The Perceptual Form of Life

Christine A. Skarda

Thanks to J.C.

Table of Contents

Acknowledgements

No one writes a book in a vacuum. The ideas of many people have influenced this book. Chief among them, are the ideas of the philosopher Merleau-Ponty, in whose work I have had an abiding interest for many years and which inspired in me the desire to think about perception in ways that others have not done. He is the true pioneer in the field of perceptual theory.

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INTRODUCTION

A Working Model of Body and Mind

Eventually, we just have to *<u>'see</u>* *the rule...'. If we cannot see it, no amount of explanation is going to make it comprehensible; if we can, then there comes a point at which explanations are superfluous...* (Monk 1990).

This book, which purports to be a new working model of body and mind, is more than anything a methodological exercise. Although it presents a theory of perception, perhaps it would be more accurate to say that it shows a new method of thinking about the body and the mind by approaching perceptual functioning in a new way. It does not introduce any new scientific data about the body or the mind, nor does it argue for rejection of data that have already been gathered. It is not a piece of neuroscientific research or a fully elaborated theoretical structure, so much as it is a new method of thinking about the perceptual form of life.

The new method revolves around a set of key ideas, chief among which is the concept of articulation and its relationship to holism. "Articulation", when used in this book, means one thing only: it is a dynamic process that takes apart or breaks up an holistic phenomenon. Here is an example. When a softball crashes into a window, the pane of glass that it hits undergoes articulation: the pane of glass--a holistic phenomenon--shatters, and pieces are created that did not exist before the ball hit the window. This is articulation. This example also neatly demonstrates the relation between the process of articulation and holism that is emphasized in this book. Holism *always precedes* articulation, just as the whole pane of glass precedes the shards of glass into which it is broken by the ball. The new method demands that when thinking about perceptual functioning one should always assume that the original situation is holistic and that articulation, the creation of parts, follows. This is the basic conceptual reorientation of the new methodology.

It is harder to think in this way about organismic functioning in general, and perceptual functioning in particular, than one might imagine. Ordinarily, we do not think about physical reality holistically. This is because we do not *perceive* physical reality holistically. Perception actually conceals the holistic nature of physical reality from perceivers. Perceptual experience delivers to perceivers an "articulated version" of physical reality. Perceivers hear distinct sounds, they see discrete objects with features, they perceptually experience themselves as individuals operating in a surrounding world of objects. The world as it is perceived is first and foremost an articulated world. As far as perceivers are concerned, partial phenomena are more fundamental than holism because partial phenomena form the fabric of the world as they perceive it. So it is natural for perceivers to think about holistic phenomena as secondary: the *result* of a constructive process that puts together the articulated phenomena that they perceive. Instead of being the fundamental condition of physical reality, holism is perceptually transformed into the product of integration.

The conceptual reorientation required to read this book, therefore, demands that the reader think in an unnatural way. It says, "Look, although you perceive individuated phenomena, don't think about the nature of physical reality in the way that you perceive it. Look at physical reality holistically first. The *parts* are the things that require an explanation, not the holistic phenomena!" Whenever you catch yourself wondering how different phenomena are put together, you can be sure that you are no longer thinking within the conceptual framework of the New Model. Applied to perceptual functioning, this conceptual reversal has important implications. Today the entire perceptual process is thought of in terms of constructing wholes and achieving integration--e.g., feature unification, percept construction, successful integration of organismic functioning with the extra-organismic world. This is not how the New Model characterizes the process. Instead, the New Model characterizes the entire scope of perceptual and organismic functioning *articulatively*. It claims that the function of perception is to deconstruct holistic phenomena, not to put partial phenomena together. Perceptual functioning doesn't put anything together. The aim of the new perceptual theory is to explain how a perceiving organism, which is of one piece with the holistic, unbroken fabric of physical reality, is able to perceive individuated phenomena with features and act as an individual separate from the world which it experiences as its environmental surround. The book's chief aim, therefore, is to explain what perceivers take for granted, viz., the existence of all partial phenomena, from perceived features and objects to the organism behaving as a separate entity in its environmental surround.

CHAPTER ONE

The Current Model of Perception

The history of vision research has been a process of continual improvement of our understanding of how the physical world comes to be represented in our mind by our brain (Harvey 1994).

The science of physics matured earlier than perceptual neuroscience, i.e., if it is true that maturity in a science can be measured in terms of crises in its basic principles (Ortega y Gasset 1964). Perceptual neuroscience exhibits all of the business as usual hallmarks of what Thomas Kuhn (1962) has referred to as normal science. Indeed, so long have the theoretical waters of perceptual research remained undisturbed, that any theoretical re-examination that is critical of the fundamental concepts in terms of which perceptual functioning is understood tends to be dismissed as profoundly "anti-scientific" in motivation. This charge is unwarranted. The current understanding of perceptual functioning is incomplete. Neuroscientists who study perceptual systems readily concede that an enormous amount of work remains to be done before a complete neuroscientific explanation of perceptual system functioning is available. It is generally agreed that only the proverbial tip of the iceberg is currently understood. Yet, at the same time, when questions are raised concerning the theoretical underpinnings of perceptual system research, researchers are quick to assure one that it is "just a matter of time" before the present conceptual framework for understanding perception is verified. How could this be? How can it be that such conservatism concerning the present state of knowledge about perceptual functioning is accompanied by blind acceptance concerning theoretical principles? How can the theory in terms of which the data are gathered and interpreted be so secure in its validity, when the data in terms of which it must be evaluated have yet to be gathered?

Keep in mind that the conceptual framework in terms of which data are gathered is distinct from the data. When theorists criticize the conceptual framework, therefore, they do not criticize the empirical research. Perhaps, this difference is not sufficiently appreciated by perceptual neuroscientists and explains their unwillingness to accept the possibility that their research model may have conceptual problems. They wrongly assume that theorists critical of their conceptual model are critical of their research, which is clearly not the case. Perhaps, researchers are not so much defending the underlying model as they are standing up for the rigorousness of their data collection. For whatever reason, researchers today tend to miss the critics' real point, which is not that perceptual neuroscience is bad science, but that perceptual neuroscience is saddled with a bad theory, i.e., an inadequate conceptual framework for interpreting their experimental findings.

From a theoretical point of view, there is good reason to be critical of the conceptual underpinnings of perceptual research today. Problems inherent in the underlying conceptual framework have been pointed out by successive generations of critics. In this century alone, several convincing critical arguments have been put forward in the fields of psychology (Goldstein 1934; Gurwitsch 1964; Gibson 1979), philosophy (Merleau-Ponty 1942), and neuroscience itself (Varela, Thompson & Rosch 1991). Some of these arguments will be discussed in this and the following chapters. For example, several critics have pointed out the inadequacy of the concept of neural representation for interpreting perceptual system functioning. Neural representation is the central concept in terms of which perceptual functioning is understood today. If, as the critics charge, this concept is inherently flawed and problematic, then the whole interpretive model in use in perceptual neuroscience today is also called into question. Additionally, contemporary neuroscience faces empirical difficulties for which it has found no neural solutions to date. Chief among them is the failure to find the neural basis of the binding process, a process that supposedly compiles or puts together all of the separate features detected by neurons to produce a complete internal neural representation of the external stimulus. Contemporary researchers seem to be convinced that their failure to discover the neural basis of the binding process is a research failure. But this is not the only possibility. They fail to consider the genuine possibility that what appears to them as a research failure is in fact a problem created by the representation-based theoretical model which informs their research and which requires them to find a neural process that may not in fact exist. The latter interpretation would relocate the failure from the realm of research to that of theory, taking the burden off of neuroscientists and placing it squarely in the laps of those whose job it is to develop viable theories. Therefore, there is good reason for neuroscientists to encourage, rather than to dismiss, a theoretical re-examination of their interpretive model at the present time.

In order to facilitate a thorough theoretical reappraisal, the present chapter reviews the basic principles concerning perceptual system functioning at use in perceptual neuroscience today. This set of basic theoretical principles is referred to as the "Current Model".

The Current Model

The Current Model is not a theory proposed by a particular research group or neuroscientist, rather it is a shared set of underlying principles around which many competing theories have taken shape over the years. The Current Model is a set of fundamental claims about perceptual system functioning that are shared by nearly all contemporary neuroscientists, as well as by perceptual theorists in fields as diverse as psychology, philosophy, and computer science. As such, the Current Model represents an enormous simplification of the neuroscientific literature on perception. It does not reflect the extreme diversity of approach that is characteristic of the field of perceptual research, nor does it deal with all of the data on the many aspects of neural functioning that contribute to perception. The Current Model is simply the bare conceptual framework in terms of which data are gathered and later analyzed.

