *are* the glass window. A fundamental feature of physical reductive explanation, at least in many cases, is the idea that a given physical entity can be described at different scale, and the reductive analysis is the explanation of one *scale* in terms of a different scale, but with the assumption that the referents of descriptions in both cases are different "scalar parts" of the same thing. It is not then necessary to identify causal *influences* between referent-obejcts at one scale and those of a different scale, as if they were two different things which needed some medium of transmitting influence between them. Instead, it is assumed that the higher-scale description of phenomena is appropriate because our perceptual capacities do not permit the direct awareness of micro-scale reality insofar as it is studied by modern science. The force of explanation is the demonstration that the high-level reality we perceive is a simplification of a low-level reality, and to make a convincing case that a theorized low-level description could plausibly cause the high-level reality to appear as it does. For example, the explanation can claim that light waves are really individual photons travelling in the spaces between glass molecules, but this low-level reality — where we do not see individual molecules or photons — is the same, at a different scale, as the reality we do actually perceive, namely the fact that objects on the other side of the glass pane than us appear nearly the same with the glass in between, as if the glass were not there.

It is therefore important, in the context of reductive explanation, to distinguish between that part of an explanatory process which identifies lines of causation and that part which explains how a system, ones within which those lines of causation operate, appears as it does to us with our perceptual capacities suited for high-scale descriptions of reality. The low-scale properties cause us to observe the high-scale details as we do, but it is innaccurate to say (in general) that the low-scale properties or events *cause* the high-scale ones. Certainly there are occasions when a causal influence is highlighted between distinct phenomena; for example an infection causes a fever. But in these cases there line of causaiton is not between low-scale and high-scale dimensions of the same system, but between two system, each of which exists on multiple scales and can be described in both high- and low-scale terms. It may be that an explanation emphasizes causal relations between the entities posited by a low-scale description of one system and those of a high-scale description of a differet one, but here the "line of causation" is again between system, not between scales;

the cross-scalar aspect of the explanation is a way of presenting the low-scale description in a manner which convincingly explains why the phenomena identified as a cause of apparent high-scale behavior *and* described in a low-scale way, will cause *low-scale* behavior which, when described at the high-scale level, takes on these appearances.

If our goal is to explain what *causes* transparency by developing a low-level description of a transparent material, then this strategy has two differnt parts: developing the description and identifying the causal relations within the described system. Identifying causal relations in turn depends on identifying the carriers of causal influence, that is, identifying which objects, physical influences, or interactions between objects via physical influences, that give rise to systematic cause/effect relations. Considering that the low-level entities in this case-study explanation are glass molecules and light waves, any posited causal relations must be identified between these entities. In many ways, the main story in this particular case is the *lack* of causal influence between them. The impoertant causal (or potentially causal) relations here appear to be what occurs as the light waves pass between glass molecules, and in this case the low-level system is described such that there are relatively few interactions between them. There is a sense in which *the fact that* such states of affairs tend to obtain at the micro-scale "causes" the high-level phenomenon identified with the concept of transparency, but this is an imprecise notion of causation. It is better to describe causation in this sense instead as a descriptive account of the micro-scale nature of a given macro-scale phenomenon (here a pane of glass) together with a story about how a system with this structure, at the micro-scale, *appears as* a system which has observed macro-scale properties (such as allowng objects to be visible despite a glass pane). What is *caused* in this case is not the macro-scale nature of the system but the fact that this macro-scale nature appears in such-and-such a way. So when considering reductive explanations as *causal* explanations, it is necessary to distinguish cases where micro-scale phenomena are asserted to cause *other* macro-scale phenomena, and when the micro-scale nature of a phenomenon is asserted to cause how that phenomenon appears at the macro-scale. Much of the content of many reductive explanations is of the latter variety; so reductive explanation should not be theorized in general as an analysis of causal relations which "propagate" across scales, but rather as the attempt to build convincing micro-scale models of commonly recognized macro-scale phenomena.

In the case of perceptual manifolds, causal relations are similarly only secondary to many parts of a meaningful reductive analysis. There are occasions when we can consider causal relations between perceptual and/or cognitive phenomena; for example, unanticipated intrusions in our perceptual field, such as a slip of paper falling from the pages of a book, cause our attention to be redirected, often instinctively, so that this shift in focus is not experienced as a deliberate action on our part but rather as if our mental state were subject to causal influences from outside. Of course, this very susceptibility of the state of our experience at any given moment to external influence, is precisely why we trust our experience as a vehicle for carrying information about the outside world; we are aware of and therefore make use of the distinction between changes in what we experience due to our conscious acts or our using imagination, and changes brought on by contents which we receive from the outside world. I feel confident in asserting this even in the context of phenomenological bracketing of the commonplace notion of "the external world". The obvious experiential differences between pure imaginings, anticipated impressions which are then experienced more or less as anticipated, anticipations or *protentions* which end up yielding perceptions different from anticipated, and wholly unexpected perceptual intrusions; these differences are experientially evident even if we make no effort to thematize the "external world" as we presume it in the Natural Attitude, and therefore provide a basis for accepting that this very Natural Attitude assumption of the existence and externality of the external world is not vacuous. So there is some notion of causal influence between perceptual content and my experiential and cognitive state, but this is not a case of some identified "reductive base" entities — here peceptual quasi-atoms — "causing" observed phenomena at the macro-scale.

