CHAPTER FOUR

SEMANTICS

We have a definition of observer, but not of the observed. A theory of perception cannot be complete without some account of the objects of perception. Parsimony suggests that we not postulate a new ontological category for these objects. We therefore explore the possibility that the objects of perception are themselves observers. We develop this proposal in the context of an investigation of the meaning and truth conditions of conclusion measures. To this end, we introduce a "primitive semantics" and an "extended semantics" for the representations appearing in the definition of observer.

1. Observer/world interface: Introduction

What are true perceptions? Without addressing this central question, no theory of perception can be complete. In observer theory the perceptions of an observer are represented by its conclusion measures so that, rephrasing, we may ask the question: What are true conclusion measures? Now on a correspondence theory (as opposed to, say, a consensus or consistency theory) the truth of a conclusion measure depends primarily on two factors: (1) the meaning of the measures and (2) the states of affairs in an appropriate external environment. Recall, however, that Definition **2**–2.1 of observer nowhere refers to a real world or to an environment external to the observer. The spaces X and Y represent properties of the interaction between the observer and its environment but are not the environment itself. Therefore to study true perceptions we first propose a minimal structure for environments and for the relationship between observers and environments, thereby advancing a primitive theory of semantics for observers. We extend this theory in section four. In the next chapter we begin to build a model for the theory by the introduction of "reflexive observer frameworks."

In chapter two we describe the observer-world relationship as follows:

1.1. When the observer (X, Y, E, S, π, η) is presented with a state of affairs in the world which corresponds to a point x of X, the point $\pi(x) \in Y$ "lights up." If $\pi(x) \notin S$ then the observer outputs no conclusion measure. If $\pi(x) = s$ is in S then the observer outputs the conclusion measure $\eta(s, \cdot)$.

Our task is to explain this statement.

We distinguish two levels of semantics: primitive semantics and extended semantics. In primitive semantics a "state of affairs" is an undefined primitive (much as, in geometry, a "point" is an undefined primitive); in extended semantics it is directly defined. Primitive semantics is the "local" semantics of a single observer, a minimal semantics which interprets the observer's conclusion measure η in terms of an external environment. Structure in addition to that of the observer is necessary for this purpose since conclusion measures are representations internal to the observer and have no a priori external interpretation. (In other words, the internal representation embodied in the conclusion measure is not itself a conclusion. For a conclusion is by definition a proposition: it is an assertion about states of affairs in some environment.) The necessary additional structure consists in a formal description of an environment; in terms of this description, meaning can be assigned to the representation η, and this meaning is the conclusion in the correct sense of the term.

In primitive semantics we assume that the "states of affairs" with which an observer is presented are undefined primitives, and that "presenting an observer with a state of affairs" is a primitive relation. States of affairs are not objects of perception. We reserve the term "object of perception" to refer to "that with which an observer interacts" in an act of perception. Rather, intuitively, *states of affairs are relationships between the observer and its objects of perception.* For now these relationships are undefined primitives; the environment of states of affairs is, in the primitive semantics, an abstract formalism. The primitive semantics provides a dictionary between the internal representations of the observer and this abstract formalism.

By contrast, in extended semantics the states of affairs themselves—not only the single observer—are directly defined. At this level, the environment of the observer, as well as the states of affairs in it, have a priori meaning independent of the observer's conclusion measure.

This environment of states of affairs is not to be regarded as a theatre for all possible phenomena; it need only be rich enough in structure to provide a concrete model of the theoretical environment posited at the first-level. The environment is not accessible to the given observer; its perceptual conclusions are the most it can know in any instant. The environment may, however, be accessible to other "higher-level" observers under various conditions; this leads to the notion of "specialization" which we take up in chapter nine. The first three sections of this chapter consider primitive semantics. Section four studies extended semantics.

2. Scenarios

We begin with a fixed observer $O = (X, Y, E, S, \pi, \eta)$. As an abstract observer, O consists only of its mathematical components X, Y, E, S, π, η as set forth in Definition **2**–2.1. We want to view O as embedded in some environment as a perceiver. Therefore we must provide additional structure to represent such an embedding. We call this structure a *scenario* for O. Given a definition of scenario we can then discuss the semantics of O's conclusions.