The Current Model of perception consists of three basic claims. It maintains that there are two different "levels" of neural activity within perceptual systems (Service 1993; Eichenbaum 1993). Each level of neural functioning is thought to involve different types of neural processes which contribute differently to perception. The two levels of neural functioning are currently characterized as follows.

1. The first level of neural functioning within perceptual systems, "Level One", involves the activity of single receptor neurons and small localized post-receptor neural networks that respond respectively to features of the external stimulus and to feature complexes.

2. The second level of neural functioning within perceptual systems, "Level Two", involves the activity of large neural networks that become active in response to the input received from Level One neurons. Level Two neural players operate as members of large globally distributed supernetworks.

The third claim of the Current Model characterizes the contribution made by each of the two levels of neural functioning to perception.

3. Level One neural activity represents individual features and feature complexes, while Level Two neural activity represents the complete percept.

My own position on the Current Model is that its distinction between two distinct levels of neural functioning within perceptual systems is a legitimate distinction that should be retained by any future perceptual theory. However, this is where my agreement with the Current Model ends. I do not identify the two levels of neural functioning with the same types of neural processes as the Current Model does, nor do I define their respective contributions to perception in the ways in which the Current Model does. Whereas the Current Model holds that Level One neural functioning encompasses the activity of individual receptor neurons and small networks comprised of post-receptor neurons, I will argue in Chapters Three and Four that Level One functioning must be expanded to include both the activity of large, supernetwork neural activity that the Current Model relegates to Level Two, as well as the non-neural contribution of the sense organ event. In Chapter Four, Level Two neural activity, instead of being identified with supernetwork activity, is identified with the global activity of neural masses involving tens of thousands of neurons. I also completely reject the notion that neural activity represents or is a correlate of external stimuli throughout the book. Neither external objects nor their features are represented by perceptual system activity. This is not how perception works. Representation has nothing to do with perceptual activity. These changes lead to further departures from the Current Model that are discussed in the following chapters. But first a word about neural representation is in order.

Neural Representations

Without the concept of neural representation, there would be no Current Model. This is because representational thinking completely determines the way in which neural activity is interpreted in the Current Model. Representational concepts form the bedrock of the Current Model.

Representations are familiar to everyone. They come in many different forms. For example, a photograph is a representation. It is a 2-dimensional translation or copy of a 3-dimensional object. In a photograph, a flat circle represents the original, a round sphere. Representations are a way in which to copy something from one form to another, to get one thing to stand in for another. You cannot carry your mother around in your pocket, but you can carry a picture , i.e., representation, of her around with you. Representations are handy inventions.

What attracts perceptual theorists to the concept of representation is the fact that representations are copies or stand ins for something that is distinct from them. It is not just the fact that they are information bearers that makes representations attractive to perceptual theorists, although this too is important, but the fact that they carry information *in a form that conveys the original source's own features in a transformed physical state*. They allow their interpreter to get back to the form of the original, be that acoustic or visual or what have you, via some distinct physical entity.

To understand how the concept of representation got a toehold in perceptual theory, reflect on your own perceptual experiences. Perceptual experience contains information about the state of the external world and its objects. For example, when I open my eyes, I see external objects and their features, e.g., trees, the sidewalk, other people, buildings, books, and so on. When I listen, I hear sound "objects", e.g., a dog's bark or a melody. Taste, and I taste the flavor of an apple. In short, perceptual experience makes available what is "out there". A fundamental characteristic of perceptual experience is that it is about something that it is not.

Since it is widely believed that neural activity is responsible for what perceivers perceive (i.e., the percept), the sort of reflection just mentioned has led perceptual theorists to conclude that neurons represent. Perceptual experience is about the external world, so it makes sense to assume that somehow what is outside must get inside the organism in order for the perceiver to experience it, right? Neural representations are thought to be the perceiving organism's mode of access to the external environment. Therefore, perceptual researchers assume that the job of the neural components of perceptual systems is to create and manipulate internal representations of the external environment. Neural representations are referred to variously as "information", "neural images", "neural templates, and "neural correlates". This way of thinking about perception is basic to the Current Model.

Level One Neural Functioning in the Current Model

Neurons are one of two kinds of cells that make up the brain and the nervous system. (The other kind of cell is called a neuroglia or glial cell.) There are said to be about 10 billion neurons in the human cortex alone, although not all perceiving organisms have such large numbers of neurons; far fewer also seem to do the trick as far as perception is concerned. Neurons are unique kinds of cells in the body. They are unique because they have evolved with the capacity to interact with other neurons. They also have the capacity to react to phenomena other than neurons, both inside and outside the body. For example, within the body some neurons interact with muscle fibers, while others react to nonorganismic or extra-organismic phenomena such as light waves. Their unique structure is said to be "a reflection of cellular specialization for long distance intracellular communication and unique forms of interaction" (Carpenter & Sutin 1981).

Neurons make up the brain, but as you also know some neurons are located outside of the brain proper, e.g., in the spinal cord. Others are located near the surface of the body in the skin and in the sense organs (eyes, ears, nose, etc). Neurons located at the periphery of the nervous system, e.g., in the sense organs, are called "**receptor neurons**". Receptor neurons are the first type of neuron in Level One. Receptors are unique kinds of neurons in that they "respond to" or are "triggered by" highly specific external stimuli, such as a certain wavelength of light or sound. Each receptor neuron is stimulus-specific in its response characteristics, which means that each receptor reacts maximally to a specific kind of stimulus. The receptor neurons' narrow response sensitivity means that receptors isolate one feature and one feature only from the complex stimulus array. Receptor neurons are one of two kinds of neurons included within Level One according to the Current Model. The second class of neurons in Level One are **post-receptor neurons**. Post-receptors do not interact with external stimuli, only receptor neurons do this. Receptors are triggered into an active state by external stimuli, and then pass this activity along to post-receptor neurons. Post-receptors, therefore, follow receptor neurons in the neural hierarchy that is characteristic of Level One neural functioning. Post-receptors interact with receptor neurons and with other post-receptor neurons. To summarize, Level One neural functioning includes two classes of neurons, receptors and post-receptors, each of which involve different triggering stimuli--external stimuli in the case of receptors and only other neural stimuli in the case of post-receptors.

According to the Current Model, Level One neural functioning is characterized by several features. The first is that Level One neurons function singly or as members of small neural networks (groups of neurons that are linked together and that become active as a group). The second feature of Level One neurons is that they are organized in a hierarchical manner. This means that Level One neurons make their contribution to perception in a sequential manner, with succeeding levels of neural activity dependent on what went on at earlier levels of functioning. Moreover, many hierarchically-arranged pathways of neurons are simultaneously active in Level One. They are said to be engaged in parallel activity. This is the third feature of Level One neural functioning. The fourth feature of Level One neural functioning, according to the Current Model, is that Level One neurons represent isolated and then sequentially more complex features of the external stimulus. According to the Current Model, Level One neural activity constructs the basic building representational blocks of perception by first creating representations of single, isolated features of the external stimulus, and then by combining these isolated fragments into more complex representations of combinations of features.

Neuroscientists believe that the data that they have collected on Level One neural activity support the representational reading of neural activity by the Current Model. For example, in the retina, that part of the eye in which many thousands of receptor and post-receptor neurons cluster together, receptor neurons have been found to be sensitive to, and triggered into activity by, specific types of light phenomena. This led researchers to dub receptor neurons "feature detectors", i.e., neurons that encode a stimulus feature in the form of neural activity. Another early discovery, revealed that a particular post-receptor neuron in the frog's retina, called a ganglion cell, was most effectively triggered into activity by a black spot moving back and forth in a specific location in front of the frog's eye. Other neurons in the frog's retina did not react to the spot at all, they reacted to quite different external stimuli. It didn't take long before researchers discovered other neurons with different "trigger features", such as lines, edges and colors. The selective sensitivity of the frog's ganglion cell to the moving black spot suggested to its discoverer, H.B. Barlow, that this neuron was a "bug detector" (Barlow 1953). It was but a small step to further conclude that the ganglion cell "represented" the bug within the nervous system of the frog. The selectively sensitive of neurons to stimuli became translated into the claim that neurons represent features. Once this was done, it was natural to conclude that neurons were mechanisms for internalizing external stimuli in a representational manner.