Insofar as micro- and macro-scale descriptions of physical phenomena describe *the same* system, just at different scales, then the focus of explanation is not on tracing lines of causation between two different things, although it may be necessary to define such lines between different entities on the lower scales. The trans-scalar identity phenomena under investigation guarantee that although *descriptions* may differ, the actual things referenced by two distinct descriptions may be physically identical. Reductive explanations of mind and consciousness, on the other hand, are compleicated by the fact that trans-scalar identities are unknown or controversial. This is true in the case of basic perceptual reduction of conscious states into aggregate perceptual manifolds, because consciousness is more than just perceptual awareness; the distinct layers of self-awareness, cognitive judgment, intentionality and attention, thoughtful anticipation and remembering, etc., all add additional mental content to the basic perceptual layer. It is still further true that reduction to minimal perceptual units, even to the degree that this is a productive representation of mental states, is still not physical reduction proper. There exist correlations between perceptual features and sensory, therefore physiological and potentially physical details, but these correlations are not so clearly understood that perceptual quasi-atoms as a partial reduction of conscious experience can be further reduced down through sensory mechanisms to a physical level, completing a reductive chain from the mental to the physical.

But despite this hardship in envisoning a full-fledged physical reductive explanation of conscious or mental states, there are still some revealing similarities between our case-study reductive explanation and our case-study analysis of cognitive and perceptual manifolds. Different stages of the reductive endeavor are associatd with objects which tend to present themselves or be disclosed in consciousness in different ways: I mentioned the operational valence of the glass-window, the geometric, macro-physical valence of the glass pane, and the quantitative, unfamiliar and semi-abstract valence of the glass molecule and the light wave. Similarly, intentions-to-act, cognitive judgments, and perceptual qualia, which contribute valence to structures at the operational, cognitive, and perceptual levels of mental reality, are all conscious contents that are disclosed in qualitatively distinct ways.

It is also true that warrants to these phenomenological claims are not based on empirical observation. I have not demonstrated through any empirical or mathematical argument that, for example, this distinction of operational, cognitive, and perceptuaL mental contens are *present to consciousness* in different ways. I have not provided a formal definition of terminology such as "present to consciousness" or the terms operational, cognitive, and perceptual; nor have I defended the claim that to the latter tripartite distinction there is a corresponding distinction within the former notion of different *modes of being present-to-consciousness*. Certainly philosophical communication can marshal the semantic resonance of words like "presence" and "consciousness", but there remains a gap in philosophical argumentation which must be crossed, however (and even deliberately) imperfectly by the philosophical reader who complete the thoughts by grasping the semantic unity envisioned. The degree to which 20th-century philosophy has embraced such gaps seems to vary from place to place; Anglo-American Analytic philosophy appears to seek to avoid these gaps as much as possible; phenomenology appears to acccept the necessity for these gaps because introspective, phenomenological analysis is by nature private, its details conveyed not through reference to publicly observable data but by attempts to reconstruct moments of introspective clarity through shapes of language, which must be reassembled by the addressee with reference to her own introspections; and post-phenomenological "Continental" philosophy often embraces these gaps, makes them the central focus and possibility of philosophy, and claiims that understanding is possible *because of* them rather than despite them.

But this argumentation gap — this need for phenomenological analysis to reconstruct an experienced clarity of thought via semantic resonance rather than simply encoding the structures of this clarity in propositional form — while demanding a cognitive collaboration of a different *kind* than one finds in science and mathematics, does not render Continental Philosophy "speculative" in a sense of being rigorously weaker than logical or empirical analysis. All argumentation built around a copresumptive mutuality of understanding within a certain set of concepts, from which a theory or explanation can then branch off. Whereas the copresumptive structures of reductive physical explanation tend to attribute to all participants a shared recognition of some familiar, macro-scale "lifeworld" concepts, the copresumptive structures of phenomenological analysis tend to gravitate instead toward structures and qualitative feels of conciousness itself and its contents. These structures may not have the same objective status of publicly observable data or even of concepts which apply to them, like transparency; but if some structure within consciousness is felt by a thinker as having a certain evidential weight, a certain *ty*, then this very fact is an objective datum which deserves further consideration. The experientially certain is not objectively certain, but the feel of this very certainty is an objective fact for the percepts for whom it forms a valence within the presentation of its content. There is within phenomenological analysis a copresumptive community with respect to the broad nature of this subjective objectivity, the means of communicating experiences of phenomenological clarity through manipulations of philosophical language, and the ability of addressees to test the claimed objectivity against their own experience. Thereby provisional copresumptive structures expand into analyses which may be generally accepted or not by a cognitive community, following a pattern which is dialogically similar, even if structurally different, from the course of reductive phyiscal explanation. Insofar as this phenomenological process overlaps with a research method which focusses on the aggregative synthesis of perceptual elements into conscious mentality as a whole, this similar dialogic process between phenomenological and reductive analysis can also reveal some structural similarities as well.