The definition of scenario involves an unusual notion of time. Just as we assume no absolute environment, so also we assume no absolute time. We assume only that there is given, as part of each scenario, an "active time"; the instants of this active time are the instants in which O receives a premise. This active time is discrete. Perception itself is fundamentally discrete; any change of percept is fundamentally discontinuous. To put it briefly: we model perception as an "atomic" act. An atomic perceptual act is one whose perceptual significance is lost in any further temporal subdivision. This view is developed in later chapters, but a few remarks are in order here.

As we have indicated, observer theory is not a fixed-frame theory in which all phenomena are objectively grounded in a single connected ambient space—an analytical framework which plays the role of an absolute "spacetime." Absolute spacetime is surely of interest both psychologically and physically, but in neither case is this due to a principled requirement that every scientific model must begin with it. In particular, this is true of absolute time. In building a theory which is centered on acts of perception there is no reason to assume, in general, that the active times of (the scenarios of) different observers bear any describable relationship to each other. Thus there may be no natural way to embed the active times of two different observers into a third time-system (in some order-preserving manner). In special cases, however, it is natural to assume that the active times may be so embedded; this occurs, for example, when the observers occupy the same "reflexive framework" (Definition **5**–2.2). In other cases the active times of different observers admit comparisons of various kinds. For example, one instant of the active time of a "higher level" observer may correspond to an entire (random) subsequence of instants of the active time of a "lower level" observer.

Definition 2.1. A *scenario* for the observer $O = (X, Y, E, S, \pi, \eta)$ is a triple $(\mathcal{C}, R, \{Z_t\}_{t \in R})$, where

(i) $\mathcal{C}$ is a measurable space whose elements are called *states of affairs;*

(ii) R is a countable totally ordered set called the *active time;*

(iii) $\{Z_t\}_{t \in R}$ is a sequence of measurable functions, all defined on some fixed probability space Ω and taking values in $\mathcal{C} \times Y$.

In other words, a scenario is a stochastic process (**6**–1) with state space $\mathcal{C} \times Y$ and indexed by R.

Terminology 2.2. Z_t is called the *observation* at time t or the *presentation of the observer with a state of affairs* at time t or the *channeling* at time t. If Z_t takes the value (c_t, y_t) with $c_t \in \mathcal{C}$ and $y_t \in Y$, we say that c_t is the *state of affairs* at time t and y_t is the *premise* (or *sensation* or *sensory input*) at time t. For any sample point $\omega \in \Omega$, the sequence $\{Z_t(\omega)\}_{t \in R}$ corresponds to a sequence of points $\{(c_t, y_t)\}_{t \in R}$ in $\mathcal{C} \times Y$. We call this an *observation trajectory.*

The "states of affairs" in Definition 2.1 are external to the observer in the sense that they are not part of its structure. This does not imply that these states of affairs are states (or parts) of a physical world.[1] In fact, physical properties are an observer's symbols for these states of affairs, or for stable distributions of these states of affairs. Any attempt to ground a theory of the observer in an a priori fixed physical world encounters great difficulties from the outset. Contemporary physics, for instance, holds that physical theory

[1] In particular, when we define the collection of states of affairs to be a measurable space $\mathcal{C}$, we are not claiming that any part of a physical world is a set.

itself must include the observer. This is evident at the quantum level, where it seems impossible to escape the conclusion that acts of observation influence the evolution of physical systems. It is also seen in relativistic formulations, where the theory, by its very definition, consists in the study of statements which are invariant under certain specified changes in the perspective, or frame of reference, of observers. For such reasons it is scientifically regressive to cling to a fixed "physical world" as the ultimate repository for states of affairs. We do not deny the existence of physical worlds but suggest that, habit aside, it is more natural to ground physical theory in perceptual theory than vice versa.

To summarize: we distinguish between perceptual conclusions, states of affairs, and objects of perception. In primitive semantics the states of affairs are undefined primitives whose existence is assumed as part of a given scenario. These states of affairs are relationships between the observer and its objects of perception, which are not specified. The observer is presented randomly in discrete time with states of affairs. This presentation is a primitive, assumed as part of the scenario. The presentations consist in a stochastic sequence (in the given discrete time) of pairings of states of affairs with premises from the premise space Y of the observer. These elements of Y constitute the only information accessible to the observer about the scenario, i.e., about its "environment." The scenario provides the syntactical structure to which semantics can be attached.