After early discoveries about the activity of receptor and post-receptor neurons located in or in the vicinity of the sense organs, interest shifted to the functioning of neurons located in areas deeper within the perceptual system to which the peripherally located neurons in the sense organs are connected and upon which they act. One such area in the brain is the primary visual cortex. The primary visual cortex is part of the "neo-cortex", the outermost layers of the brain where neural activity has been associated with higher level organismic functions such as perception, movement and language. Two early researchers, for example, found that neurons in the cat's visual cortex selectively responded to particular visual stimuli (Hubel & Wiesel 1959). They discovered neurons that were sensitive to the orientation of a bar of light, and other neurons that responded to a specific direction of movement of the light stimulus. More recently, evidence for neural selectivity throughout the brain has been gathered (Wilson 1993). It was also found that some post-receptor neurons in Level One are sensitive to more complex kinds of stimuli than, say, a simple bar of light (Hubel & Wiesel 1962). To say that a stimulus is more complex means that it involves more than one feature. Researchers discovered that neurons stimulated by a single feature, e.g., a line, were connected to neurons selective for different isolated features. Neurons which received input simultaneously from different kinds of feature detectors are thought to represent a compound of features of the external stimulus. They are referred to as complex and hypercomplex cells. Once again the representational interpretation of neural functioning was brought to bear on the data, so that the discovery of connectivity between stimulus selective neurons was interpreted as the discovery of the first of many steps in which isolated features were integrated within the brain to produce a complete neural correlate of the external stimulus.

Perceptual neuroscience today is the experimental quest to confirm the hypothesis of progressive integration of features into a complete internal neural representation of the external object, scene or event. Three generations of researchers have devoted their time and talents to this quest, and hundreds of millions of research dollars have been spent. What is striking, is that the confirmation of the representation-based concept of integration into a complete internal representation still eludes researchers after nearly half a century, as we shall see.

Level Two Neural Functioning in the Current Model

Neurons that encode single features or small groups of features cannot explain how the brain represents the complete percept, and yet this is what the Current Model requires. Therefore, Level One neural activity begins, but does not complete, the integration process. According to the Current Model, Level Two neural activity is responsible for final integration and the production of the neural correlate of the stimulus.

Today it is widely believed that Level Two functioning is carried on by large networks of neurons. This was not always the case. Earlier versions of the Current Model conceived of Level Two neural functioning in terms of the activity of single neurons located high up in the neural hierarchy and deep within the brain. H.B. Barlow's Neuron Doctrine, which will be discussed shortly, is the best example of the single neuron view of Level Two activity. Currently, however, neuroscientists are leaning towards the view that large supernetworks of neurons, linked together so that each neuron excites other members of the network into activity, are responsible for integrating all relevant features and feature complexes into a complete representation of the external stimulus.

Feature integration may seem a simple task, but it is not. Features must be integrated in the "right way". Only features belonging to the same object should be integrated, and they must be reassembled to match the arrangement that their stimulus counterparts enjoy in the external world. The dilemma that the brain faces is somewhat analogous to the problem that you or I might face in putting together a bunch of nuts, bolts, and strange thingamajigs without instructions and without a clue as to what the finished product looks like or does. Our cluelessness as to how to proceed and the infinite variety of possible integrative solutions available, parallel the problem faced by a perceptual system that starts out with bits of isolated, unrelated receptor-level features and is supposed to contruct a correlate of the original out of them. The brain cannot do this. No one can, which is why many critics have argued, as I will argue at the end of the present chapter, that the Current Model is flawed.

Level Two neural functioning is much less well-understood than is Level One. Three different hypotheses have been proposed in the past four decades regarding the neural mechanisms that might explain how Level Two operates. All three hypotheses are representation-based. All three also require that Level Two functioning achieve integration of features into a complete neural correlate of the external object. They differ only in terms of how they view the neural basis of integration. Thus, all three hypotheses are versions of the Current Model. The three are: (1) the Neuron Doctrine, (2) the Network Model, and most recently (3) the Synchronization Model. A review of these hypotheses helps to illustrate the difficulties faced by the Current Model.

The Neuron Doctrine

The first theoretical attack on the problem of Level Two integration to be widely discussed in neuroscientific circles was formulated H. Barlow. Barlow's theory is known as the "Neuron Doctrine" (Barlow 1972). The Neuron Doctrine views Level Two neural functioning as a extension of the same sort of neural activity that occurs at the earliest stages of Level One processing, where each neuron passes on the information that it detects or that it receives from another neuron or neurons. The Neuron Doctrine, therefore, claims that single neurons are the basic functional units throughout the perceptual system. Level Two neurons function singly and not as a group.

Barlow's model represents an early information processing interpretation of neural functioning. It views neural integration by analogy with a flow chart in which individual neurons each contribute their own parcel of information and are arranged such that, at succeeding hierarchical levels, the information passed on becomes more and more complex and complete. At the first level, Barlow knew that individual receptors are stimulated by specific, isolated features and that their activity is communicated to complex and hypercomplex neurons, which Barlow assumed code for complexes of features. Barlow hypothesized that this hierarchy or concatenation of more and more complex feature representations continues until, at the apex of the hierarchy, i.e., Level Two, a single neuron becomes active that represents the complete stimulus event and that causes the corresponding perceptual experience. The final neurons in the hierarchy, those that achieve final integration and that directly cause the percept of an object, Barlow named "pontifical cells", following Sherrington (1941). The activity of pontifical neurons in the brain "is" the percept, according to Barlow's theory.

The example, usually cited, to illustrate the basics of Barlow's model, concerns the visual perception of grandmother. According to the Neuron Doctrine, individual receptors in the retina are stimulated into activity by specific isolated features of the visual stimulus (grandmother), e.g., the color of her hair. This information, Barlow hypothesized, is then passed on to succeeding levels of neural processing where it is combined with other features (by complex and hypercomplex cells) and finally to a neuron in Level Two which only becomes active or "fires" when grandmother is present. Hence the nickname given to Barlow's theory: the "grandmother cell hypothesis". The basic idea is that when all of the partial information is passed along to this particular pontifical neuron, and it becomes active, the perceiver would experience the visual percept of grandmother.

It sounded pretty good, but the Neuron Doctrine quickly ran into conceptual and empirical difficulties. There are two generally acknowledged problems for the Neuron Doctrine. The first of these can be understood if, once again, you consider the perception of grandmother. The Neuron Doctrine says that, at Level Two, a single neuron is activated that uniquely represents grandmother. But consider this: grandmother is a highly variable quantity. One day she wears a red dress, another day blue jeans and a green sweater. She may get her hair colored or have it cut. One day she wears a hat and on another day she doesn't. Each of these combinations of features out of which grandmother is composed (according to the representational model), when changed, would require a new grandmother cell to represent them. Why? The reason is that grandmother always has a different set of features, not just day to day but minute to minute. This implies that an indefinite number of pontifical cells would be required to represent grandmother and all of her changes at Level Two, not just one as Barlow's theory seems to suggest. Moreover, this is true not only of grandmother, but of everything that we perceive. Variability is the rule, not the exception. Enormous numbers of pontifical neurons would be required to represent every change.

Now contrast this with what is known about the brain. The brain contains many billions of neurons, but their number is finite. It wasn't long after Barlow proposed his model, that researchers realized that the brain just does not contain enough neurons to achieve integration of features into a complete representation of the percept in the way suggested by the Neuron Doctrine. The problem is known as "combinatorial explosion". In the case of grandmother alone, an astronomical number of pontifical cells would be required to represent all of the changes in grandmother that occur over time. Grandmother cells would abound in the brain at Level Two. Where would the brain get the neural resources to learn anything new, if everything that we perceive requires astronomical numbers of neurons to represent it?

Secondly, Barlow's Neuron Doctrine ran aground experimentally. Although preliminary research seemed to support Barlow's theory, the results were equivocal at best (Perret, Mistlin and Chitty 1987). The hypothesized pontifical cells for complete percepts were never found, and even when object correlated neural activity has been discovered, such as hand detector neurons in the visual cortex, those neurons have been shown to respond to a range of stimuli that are far too broad to be the pontifical cells of which Barlow's theory speaks (Engel et al. 1992).

It is important to note that the Neuron Doctrine ran into difficulties on the issue of final neural integration at Level Two, not in terms of Level One neural functioning. Barlow's characterization of Level One neural activity as a hierarchical process of feature integration is today a standard feature of the Current Model's characterization of Level One neural activity, as is Barlow's clearly stated formal hypothesis that neurons are in the business of representation. The only problem for the Neuron Doctrine is thought to consist in the fact that it could not explain the final integration of features into a complete neural correlate of the whole. The New Model contends, however, that even the Neuron Doctrine's characterization of Level One functioning is misleading (Chapter Three).