Within the copresumptive collaboration of describing the structures of consciousness and their apparent objectivity, insofar as claims of the apparent objectivity of some structural feature are subject to collective disputation, the foundation of the objectivities sought by phenomenology are structures of consciousness themselves. This is not fundamentally the same as structures of conscious *contents*. No one moment of conscious content is the same as any other, nor one person's experienced content the same as any other person's. To the degree that there is an objectivity to be pursued here it is to be found in the structures within the conscious experience of experiential details, the experience of how they are synthesized, how they interact with intentions (in the sense of practical intendings to do something) and cognitive judgments; the second-order experience which is the experience of how experienced content unites into subjective wholes. The pursuit of this objectivity shares some features with the pursuit of physical objectivity: for example, the fundamental use of hypothetical rather than actual expereinces. We perform phenomenological analyses not of what we experience at the moment of writing or typing, but of some real or hypothetical experiential episode from the past. There is separate and apart from the written analysis then another analysis possible, an analysis of this hypothetical episode as a real conscious and cognitive content in its own right; for example the actual memory of looking for a room in a book insofar as it presents itself to me while I try to formulate a hypothetical example with similar details, or the imagination of this hypothetical situation itself, the imaginary light switch, bookshelf, and unexpected paper-falling insofar as these imaginations are real mental contents. But phenomenological analysis knows not to analyze everything; it knows how to construct examples and case-studies and place these beyond the inventory of analytic presentation; it knows how to be a performance, a demonstration, a performative exposition of a method. There is something deliberately artificial about the objectivity attained through these staged examples of consciousness, just as the objectivity of a model solar system is bracketed by the very stagedness of its modelled artificiality, its assertion of the right to be considered objective precisely because it is not just another objectively existing phenomenon but an artifical construction.

The structures of consciousness identified through these hypothetical case-studies are structures of experiential *unity*, or experience *as* unity, rather than merely experientical contents. Whereas the contents of an experience themselves can not readily be packaged into a staged example, the patterns of their synthesis can be abstracted from the contents themselves, and therefore described using indirect representations of the contents as examples. The goal of phenomenological analysis is not to end at an identification of minimal perceptual contents but to trace the high-scale effects of judment, personhood, deliberate action, mental intentionality, etc., as they alter the structures at the basic perceptual levels in their synthesis and interrelating. Insofar as the analytic end of a putative reductive process are not the “quasi-atoms” of a reductive base, but rather the “convolution patterns” of the higher-scale affecting the lower-scale, then there is an imperfection in the analogy between $\Gamma_{\mathcal{B}}$ (the reductive base of our case-study physical explanation) with $\Gamma_{\mathbb{P}}$ (the base layer of perceptual contents within the larger system of consciousness). The proper phenomenological analogue of $\Gamma_{\mathcal{B}}$ is not $\Gamma_{\mathbb{P}}$ but instead $\Gamma_{\widetilde{\mathbb{P}}}$, or more precisely the convolution effects which transform the former to the latter, the *difference between* $\Gamma_{\mathbb{P}}$ and $\Gamma_{\widetilde{\mathbb{P}}}$.

But even though the reductive base of the *theory* is not the same as the reductive base of the *contents* theoretically investigated, does not mean that disaggregative reduction fails to play a role in the subsequent reductive analysis, or that the analysis of conscious structures in terms of $\Gamma_{\mathbb{P}}/\Gamma_{\widetilde{\mathbb{P}}}$ different is not properly a reductive explanation. Moreover, I have argued that there exist some practical mechanisms — such as Virtual Reality and 3D Reconstruction — which offer case-studies of this theorized $\Gamma_{\mathbb{P}}/\Gamma_{\widetilde{\mathbb{P}}}$ difference and ways to explore it formally and qualitatively. While the copresumptive norms of phenomenological discourse provide a dialogic setting which is just as rigorous and objectively mindful as the rules of scientific communication and collaboration, considering the differences of their respective spheres, the the genius of scientific method is that this collaborative space of cognitive community becomes analytically mapped to a quantitative space of data and measures, which does not *replace* the need for presumptive cognitive assent but supplements it with details which are cognitively present in a different, more mathematically rigorous way. Phenomenology can only be helped by a comparable mapping of its theses onto quantitative structures marshalled by some experimental situation, and the rise of technologies which create perceptually real but also quantiatively specified environments — like Virtual Reality and 3D Models — has openned the possibility of quantiative analysis of phenomenological process of synthesizing perceptual contents into an experiential whole, whereas earlier psychological experiments could do little more than quantiatively model ths basic contents themselves, or model their synthesis in obviously artificial ways. The difference between Virtual Reality and the toy unitiues of experimental Gestalt Theory, for example, is that the latter create a unified world-represention convincing enough that phenomenological patterns of experiential synthesis are vividly apparent to its subjects and therefore enter the domain of quantitative modelling, on the coattails of the modelling of a virtual world itself.

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