However, in the scenario itself there is no semantics: there is no conclusion in the correct sense of the word. Namely, the data of the scenario alone contain no direct relationship between the states of affairs in $\mathcal{C}$ and the conclusion measure η or, for that matter, the observer's configuration space X. (We regard the indirect relationship, at each instant t, which exists because the conclusion measure $\eta(s, \cdot)$ is deterministically associated to s, as a purely syntactical relationship: the symbol $\eta(s, \cdot)$ is formally attached to the symbol s, which in turn is formally attached to c_t via $Z_t = (c_t, s)$.) The scenario directly relates states of affairs with points of Y—not with points of X.

The only information an observer directly receives is a premise, a sensory input, at each instant of active time. The scenario is a minimal formalism for an external world whose states of affairs are related in some unknown manner to the successive production of these premises. This world must be external to the observer, because the internal structure of the observer, by definition, consists only in X, Y, E, S, π, η; these alone say nothing about the production in a time sequence of elements of Y.

To go further, to posit a relationship between the states of affairs and X that is compatible with the scenario data, brings us to the issue of meaning.

3. Meaning and truth conditions

Let there be given an observer O and a scenario $(\mathcal{C}, R, Z_t)$ (Definition 2.1). We have been referring to the "conclusion of the observer" as the ***meaning*** of its conclusion measure. This meaning is a proposition regarding a relationship between the conclusion measure and the scenario. Now the truth or falsity of this proposition can be decided only in the presence of a concrete model of the scenario, i.e., only in the presence of an extended semantics. Prior to such a model, i.e., within a primitive semantics, we are free to assign meaning to O's conclusion measure by ***postulating*** a relationship between it and the scenario. In the definition to follow we state this relationship. In chapter eight we discuss truth conditions for the postulated relationship in the context of an extended semantics.

Definition 3.1. Let pr_1 and pr_2 be the projections of $\mathcal{C} \times Y$ onto the first and second coordinates respectively. The ***meaning*** of the conclusion measure η is the following pair of postulates:

> **Postulate 1.** There exists a measurable injective function $\Xi\colon \mathcal{C} \to X$ such that, for all $t \in R$, if $Z_t = (c_t, y_t)$ then $y_t = \pi \circ \Xi(c_t)$.

Let $X_t = \Xi \circ \mathrm{pr}_1 Z_t$. Then X_t is a measurable function with the same base space as Z_t and taking values in X. Letting ν_t be the distribution of X_t, denote its restriction to $\pi^{-1}(S)$ by ν_t^S: for $A \in \mathcal{X}$, we have $\nu_t^S(A) = \nu_t(A \cap \pi^{-1}(S))$.

> **Postulate 2.** ν_t^S is a nonzero measure and η is its rcpd with respect to π.

To specify a meaning for η in a given scenario, we need only specify a Ξ such that $\nu_t(\pi^{-1}(S)) > 0$; the interpretation of η is then established by Postulate 2.

Terminology 3.2. The measurable function Ξ is the ***configuration map;*** $\Xi(c)$ is the ***configuration*** of c. If Definition 3.1 holds, $(R,\ \mathcal{C},\ \{Z_t\},\ \Xi)$, is called a ***primitive semantics*** (for O). A state of affairs $c \in \mathcal{C}$ is called a ***distinguished state of affairs*** if $\Xi(c) \in E$.

Discussion of Postulate 1 of 3.1

The existence of the configuration map Ξ, asserted in Postulate 1 of 3.1, means that there is a time-invariant relationship between the states of affairs in $\mathcal{C}$ and the configurations in X; we therefore can now say what X represents. Until now X was simply part of the internal formalism of the observer, an abstract representational system. It is only by virtue of Ξ that X represents the states of affairs; indeed Ξ defines that representation. The postulate states further that the pairing in the scenario between c_t and y_t (via the channeling Z_t) is imitated within the observer by the pairing between $\Xi(c_t) = x_t$ and $\pi(x_t) = y_t$. We may say that $(x_t, \pi(x_t))$ is a picture of (c_t, y_t).