In recent years, the feature integration problem has occupied center stage in perceptual neuroscience, and is known as the "binding problem" (Damasio 1990). Unless neuroscientists can discover the neural processes that integrate isolated features into percept wholes, the Current Model will fail for lack of experimental support. Forced to look for another theoretical proposal to solve the binding problem, a second model of integration captured the imagination of neuroscientists trying to explain feature integration.

Hebb's Network Model

With the collapse of the Neuron Doctrine, neuroscientists rediscovered a very different model of integration that had been formulated before Barlow's Neuron Doctrine was first proposed. That model was presented by Donald Hebb in a book entitled, *The Organization of Behavior* (Hebb 1949). Often mentioned in the literature today, this book and its model of neural functioning languished for decades attracting little or no attention. I suspect that many factors contributed to the obscurity of Hebb's model until it drew the attention of some researchers nearly 40 years after Hebb presented it. One reason for its obscurity must be that, already in the 1940s, perceptual neuroscience was pretty much synonymous with research on single neurons. This trend was reinforced after Hubel and Wiesel discovered the stimulus specificity of Level One neurons shortly after the publication of Hebb's book. The distinctive feature of Hebb's model, on the other hand, was its view of neurons as group players rather than as individual functional units.

Hebb's interest in the psychological level of explanation was chiefly responsible for the novel approach that he took to neural activity in his book. The psychological level of explanation is by nature holistic. Perceptual experience, after all, is the perception of whole objects and events, not of isolated (unrelated) features. Perceptual wholes or "gestalts" constitute the bottom line, i.e., psychological reality, that Hebb hoped to explain. Thus, for Hebb, the integration problem was never a hidden problem, as it was for his contemporaries. For Hebb, integration was *the* problem of perception. It should not come as a surprise, therefore, that Hebb took a more "global approach" to neural activity, rather than focusing on single neurons and their activity as Barlow did. Hebb reasoned that if perception is the perception of wholes, then the neural basis of perception should reflect this holism in some way. The neural basis for holistic perception Hebb termed a cooperative "neural assembly", which today is refered to as a "neural network".

In order to understand what a neural network is, you must understand how a neural network forms. The basic Hebbian hypothesis is this: when neurons share mutually excitatory connections with one another, i.e., when each neuron's activity delivers excitatory input to the other and the two become simultaneously active, they are able to form network connections with one another This happens as follows. When two or more neurons are triggered by a stimulus into activity at the same time, their activity becomes "associated", such that in the future even if only one of the neurons is directed stimulated into activity, all of the neurons that previously were active when this neuron was active, i.e., its partners in the network, will become active as well. This is network activity. Hebb's hypothesis about network activity is based on the widely accepted associationist principle that when two things or events are paired together often enough, one becomes associated with the other. I like to think of it this way. The situation for neurons in a neural network is a bit like the situation in a childcare center, in which, when one baby begins to cry, all of its cohorts chime in. It almost appears as if the children were connected by a "crying network", the whole of which can be activitated by only one of its members.

Hebb asserted that the underlying neural mechanism responsible for the formation of a network is that of strengthened neural connections, a physiological alteration that occurs between neurons when they are activated at the same time. When neurons are co-activated, a structural change occurs at the points of connection between the neurons, at the so-called "synapses". The structural change of strengthened connectivity facilitates the ability of one neuron to trigger the other neuron into activity. The structural process of change allows activity to spread easily and quickly throughout the network because it makes it easier for one neuron to trigger another into activity. Strictly speaking, synapses are not connection points because neurons do not make actual contact with one another at synapses; a gap, although very small indeed, occurs between neurons. "The assumption", Hebb said, "is that a growth process accompanying synaptic activity makes the synapse more readily traversed" (Hebb 1949). This growth process is referred to as synaptic strengthening. In this way Hebb's Network Model places emphasis on neural connectivity, rather than on neurons as individual entities that become active.

The Network Model's solution to the binding problem within Level Two, therefore, says that when a neuron representing a particular feature, such as the color red, becomes a member of a network of neurons by undergoing synaptic strengthening, the information carried by that individual neuron becomes integrated with the information carried by other neurons in the network to which it belongs. The activity of the network itself is believed to represent all of the features of its individual members, and eventually the complete stimulus array. Ultimately, Hebb's Network Model would have the network integrate all of the relevant features into a complete neural representation of an external object. Hebb's networks replace Barlow's pontifical cells as the ultimate Level Two integrative units in the Network Model.

You will recall that the main problem for Barlow's Neuron Doctrine was numerical: there aren't enough neurons in brains to represent all of the objects that perceiving organisms perceive. The Network Model provides a solution to the problem of combinatorial explosion. If networks represent percepts (whole objects or events), rather than individual neurons, and network activity can be triggered by the activity of only a few of its members, then the situation at Level Two is much different than Barlow hypothesized. Hebb's theory implies that the external object could change in many respects, with different receptor neurons active in any given instance of seeing grandmother, but if some features remain constant and are fed into the grandmother network by receptor neurons, the whole network would become active and one would perceive grandmother. The Network Model emphasizes that although grandmother is a variable quantity, she is one that does not change *completely* on every occasion of perceiving her. Some degree of identity regarding features would be enough to insure that the same network would be activated at Level Two despite the continual presence of differences. In other words, grandmother may age or change her clothes or hair color, but if there is a sufficient degree of continuity between various presentations of grandmother, i.e., her essential characteristics remain stable, the grandmother network still would be activated and the perceiver would perceive grandmother.

It might seem that Hebb's Network Model would require *more* neurons than Barlow's model, rather than fewer, since whole groups of neurons take over the work that is accomplished by a single neuron in Barlow's model. But as counter-intuitive as it may seem, the Network Model actually reduces the number of neurons required in two ways. Neural networks achieve what is termed "generalization" regarding the stimulus event. Generalization basically means that the details or small changes from case to case are ignored for the purpose of stimulus identification by the system. Barlow's model essentially requires a new pontifical neuron to represent grandmother every time grandmother is perceived, given that grandmother is always changing, whereas Hebb's model only requires the formation of a relatively small network of core neurons to represent grandmother in each case. Network activity, therefore, actually reduces the number of neurons required to represent an external stimulus. The second way in which Hebb's Network Model avoids the problem of combinatorial explosion is that it allows individual neurons to function as members of different neural networks at different times. For example, a neuron representing the feature red need not be dedicated forever to one neural network, e.g., to the grandmother network. It can, at different times, function as part of the beachball network or the apple network, and so on. It is not the activity of the individual neuron on its own that explains the percept in the Network Model, it is the activity of the neuron as a member of a specific network that represents the stimulus.

Today, it is generally accepted in neuroscience that neural networks play a central role in perceptual systems at both Level One and Level Two. Network modelling and theory are important areas of research in contemporary neuroscience. Network theory is here to stay, but is Hebb's Network Model a solution to the binding problem? It is not, and here is why it fails. The main problem with Hebb's Network Model is that it cannot account for the simultaneous perception of multiple objects or complex events. This is because only *one* network can be activated at a time in a given area of the cortex. Neurons may function as members of different neural networks at *different times*, but it is impossible for different networks to make use of the same neurons simultaneously and still represent the percepts that they do. For example, if the beachball network and the grandmother network were activated at the same time, there would be no way of knowing that two networks were active and whether, say, grandmother was red or the beachball, or both. This is because, in Hebb's theory, the brain has no means by which to distinguish the neurons that belong to one network from those neurons that belong to another, and, thus, to establish two neural representations of different external objects as distinct from one another. Some means to label the neurons from one network apparently would be required if Hebb's Network Model could be accepted.

The problem is a serious one because normal perception is highly complex, involving the perception of many objects and features at once. The binding problem is, therefore, a multi-faceted problem, something that Hebb's theory does not reflect. A solution to the binding problem must explain how complete objects are reconstructed out of features, but also how complete percepts are organized. Grandmother never appears in a vacuum (except in scientific experiments), grandmother appears in the room or on the beach. Each percept is really a complex of objects and events. Since Hebb's Network Model cannot explain this, it does not solve the binding problem.

The Synchronization Model

In 1981, Christoph von der Malsburg published an article in which he suggested an interesting modification of Hebb's Network Model, and thus a new version of the Current Model of perception. Von der Malsburg devised a way to explain how more than one neural network could be activated at one time, obviating the resulting confusion implicit in Hebb's model. Finally, a solution to the binding problem seemed imminent.