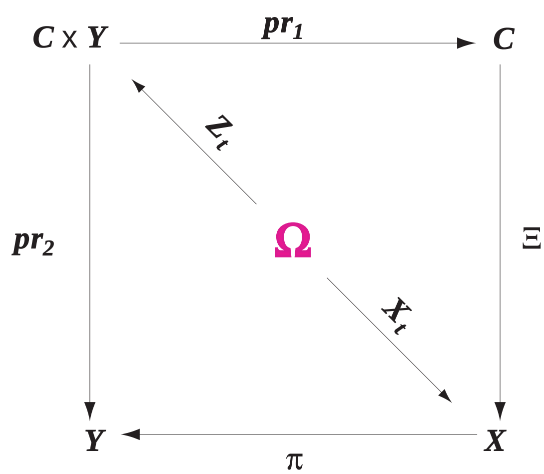

FIGURE 3.3. *Postulate 1 says there exists a Ξ for which this diagram commutes.*

Given the configuration map Ξ satisfying the properties of Postulate 1, we may effectively replace $\mathcal{C}$ with X, at least for the purposes of the primitive semantics. Because Ξ is one-to-one, the internal formalism of the observer, specifically X, Y and π, gives a good representation of the interaction of the observer with its environment (as provided in the scenario). Thus we can formally bypass $\mathcal{C}$, and view the scenario as consisting, in essence, of a discrete-time probabilistic source of elements of X, i.e., as the sequence of measurable functions $\{X_t\}_{t\in R}$. These measurable functions take values now in X, and are related to the original measurable functions Z_t of the scenario by $X_t = \Xi \circ \mathrm{pr}_1 Z_t$. To emphasize this simplification, we will sometimes use the word "configuration" in place of "state of affairs." Of course, this is an abuse of language; when we say, for example, "a configuration x channeled to the observer," we mean that a state of affairs c, for which $x = \Xi(c)$, channeled to the observer. Figure 3.3 illustrates Postulate 1.

The condition that the X_t's have identical conditional distributions over points $s \in S$, namely the distributions $\eta(s, \cdot)$, expresses an assumption built into the observer that its relevant environment is stationary: the distribution of states of affairs which channel to the observer, resulting in premises in S, does not vary with time. We mean neither that the observer has made a considered or learned inference to this effect, nor that it has made a scientific judgement about the stability of its environment. Rather, our viewpoint is that a de facto assumption of stationarity is fundamental to perceptual semantics; we are here modeling perception at the level where each instantaneous percept involves the output of a de facto assertion of some stationarity in the environment. The stationarity condition given above is the strongest such assertion that the observer can make without exceeding the capacity of its language.

Discussion of Postulate 2 of 3.1

The set $\pi^{-1}(S)$ consists of the configurations of those states of affairs whose channelings could result in a distinguished premise $s \in S$. Postulate 2 says, then, that there is a nonzero probability $\nu_t(\pi^{-1}(S))$ that such channelings occur. Moreover, it assigns meaning to the conclusion measures $\eta(s, \cdot)$. Since $\eta(s, \cdot)$ is deterministically associated to $s \in S$ it can be viewed as the "output" given s as "input"; in fact we have tacitly but consistently viewed it in this way up to now. Using this terminology, and given Postulate 1, the meaning assigned by Postulate 2 may be expressed as follows:

3.4. If the premise at time t is $s \in S$, then the observer outputs the conditional distribution, given s, of the configurations of states of affairs whose channeling could result in s; this conditional distribution is $\eta(s, \cdot)$. It is independent of the value of t. If the premise at time t is not in S, then the observer outputs no conclusion.

This explains statement **1.1** in the first section.

For Postulate 2 to hold at all times t, it is necessary that the distributions of the X_t have identical rcpd's over S. Now the observer itself cannot verify such a stationarity in the distributions. For the observer has no language other than that provided by η, with which to represent information about the distributions of the X_t's. In fact, it can say nothing about what happens when $y_t \notin S$; the observer is necessarily inert at such instants t. Nevertheless this stationarity in the observer's environment is fundamental to our perceptual semantics; we as modelers can verify the existence of such a stationarity.

As noted in section two, truth conditions for the conclusions of an observer amount to giving additional conditions on the scenario under which these conclusions are true propositions. Thus the truth conditions will be satisfied in some models (of the abstract scenario formalism), and not in others. We reiterate that, for this reason, the truth conditions can only be verified in the extended semantics where a concrete model of the scenario is given.

Terminology 3.5. Given an observer in a scenario and given a model of that scenario (i.e., an extended semantics for the observer) we say that *the observer's conclusion is true at time* t or that *the observer has true perception at time* t if the postulates of Definition 3.1 are true in that extended semantics. If the observer has true perception at time t for all t, and if the map Ξ is the same for each t, then we simply say that *the observer has true perception.*

Terminology 3.5 allows truth an instantaneous character.

4. Extended semantics

So far we have assigned meaning to the observer's conclusion measures, but not to the states of affairs. A "state of affairs" in $\mathcal{C}$ is a relationship between the observer and its objects of perception. The objects of perception do not appear explicitly in the definition of scenario, although each channeling arises from an interaction between the observer and these objects. In order to assign meaning to the states of affairs, i.e., in order to *extend* our semantics, we must construct models for the scenario in which the objects of perception are specified.

In the next section we propose one such specification of the objects of perception. Here we ask the following question: In order to be able to extend our primitive semantics, what relationship must obtain between the set of objects of perception and the primitive semantics? Let us denote the set of objects of perception by $\mathcal{B}$. The primitive semantics, as above, is $(R, \mathcal{C}, Z_t, \Xi)$. In an extended semantics the set $\mathcal{C}$ of states of affairs plays a dual role, both as the set of referents for O's conclusions and as the set of relationships between O and $\mathcal{B}$. The answer to our question must ensure a compatibility between these roles. The elements of $\mathcal{B}$ are the source of the channelings, they can in principle be individuated by O only to the extent that they are individuated by the relationships in $\mathcal{C}$. We may now state our requirement of compatibility between $\mathcal{B}$ and $(R, \mathcal{C}, Z_t, \Xi)$.

Assumption 4.1. Suppose that we have a primitive semantics $(R, \mathcal{C}, Z_t, \Xi)$; in particular, suppose Ξ exists and has the property stated in Postulate 1. Suppose that we are given a set $\mathcal{B}$ such that at the instant t of O's active time there is at most one channeling to O, and that this channeling arises from the interaction of O with a single element of $\mathcal{B}$. The class of such interactions is parametrized by $\mathcal{C}$. Suppose further that the primitive semantics $(R, \mathcal{C}, Z_t, \Xi)$ induces an equivalence relation on $\mathcal{B}$: two elements, say B_1 and B_2 of $\mathcal{B}$, are equivalent if and only if any channeling at time t arising from the interaction of O with B_1 or B_2 results in the same value of the measurable function X_t, where X_t is defined as in 3.1. Since distinct elements of X_t correspond to distinct elements of $\mathcal{C}$ the equivalence classes are in one-to-one correspondence with elements of $\mathcal{C}$. Let $\mathcal{B}_c$ denote the equivalence class in $\mathcal{B}$ which corresponds to the element $c \in \mathcal{C}$ for the equivalence relation just defined.

We can now say precisely what is the meaning of the elements of $\mathcal{C}$ as relationships between O and $\mathcal{B}$:

Condition 4.2. To say that an observer stands in the particular relationship c of $\mathcal{C}$ to $\mathcal{B}$ at time t means that the observer interacts with some element of the equivalence class $\mathcal{B}_c$ at time t, and that a channeling at time t arises from this interaction; the channeling results in the value $\Xi(c)$ for the measurable function X_t.

Since the state of affairs c is specified by the corresponding equivalence class $\mathcal{B}_c$ we can think informally of the relationship corresponding to c as the "activation" of the class $\mathcal{B}_c$. As defined, the notion is instantaneous. The formal definition of extended semantics is then the following:

Definition 4.3. Given a primitive semantics $(R, \mathcal{C}, Z_t, \Xi)$ for the observer O, an ***extension*** of this semantics consists in a set $\mathcal{B}$ for which the hypotheses of 4.1 hold (for some notion of "interaction"). $\mathcal{B}$ is then called the set of ***objects of perception.*** Such extensions of primitive semantics are called ***extended semantics.*** In an extended semantics, the ***meaning*** of the states of affairs as relationships between O and $\mathcal{B}$ is described by 4.2.

Once we are in an extended semantics, it is usually convenient simply to bypass the states of affairs $\mathcal{C}$ and to speak only of the objects of perception $\mathcal{B}$ and the configuration space X of the observer. For the states of affairs map injectively to the configurations by Ξ, so no information is lost thereby. Moreover, by assumption, all channelings originate in interactions of O with elements of $\mathcal{B}$. Thus the essential information in an extended semantics for O is $R, \mathcal{B}, \Phi$, and X_t, where

$$\Phi \colon \mathcal{B} \to X$$

is defined by $\Phi(B) = \Xi(c)$ for that c such that $\mathcal{B}_c$ is the equivalence class (described in 4.1) which contains B. In this way, the equivalence classes now appear as the sets $\Phi^{-1}\{x\}$, for $x \in X$, so that the original information carried by the states of affairs is not lost.