Clearly, if the brain is to distinguish different neural networks that are simultaneously active in an area of the cortex, something about the networks themselves must be different. Von der Malsburg reasoned that each network might distinguish itself from other simultaneously active networks by having the activity of all of its neural members "synchronized" (von der Malsburg 1981; 1982). Von der Malsburg's innovation recognized the potential relevance of the fact that neurons are not continuously active, constantly conducting activity and chemicals to their neighbors. Neurons "burst" or "pulse" with activity, i.e., neural activity is intermittent. Von der Malsburg hypothesized that neural networks might make use of this pulsing behavior. His idea was that neurons belonging to one network might somehow synchronize the timing of their bursts of activity, so that all of the neurons belonging to one network would pulse together. Neurons belonging to different networks would exhibit a different pattern of bursts. Members of one neural network would burst "out of synch" with neurons belonging to another, simultaneously active network. It would be a bit like one group of people beating out a 3/4 rhythm, while another group beat out a 4/4 rhythm. Members of each group, although interspersed with one another throughout the room, could be distinguished quite easily from one another, even though they were active at the same time. In this way the main problem with Hebb's original hypothesis regarding neural networks would be solved.

Von der Malsburg's model offered an added advantage in that it also explained how individual neurons could be players in more than one simultaneously active network. Von der Malsburg hypothesized that individual neurons could play a role in different neural networks by rapidly changing their pulse patterns to match those of another network, something that is possible given what neuroscientists have discovered about the response characteristics of neurons. Von der Malsburg's theory is an ingenious revision of Hebb's Network Model. It marries Hebb's structural notion of synaptic strengthening which creates the neural network with the now current view of neurons as dynamic players in the nervous system.

The most recent neuroscientific research suggests that synchronicity is indeed a feature of neural activity and that it is characteristic of neurons whose activity researchers have correlated with features of the same external object. Both neighboring neurons in a local region of the cortex exhibit synchronized firing patterns, and neurons that are widely distributed across different cortical areas in the brain (Engel et al. 1992). These findings have created a lot of excitement and many neuroscientists believe that at long last they have discovered the glue that binds together distributed neural activity into unique representations of the percept. Has the Synchronization Model solved the binding problem? Is the Current Model finally confirmed?

Not quite yet. To prove successful, there are a few absolutely essential issues that the Synchronization Model must address. Researchers must show that *all* of the features included in a percept have neural correlates (i.e., are neurally represented), and that all of these neural correlates are integrated in the right way by synchronous bursting into one network or unit. This is a tall order. As yet, no one has yet tackled these issues head on, although the Current Model clearly implies that all features must be neurally represented and then bound together in the right way to create a complete neural representation of a percept. To date, researchers have discovered only a relative handful of feature-correlated neurons in the brain; a handful, that is, in comparison to the immense numbers of features that are included in a single percept. Research have found that *some* neurons, which respond to features, exhibit synchronous bursting patterns. This alone is not enough to support the model's claim to be a solution to the binding problem. Thus far, the evidence only supports the hyppthesis that feature groupings are established by synchronous activity. There is no evidence as yet to indicate that synchronous bursts of neural activity relate in any way to a complete internal correlate of the percept. Without evidence for a complete internal correlate, however, the

Synchronization Model is not yet a solution to the binding problem, which is the task assigned to Level Two functioning by the Current Model.

Add to this the fact that the binding problem is not just the problem of how individual objects are neurally represented. Perceivers do not perceive isolated objects. Perception is complex: we see groupings of objects in scenes or objects against backgrounds, we hear the birds singing in the background while tapping away at the computer keys, we smell and taste subtle combinations of smells and flavors, and so on. The binding problem must explain how such complexity is bound together *in the right way,* and not just how the brain distinguishes one neural network from another, which is what the Synchronization Model addresses. The binding problem is not the problem of how brains *segregate* neural network activity, it is the problem of how brains *integrate* disperate information in the right way to form the neural correlate of a percept. These are the deeper issues that must be addressed, not only by the Synchronization Model but by all versions of the Current Model. Therefore, the Synchronization Model is far from being a solution to the binding problem in its current form.

Why the Binding Problem Cannot be Solved by Association

The reason that all versions of the Current Model, including the Synchronization Model, must tackle these deeper issues just mentioned is that the percept is an holistic phenomenon with its integrated features and yet perceptual system functioning begins, according to the Current Model, with receptor level neural activity which is triggered by isolated micro-features. It is precisely when the Current Model tries to address the issue of the integration of isolated features that its deep conceptual flaws become evident. At its heart, final integration is impossible given the assumptions of the Current Model about the nature of perceptual functioning.

Historically, the only "solution" that has been proposed to the problem of feature integration is that based on associative mechanisms, and associative thinking lies at the heart of the Current Model. Synchronization theorists have proposed that associative mechanisms can explain how the brain determines which neurons should burst synchronously to form the integrated neural representation of the complete percept. Association is a process that relies on properties like similarity and proximity, properties that relate features. Associative properties are relational properties. Unfortunately, associative mechanisms cannot explain feature integration within the perceptual system. Associationism fails, and the way that it fails reveals the underlying conceptual flaws of the Current Model.

In psychology, association is used to explain psychological phenomena such as memory recall. I, for example, always recall my grandmother when looking at photographs of Queen Elizabeth. Associative theory explains that I recall my grandmother when viewing Queen Elizabeth because I have memories of my grandmother wearing crazy hats. When I see Queen Elizabeth in her hat, the present perception of the famous hat-wearing queen becomes associated with stored memory images of my grandmother in her flamboyant hats. The *similarity* between my memories of my grandmother and the queen, in that both wear crazy hats, associates the two experiences with one another resulting in my sudden memory of my grandmother when I see Queen Elizabeth. This is how associative processes are thought to work in the psychological realm.

It is thought that associative mechanisms work in a similar way to integrate neural representations of different features. Here the theory is physiological, rather than psychological, but the same principles are thought to apply. According to a recent article on neural synchronicity, the parallelism is clear.

> As shown already by the Gestalt psychologists, criteria such as continuity, proximity, similarity and common fate are used perceptually to group parts into wholes. If temporal correlation [i.e., synchronized bursts of neural activity] between cortical neurons provides the basis for object representations it should reflect these coherence criteria (Engel et al. 1992).

This quote claims that neurons, which encode external features that are similar to one another or that lie next to one another in the external stimulus array, will exhibit synchronized bursts of activity. When there is a single, continuous stimulus in the external world, all of the neurons responding to isolated segments of that continuous stimulus will burst in concert with one another because the original stimulus is continuous (Engel et al. 1992). Associative mechanisms would seem the perfect solution to the problem of creating a complete internal neural correlate of the external stimulus. What is related outside, gets related neurally inside. It would be the perfect solution to the binding problem, that is, if neurons could do this. Unfortunately, they cannot.

The problem with transferring associative theory from the psychological realm of explanation to the neural situation, is that it results in a fundamental mischaracterization of the nature of neural functioning within perceptual systems. Neurons in perceptual systems do not work the same way as psychological events because they do not have available to them the same kinds of phenomena.

Perceptual experience is the experience of a *unified* complex of elements. Perceivers do not perceive isolated features, e.g., just a color without form. The viability of association as an integrative mechanism in psychology relies on the unified nature of perceptual experience. Whatever is associated perceptually is already embedded in some kind of relationship in the percept. For example, two segments of a line are said to be contiguous, but, the relationship of contiguity between the two line segments depends upon their prior unification in the percept as *one* perceived line. It is the same with all of the other associative properties mentioned in the quotation above. In each case, what is associated is related by virtue of prior relationships. Associationism builds relations on the basis of already existent relationships.

In the case of neural functioning, however, the situation that associationism is called upon to explain is very different. Here associative mechanisms are called upon to explain how relations are generated *in the first place* among unrelated features. The difference is clear: in the neural situation associative mechanisms are asked to generate relations among unrelataed features, while at the psychological level associative mechanisms rely upon relations that already exist.

Therefore, the main problem with attempts to apply associative principles in neuroscience is that in the case of neural functioning, we need to explain the original generation of relationsnera, and it is precisely here that associative theory cannot help neuroscience. Many other theorists have said this before, but I will say it again. It is impossible to generate relations based on associative mechanisms in a context in which relations don't already exist. Considered in isolation, individual features simply are what they are: isolated qualities. Each quality belongs to a "separate universe" (Merleau-Ponty 1962). As the philosopher Merleau-Ponty underscored earlier this century, "the unity of the thing in perception is not arrived at by association, but [the unity] is a condition of association" (Merleau-Ponty 1962).

Association-based attempts to solve the binding problem, moreover, fail when confronted by the data. Perceptual functioning, according to the Current Model, starts with the activity of receptor neurons. Receptor neurons, as discussed earlier, do not react to complete objects or even to complex features. Receptor neurons respond only to isolated features that are devoid of relational information. There are no data to support the view that receptor neurons are selectively responsive to relational features of the stimulus array. Further, according to the Current Model, because perceptual systems are completely dependent upon what they derive from Level One neural functioning when they construct the complete internal correlate of the external object, the rest of the perceptual system has no access to relational information either. If Level One functioning starts with neurons that only react to and represent isolated features, not relationships among features, how could the brain put the isolated feature fragments together into a complete internal correlate? Clearly, it cannot.

It may help to appreciate the dilemma faced by perceptual systems if you imagine yourself in the place of a feature detecting receptor neuron. Imagine that you are told to look through a viewer and to press a button whenever the color red flashes on your screen. Your screen remains empty unless it flashes red. Suppose, that unbeknownst to you, there is another person with his own screen in another room who has been given the same directions that you were given. In effect, each of you is a feature detector for the color red because both of your respective activities, i.e., button pushing, are triggered when the feature red appears in your receptive fields, i.e., on your screens.

Now suppose that the bit of external red that triggers your screen to flash happens, in fact, to be contiguous in the external world with the bit of red which triggers the other person's screen to flash. Here is the point at which the Current Model's associative solution runs into trouble. How would you know about this relationship? The answer is that you wouldn't know anything about the relationship. Nothing that appears on your screen contains any relational information. Nothing about contiguity appears on your screen. You only respond to the isolated feature, red. There is no information about "next to" or "contiguous with" on your screen, just red. It is also important to remember that the perceptual system as a whole, of which you as a feature detecting receptor neurons form the front rank, knows nothing about the external situation except that which you and your fellow receptor neurons extract. Ask yourself, then, how such a neural system could recontruct an accurate correlate of the complete external stimulus? The answer is that it couldn't do this. Integration, if it occured at all, would be purely arbitrary with respect to the external stimulus. Arbitrary integration, however, is not what the Current Model requires. There is a right way and a wrong way for features to be integrated, or the representational theory of neural functioning would make no sense. The right way to integrate features is the way in which such features are related in the external world, according to the Current Model. There is no conceivable way, however, in which perceptual systems could achieve such integration given the facts of receptor functioning with which the Current Model begins its characterization of perceptual system functioning. None.

Something is definitely wrong. Associative mechanisms cannot explain the creation of relations within perceptual systems. Therefore, the Current Model, which requires neurons to create relations in a relationless context in order to construct an internal correlate of the external object, has been empirically disproven. The Current Model is not a viable conceptual framework for interpreting neuroscientific data, despite the fact that researchers continue to believe that they are well on their way to verifying it. More experimentation will not help the situation in any way. If receptor neurons operated differently, if they responded to relational features, the Current Model might be viable; but the fact is that receptor neurons do not behave this way and the Current Model of perception must be wrong about perceptual system functioning.

The Current Model has failed neuroscience. As a result, perceptual neuroscience faces a crisis in its underlying principles. It requires a new conceptual framework for interpreting its data. Unfortunately, however, there is no theoretical alternative to the Current Model of perception. The Neuron Doctrine, Hebb's Network Model and the Synchronization Model exhaust all presently available options, and all three are just variations on the Current Model. Variations of a fundamentally flawed theory will not do. The dilemma facing perceptual neuroscience is clear. For contemporary perceptual theorists, the crisis in principles that besets neuroscience today, is a direct challenge to develop a theoretical alternative. What are perceptual systems really up to? Are there conceptual biases that are responsible for the historical inability to develop a radically new perceptual theory? Today we stand as explorers before an unknown world. The following chapters respond to this challenge. Each chapter represents a piece of the puzzle of a new theory of perception. Each chapter pushes deeper into the nature of the form of life that is perception.

CHAPTER TWO

Basic Propositions of the New Model of Perception

If we do not cast our theoretical net widely enough, we will not see what lies before our eyes, for the conceptual tools will be unavailable to us (Gould 1993).

Criticism comes cheap and, when a model such as the Current Model comes under fire, those whose work is based on that model have a right to be skeptical. After all, haven't neuroscientists discovered a great deal about neural functioning through research based on the Current Model? Surely they cannot be expected to work with no conceptual model at all. What good is mere criticism to them? Clearly, criticism is not enough and I do not propose that researchers should simply abandon the Current Model in the face of criticism alone. It would be wrong to ask them to do so. While the Current Model is seriously flawed, researchers can't be expected to reject it wholesale when they have no alternative model with which to replace it. Researchers require an alternative model in terms of which to pursue their research, and it is the lack of an alternative model that made the work of previous critics irrelevant to perceptual research. For while their criticism was to the point, the critics did nothing more than criticize. They correctly stated what was wrong with the conceptual framework based on representation and association, but not what to do about it in terms of concrete proposals. They could not say to researchers what researchers really need to hear, viz., "Look here, you've been thinking about perceptual processing this way, but consider looking at it as a process involving the following components instead." Short of being offered concrete proposals regarding alternative forms of functioning in terms of which they might interpret their data, however, what were researchers supposed to do with mere criticism? Because of the lack of an alternative conceptual framework, therefore, perceptual system research continued to be based on the same conceptual framework long after the critics had revealed its flaws.

Therefore, this book is not just a critical work. Although it, too, criticizes the Current Model, it does so from a constructive aspect. Its criticism of the Current Model is always tied to positive statements about how the New Model views perceptual functioning instead. Criticism is chiefly used as a means by which to define concrete differences between the two models of perceptual functioning. The aim of criticism, therefore, is to define the New Model in such a way that it can stand as a genuine alternative to the Current Model, as a set of new conceptual tools for interpreting perceptual functioning.

I invite those interested in perception and perceptual system functioning to take part in a bit of theory building, the construction of a new conceptual lens through which to view perceptual functioning. Even those readers who remain unconvinced by the criticism of the Current Model presented in Chapter One, may well find challenging and interesting this excercise in creative thinking about perceptual functioning. The book is intended to offer readers the opportunity to wrap their mind around the issue of perception in a new way. For my own part, the creative thinking that went into developing a new model has been an adventure. What began as a bit of wild speculation one morning, has created an entirely new intellectual landscape. Most aspects of my understanding of perceptual embodiment have undergone profound shifts as a result of the ideas that are presented in this book. I no longer view perceptual functioning as I once did, I no longer view organismic functioning as I once did, and I no longer view the physical world in the same way.

How did this change occur? How does a new conceptual framework come into being? In my own case, it began quite abruptly. One day, as I was working at my desk, I happened to look out the window and an unexpected shift occurred in how I experienced what I saw. As I would put it now, for a brief moment the underlying interpretive schema of the Current Model fell away. Instead of perceiving the camelia outside my window, that I had always seen and understood as an independent entity possessing certain features that impinged on me, I had a different impression. For just a moment, my perspective on the whole event changed and it struck me that *I perceive the results of my own interactive process.* In other words, instead of the impression of seeing something separate from me, I got the impression that I saw some aspect of my use of my own "interaction" with the physical world. It has taken some years of hard work for me to elaborate this experience into the set of claims about perceptual system functioning presented in this book.

Therefore, in the beginning, the New Model grew out of the notion of interaction. The concept of interaction, however, had to be radicalized, pushed to its furthest limits, before it could serve as the basis for a new theory of perception. Interaction is ordinarily understood as a process of interplay between two *separate* entities. This is how interaction is understood by the Current Model, in which the perceptual system is said to interact with external objects. This is the sense of interaction that comes naturally to all of us. There is a reason why we ordinarily think this way about the process of interaction. We think about interaction as a relational glue between two separate phenomena because we *perceive* interaction in this way. Perceivers perceive discrete entities, and when two individuated entities mutually affect one another in some way, we call this process of causal relatedness "interaction". Thus, the ordinary sense of interaction builds on the perceptual experience of separate phenomena and is a kind of relational glue that serves as a temporary bridge that allows causal influence to take place between the two phenomena.

This is not the sense of the term interaction that inspired in me the belief that I was onto something completely new regarding perceptual functioning. Interaction, as I experienced it that morning, was a form of *total emeshment or inseparability* that the usual sense of the term interaction does not convey. It was a relation closer in meaning to complete integration, in the sense of being one. The term "seamless" immediately came to mind.