Terminology 4.4. We refer to "the extended semantics defined by $(R, \mathcal{B}, \Phi, X_t)$." $(\mathcal{B}, \Phi)$ is called the ***environment*** of the extended semantics. We retain the terminology "configuration map" for Φ; now we can speak of the configuration $\Phi(B)$ of the object of perception B. We call B a ***distinguished object of perception*** if $\Phi(B)$ is in E. We say that B ***channels to O at time t*** if a channeling arises from the interaction of O with B at time t.

The postulates of Definition 3.1 assume a new significance in the context of extended semantics. Postulate 1 is required to hold in order that the extended semantics exist. Postulate 2 is now also a truth condition whose veracity can be tested in $(R, \mathcal{B}, \Phi, X_t)$.

5. Hierarchical analytic strategies and nondualism

In an extended semantics for an observer O, the states of affairs $\mathcal{C}$ are relationships between O and a set $\mathcal{B}$ of objects of perception, as stipulated in Definition 4.3. The objects of perception represent the minimal entities that can interact instantaneously with the observer: at each instant of the observer's active time a channeling occurs, and there is at most one channeling, corresponding to the interaction of the observer with exactly one element of $\mathcal{B}$. Thus a channeling indicates an interaction of O with an object of perception. The conclusion of O—expressed by the output of the conclusion measure $\eta(s, \cdot)$—is an irreducible perceptual response of O to the channeling. The interaction is an irreducible perceptual stimulus for O. The word "irreducible" here refers not to an absolute indecomposability, but to an indecomposability relative to the observer's perceptual act: In some (hypothetical) decomposition of both the observer and its object of perception, a single channeling might involve many "microchannelings" between components of the observer and its object. But these microchannelings have no direct perceptual significance for the original observer—neither a channeling nor a conclusion on the part of the original observer are associated to a single microchanneling.

Up to now we have been considering the interactions of systems without reference to their further decomposition—what one might call "direct" interactions (not to be confused with the direct ***detection*** of **2**–6). In this section we direct attention, briefly and informally, to the problem of analyzing the interaction between "complex systems," i.e., systems each admitting more than one distinct level of structure. Assume for the moment that the levels have already been distinguished. We suggest that an appropriate analysis of such an interaction involves matching levels of the respective systems in such a way that the total interaction appears to consist of separate direct interactions between the constituents at each of these matched levels. The constituents of any given level, or stratum, are entities which are not decomposable in that stratum, although they may be decomposable in terms of entities at lower levels of the stratification. It may be that only one level of each system interacts directly with a corresponding level of the other system, or it may be that any pair of levels, one level from each system, interacts directly. We also assume that information flows between the various levels within each system separately, so that the effects of the direct interaction at any one level can propagate to other levels. Thus it is not restrictive to require that an interaction should admit a decomposition, for purposes of analysis, into separate direct interactions between entities at certain matched levels. Nor is such a requirement to be taken as a statement about the absolute character of reality. It is rather a matter of choosing an analytical strategy.

In practice we want the freedom to choose the stratifications so as to display effectively the total interaction in terms of direct interactions at appropriate levels. (We wish to understand the total interaction, not to embed some previously distinguished elementary levels in a larger context.) This kind of freedom requires that our concept of stratification has some flexibility, that its application is not rigidly determined in every case (although each application must produce strata whose mathematical relationship to one another is of some well-defined type). The question of what principles should govern the selection and "matching" of strata rests in turn on the question of what constitutes "direct interaction," because the purpose of the matching of strata is to display direct interaction. There need not be a unique answer to this question, even in a concrete situation. Indeed, because of the internal flow of information between the levels in each system, there may be many ways to select a certain set of levels as being the sites of direct interaction. But however the definitions of stratification and direct interaction are ultimately fixed in a particular case, we would adduce at least the following general requirements:

1. **Irreducibility.** The notion of "level" is sufficiently robust so that irreducibility relative to a level makes sense: If P is an irreducible constituent of a level L in a system A (i.e., the constituent P of A is a site for direct interaction at level L), then although P may be decomposable in some way in the total system A, there is no such decomposition within L itself.
2. **Matching.** To match levels L and L', in the respective systems A and A', means that every irreducible constituent of L can in principle interact directly with every irreducible constituent of L'.
3. **Homogeneity.** There is homogeneity within any given level in the sense that the minimal syntax required to distinguish the level L from other levels is not sufficient to discriminate among the irreducible constituents of L.
4. **Transitivity.** The notion of direct interaction is transitive: Given three entities P_1, P_2, P_3, if P_1 can interact directly with P_2, and P_2 can interact directly with P_3, then P_1 can interact directly with P_3.