In hindsight, I now believe that what I briefly experienced and conceived of that morning was *the holistic fabric of physical reality itself* (see Chapter Three). In some way, I had gotten beneath the percept, that is the product of perceptual functioning, back to the percept's very basis in physical reality: my experience placed seamlessness ahead of the separability of the phenomena that I perceive. The problem, of course, was to understand what I had experienced, its relation to perceived objects, and to explain why I do not perceive things that way in the ordinary course of events. These are the issues that have occupied me ever since, and that are the subject of the following three chapters of this book.

I have stuck with the holistic concept of seamlessness, and it figures prominently in the New Model. It plays a central role in the New Model's interpretation of all aspects of perceptual functioning, from neural to non-neural aspects of perceptual system activity. According to the New Model, seamlessness--the complete unity of the organism and the rest of physical reality--is the basic condition out of which the perceptual process develops. Of course, this view contradicts our usual interpretation of the function which perception plays in the lives of organisms. We think of perceptual functioning as the means by which the organism is integrated with the rest of the physical universe, as if successful integration were a state that perceptual functioning creates. But if integration is not a problem for the organism, integrated as it always already is in the seamless fabric of physical reality, what exactly does perceptual functioning achieve? This question provides the conceptual starting point of the New Model.

Thus began the real work of developing a perceptual model based upon the recognition that organismic functioning arises from within the seamless nature of reality. I started with a simple chart of the absolute basics concerning what is known about neural functioning within perceptual systems: receptor neurons react selectively to stimuli, post-receptors work by way of contrast, neural network activity correlates with perceived feature complexes, and so on. I thought about these findings in relation to the concept of radical seamlessness and began to reframe the questions that today define the perceptual problematic. The ground shook under the Current Model, the various components of the perceptual process rose up and fell into a new conceptual configuration. The next three chapters discuss the results of this theoretical earthquake.

I have arranged the presentation of the New Model around a set of four basic proposals concerning perceptual functioning. In so doing, I follow the lead of Barlow (1972) who set forth his Neuron Doctrine as a series of propositions. This form of presentation provides readers with a clear summary of the basic claims involved, and it creates a good target for critical evaluation. The chance of misunderstanding and misinterpretation are too great to hide the New Model away in the chapters that follow. Every new conceptual framework is subject to misunderstanding simply by virtue of its novelty. Therefore, at the risk of some oversimplification, I decided to preface the more detailed consideration of the New Model with this short chapter solely devoted to presenting its basic claims to which the reader can refer at any time while reading the following chapters for a quick summary of the New Model.

The New Model is based on four propositions. Propositions One and Two are discussed in Chapter Three. Proposition Three is the topic of Chapter Four. Proposition Four is discussed in Chapter Five, the concluding chapter of the book. The four propositions of the New Model of perception are:

PROPOSITION ONE

The first result of perceptual system functioning is created by the sense organs: the non-neural, holistic, perceptually available, "phenomenal fabric" of the percept.

PROPOSITION TWO

Level One receptor neurons function to "shatter", with their selective response abilities, the holistic phenomenal fabric created by the sense organ. Then, Level One post-receptor neural activity creates features by way of contrasted forms of "neural use".

PROPOSITION THREE

Level Two neural activity is the dynamic of globally distributed, neural mass activity exhibited by an entire system of neurons. The aim of Level Two neural functioning is twofold: (1) to create systemwide neural behavior, and (2) to articulate the whole organism into distinct systems of use.

PROPOSITION FOUR

The objectivity of the percept can only be explained in terms of consciousness. Consciousness is an articulative form of use, engaged in by the whole organism, that contrasts the two results of Level Two articulative neural functioning to create the subjective and the objective.

CHAPTER THREE

Redefining Perception's Bases: The Sense Organs and Level One Neurons

*We have no excuse that there are not enough experiments, it has nothing to do with experiments. ... The only reason that we cannot do this problem ... is that we haven't got enough imagination. (*R. Feynman, quoted by Gleick 1992)

By the time that you finish reading this chapter, you will have been required to think about perception and perception's earliest stages of operation in ways that contradict, invert, completely reorganize and conceptually outdistance the Current Model of perception. Some, but certainly not all, of the ideas presented here are new. The concept of "neural articulation" is unique to the New Model, and is a pivotal notion for the development of a new approach to perceptual functioning. On the other hand, the concept of "use", which is first presented later in this chapter, was introduced originally in the context of linguistic and social phenomena, where it has had a tremendous impact. When introduced within the context of perceptual functioning, as neural and non-neural forms of articulative use, the concept of use achieves nothing short of a revolution in perceptual theorizing. You see, concepts make all the difference. In order to develop a new model of perception, one unhampered by the difficulties of representational thinking and the associationist blind alley of the Current Model discussed in Chapter One, theorists require a new set of conceptual tools.

Physical Reality and Perceived Reality

Clear thinking about perception is difficult. It is easy to miss the most basic points. For example, there is a basic component of current thinking about perception which neuroscientists generally have ignored, but which influences most of what the Current Model has to say about perceptual system functioning. This is view that the Current Model adopts regarding the nature of the extra-organismic world. The New Model starts with a critical assessment of the Current Model's characterization of the extra-organismic world with which perceptual systems interact. While criticism of the Current Model may seem an unconstructive way in which to begin to formulate a new model of perception, it is not, for it provides the foundation for an alternative way of thinking about perceptual functioning.

The New Model proposes that the Current Model gets off to a wrong start because it equates "physical reality" with "perceptual reality". Physical reality is the physical nature of the world. Perceptual reality is the world as perceivers perceive it. These two realities are not identical; they do not, as the Current Model assumes, "resemble" one another in the sense that perceptual reality is a copy of physical reality. In this connection, recall Barlow's claim that the frog retina processes moving black spots. His view is that neurons create internal representations of objects, like black spots, that exist in the external world. Is this correct? It surely seems unassailable, doesn't it? After all, isn't perception all about external objects and features?

Well frankly, it is and it isn't. It all depends upon what one is referring to when making the claim that "perception" is about external objects and features. On the one hand, the claim can be made regarding that which is *perceived*. Clearly the percept, that which perceivers perceive, is composed of distinct objects and features. Barlow's frog, a perceiver, perceives an object that is something like a moving black spot that Barlow describes. Sometimes, however, the claim is applied instead to the nature of physical reality with which perceptual systems interact. When this happens, the claim is that *external objects and features like those that perceivers perceive* causally impact on the perceptual system. These two claims are not equivalent. The first claim concerns the nature of the of the percept or that which is perceived, the second claim concerns the nature of the physical world with which perceptual systems interact.

The Current Model assumes that *both* the percept and the physical world contain objects and features. It claims that objects and features are the *result* of perceptual system functioning, in the sense that they are components of the percept which is caused by perceptual system activity, and also that similar external objects and features *cause* of the percept in the sense that they exist in the extra-organismic physical world and trigger the chain of physical and perceptual events that produce the percept. It is on this last point the New Model differs from the Current Model. The New Model claims that objects and features are components of the percept, but that their counterparts are not found in the physical (i.e., pre-perceptual) world. It maintains that objects and features are uniquely "perceptual" phenomena and cannot be copied from the extra-organismic physical world.

There is a large body of research that demonstrates that the things that perceivers perceive are essentially perceptual in nature. For example, there are the data from research on visual perception . Researchers (e.g., Helson 1938; Land 1977) have established that although perceivers perceive color, color has no counterpart in the extra-perceptual physical world. In the extra- or pre-perceptual physical world there is light. Light, however, is not in and of itself color. Photons/light waves are the physical reality of light, but they are not light's perceptual reality. The perceptual reality of light is color. Color is a property of the visual percept only. The reason for this is that color perception depends on opponent mechanisms, located within visual systems, which contrast different wave lengths of light to produce color (see Proposition Two). The dependence of perceived color on opponent mechanisms signifies that color is a property of the percept and not of the physical world, since opponency is a process that only occurs within the visual system. Opponency is not an extra-organismic process which the perceptual system can simply "detect" and copy. Therefore, the color percept does not copy an external state of affairs in the physical world, it is not an "image" of the extra-organismic physical state of affairs.