Terminology 5.1. An approach to the analysis of any type of interaction of complex systems, which involves a notion of "direct interaction," and a corresponding notion of stratification of the respective interacting systems into levels at which direct interaction occurs, will be called a ***hierarchical analytic***

strategy if the requirements 1–4 above are fulfilled.

This terminology is informal, since we have not rigorously grounded it. However it is useful as it stands for purposes of motivation and description. Here is how we apply the terminology in observer theory, in a particular perceptual context where a hierarchical analytic strategy has been adopted:

5.2. To specify the objects of perception for an observer is to specify what constitutes direct interaction for that observer.

This proposal is reasonable, for we have already characterized the objects of perception for O as "minimal entities with which O can interact instantaneously," or "irreducible perceptual stimuli of O" in a given extended semantics. If we imagine this semantics sitting at one level in a hierarchy, this characterization of O's objects of perception models "direct interaction" at that level.

Now suppose we are given a hierarchical system, say A, in which the observer O is an irreducible entity at some distinguished level L. If B is any other system, perceptual or otherwise, with which A can interact, then in virtue of 5.2 the level L' of B which is matched with L must consist of ***objects of perception*** for O. We claim that other entities, say P, in A at the same level L as O must also be be objects of perception for O. For by requirement 2 above, the entities in L' can interact directly with these. And by 4, O itself can in principle interact directly with such P. Thus, on the one hand the entities P at the same level L as O may be represented as objects of perception of O; they are structurally equivalent to objects of perception in the given analytical framework. On the other hand, by 3, these P are structurally indistinguishable from O, at least in terms of the syntax associated to the level L. We finally conclude that the P's also have some of the structure of observers. This suggests the

Hypothesis 5.3. The objects of perception for an observer O have the same structure as O in the following sense: the objects of perception share with O that part of O's structure which defines it as an irreducible entity at the fixed level L of the given hierarchical analysis. Stated succinctly, the objects of perception of O may themselves be represented as observers.

Hypothesis 5.3 makes sense only in the context of a hierarchical analytic strategy; since that notion is not rigorous, it is clear that the argument given above which leads to 5.3 is not intended to be rigorous. However 5.3 motivates the construction of rigorous models of extended semantics, models which are designed to be incorporated in a particular, well-defined hierarchical analytic strategy. This is the spirit of the reflexive observer frameworks, which we define in the next chapter. One particular hierarchical analytic strategy, which incorporates the extended semantics resulting from reflexive observer frameworks, is called ***specialization***; we consider it in chapter nine.

Hypothesis 5.3 says that a fundamental nondualism is associated with the various levels of the hierarchy; more precisely the nondualism is a property of the syntax associated with each such level, which is the minimal syntax necessary to distinguish that level. Thus, in the presence of a hierarchical analytic strategy, the apparently "dualistic" interaction of two complex systems is decomposable into a set of "nondualistic" interactions between entities at matched levels, together with information propagation through the levels of each system. On the other hand, one could take an approach which simply begins with a suitable hypothesis of nondualism and observe that it suggests (though it certainly does not require) hierarchical strategies. For example we might begin with a meta-proposition similar to the following:

Meta-Proposition. Insofar as any two entities interact they are congruent: the part of their respective structures which is congruent delineates the nature and extent of the primary aspect of their interaction. Any aspect of the interaction which cannot be described in terms of this congruence is secondary, and arises from the propagation of the effects of the primary interaction by the internal flow of information within the separate entities.

We can then take our notion of "direct interaction" to be the "primary interaction" of this meta-proposition, so that direct interaction is automatically nondualistic. Stratification of interacting systems can then be defined in terms of levels of structure at which congruence occurs.

Hierarchical analytic strategies differ significantly from "fixed frame" analytic strategies. In the latter, there is a single unchanging framework (such as spacetime) in which all phenomena of interest are embedded.