Not only is color perception not a copy of what exists in the extra-organismic world, color perception doesn't even involve or correspond to the same external stimuli. If the percept were reliably correlated with the state of the physical stimulus array as the representational theory suggests, then in the case of vision, one would expect a strict correlation between features of the percept, such as color, and the state of the physical stimulus, viz., surface reflectance. In fact, however, this does not occur and perceived colors do not correspond to the same physical stimuli in every case. Light reflectance from the stimulus array cannot explain color perception (Gibson 1979). Human perceivers do not perceive the color green, for example, because more middle-wave light is reflected from an area of the stimulus array. We know this because, although middle-wave light reflectance does occur when perceivers perceive the color green, an area of the stimulus array can still appear as green to a perceiver even when it, in fact, reflects more short- or long-wave light than middle-wave light. Nor can the identification of color with a particular wave length of reflected light explain why the same wave length of light is perceived as a different color depending on the context in which it occurs. These examples underscore the fact that color perception ought not to be identified with physical stimuli, either as copies of them or as their perceptual correlates. The same arguments concerning the dependence of perceived features on opponent mechanisms and the independence of perceived features from physical properties of the stimulus, apply to the other perceptual systems as well. Perceived features cannot be copied from the external environment, nor are they reliable indicators of the nature of the physical stimuli that impact on perceptual systems.

Moreover, as counterintuitive as it may seem to perceivers, it seems clear that even perceived objects must be uniquely perceptual phenomena. Consider the case of visual perception once again. From the perceiver's point of view, objects appear as independent entities which "possess" features. Color, for example, is perceived as a property of externally existent surfaces, volumes and hence objects. Objects do not appear to depend on their features, but on the contrary, their features seem to depend upon them; objects form the bedrock of objective reality as perceived. So, it is a lot easier for us all to accept the claim that perceived features are uniquely perceptual phenomena depending on perceptual system functioning, than that objects share the same perceptual status. To designate objects as uniquely perceptual phenomena seems the same as denying the existence of the objective world. However, as Gouras and Zenner (1981) show the perceptual independence of perceived objects is misleading. They write that it "is impossible to separate the object sensed from its color because it is the color contrast itself that forms the object". They show that perceived objects are feature-defined and hence feature-dependent phenomena. The implications are clear: since color contrast "forms the object", and color *contrast* is something that perceptual systems do, perceived objects must also be essentially perceptual phenomena. Objects are not facts about the world, they are facts about how various mechanisms within the perceptual system interact among themselves to produce features and objects.

And finally, as Varela, Thompson and Rosch (1991) have argued convincingly, following the philosopher Merleau-Ponty (1942), "what counts as a surface may in fact involve tacit reference to a type of perceiver". For example, the physical stimulus that appears as a flat surface in the human visual system may well not appear as a flat surface in the visual system of another creature, such as a louse. Surfaces and objects are really species relative perceptual phenomena that depend upon body size, perceptual system functioning, etc. It is impossible to separate objects from perceivers and their perceptual systems. Therefore, it doesn't matter that perceivers perceive the extra-organismic world as filled with the independent objects and events each with their own features, it is clear that they do not perceive the nature of physical reality itself. Perceptual functioning obscures the physical nature of physical reality from the perceiver. What "is" and what "is perceived" are not identical. This is not to say that nothing exists apart from the perception of it. Physical reality in all of its phsyicality most surely exists. The point is just that the physical nature of physical reality is not its perceptual nature.

Perceivers use their percepts as if the physical world were the way in which they perceive it to be, but the kinds of physical phenomena that perceptual systems work with are perceptually alien. Light waves, sound waves, chemicals, and so on, form the physical bases for perceptual functioning. These physical bases exhibit a fluid, constantly changing nature. Their nature changes depending on the circumstances in which they occur. These phenomena are definitely not like the entities that perceivers perceive, each with a relatively stable set of properties (Coveney & Highfield 1990; Prigogine & Stengers 1984). In fact, the physical phenomena with which perceptual systems deal, as opposed to perceived reality, is basically a "seamless web", an unbroken continuity of causal connectedness and fluidity. The state of this physical reality is "*undivided wholeness*" (Bohm 1980). As a thought experiment, try to imagine what this undivided wholeness is like. You must free your thinking, imaginatively, from the givens of perception in order to do this. The perceived world of objects and features would disappear entirely, replaced by a dynamic, unbroken continuum of physical process. If this seamless web could be perceived, it might appear as "noise", a featureless and objectless blur of process. If the percept were a representation of external physical reality, as the Current Model claims, perceptual systems should copy seamless noise because this is the physical reality of that with which they deal. Think about this for a moment, because it is really quite striking. It underscores the fact that something truly remarkable must take place when organisms perceive.

Therefore, perceptual reality cannot be copied from pre-perceptual physical reality. The Current Model is wrong to identify the contents of the percept, i.e., perceived objects and features, as features of the physical world waiting to be detected. The Current Model fundamentally mischaracterizes the nature of physical reality with its representation-based theory of perceptual functioning which requires that physical reality resemble perceptual reality when, in fact, it does not. The Current Model actually represents an attempt to explain the results of perceptual functioning, i.e., the percept, in terms of components of the percept itself. This makes it a circular theory, one that explains nothing and that misdescribes physical reality and the entire perceptual problematic. The absurdity of the Current Model's characterization of physical reality is clear: perceptual systems do not interact (directly or indirectly) with *perceptual* phenomena, they *produce* perceptual phenomena.

The task for perceptual theory, then, is to explain how perceptual functioning generates perceived phenomena in the first place. The New Model, which draws a distinction where the Current Model does not, must explain perceptual functioning as a transformative process that generates something that cannot be copied from elsewhere, it must explain why perceivers perceive objects with features rather than the seamless fabric of the physical world. The transformation from seamless web to discrete objects and features is the real task for perceptual functioning, according to the New Model. A new theory of perception is required to explain the perceptual generation of partial phenomena out of the undivided wholeness of physical reality.

PROPOSITION ONE

The first result of perceptual system functioning is created by sense organs: the non-neural, holistic, perceptually available, "phenomenal fabric" of the percept.

Proposition One deals with the functioning of the sense organs. The key difference between the New Model and the Current Model on the issue of sense organ functioning is the New Model's claim that the sense organs make direct contributions to the percept and that sense organ functioning explains what neural functioning cannot. There are four essential components to Proposition One, which will be discussed in two parts. The first division contains three components; together, they form the basis for the New Model's elimination of the binding problem. The second division, containing the fourth component of Proposition One, eliminates the great unsolved mystery of the representational theory of neural functioning: why perceivers don't perceive neural activity. The first three components of Proposition One are:

1. Sense organs create a **non-neural component** of the percept.
2. The non-neural component is **holistic**.
3. The non-neural component is **perceptually available**.

The first component of the New Model's proposed reinterpretation of sense organ functioning involves recognition of the *non-neural* contribution to the percept made by sense organ functioning. Although the Current Model recognizes that sense organs create non-neural phenomena, e.g., the refracted and focused light event that is cast onto the back of the eyeball, it does not recognize the perceptual relevance of this non-neural component in the way that the New Model does.

Fundamental to the New Model is its rejection of "neuro-centrism". Neuro-centrism is the view that the percept can be explained solely in terms of neural functioning. Neuro-centrism dominates thinking about perception in neuroscience. To appreciate this, one need only review the three versions of the Current Model discussed in Chapter One. Neuro-centrism has had a tremendous impact on perceptual theorists in other disciplines, as well. From cognitive science and computer science to psychology and philosophy, perceptual theory is essentially neuro-centric.

Recently, neuro-centrism has come under attack for a variety of reasons, e.g., Damasio (1994). The New Model, for its part, charges that neuro-centrism essentially makes a mystery out of perceptual system functioning by creating problems where none exist. Neuro-centrism forces perceptual theorists to demand too much of neurons. Neural functioning is required to explain all of the features of the percept and perform all of the perceptually relevant tasks from stimulus detection to the generation of the percept. Although neural functioning is but one aspect of perceptual system functioning, it is thought to be the sole contributor to what is eventually perceived by the organism. Proposition One of the New Model essentially reverses this trend by assigning a perceptually relevant role to a non-neural aspect of perceptual functioning as well.

Neuro-centrism is bolstered by a much too restrictive view of the role played by the sense organs. Sense organs generally are viewed as mere relay stations, filters, or passage ways for events existing outside the organism to enter into the neural--which is equated with the perceptual--world. The function of the mammalian auditory sense organ, which consists of the outer ear (eardrum, malleus, incus, stapes), is described in terms of efficiently and effectively conducting external sound into the inner ear where neurons detect and perceptually internalize its various components and pass them along to the brain where perception takes place. Sense organs are viewed as the means by which stimuli in the extra-organismic world are made available to neurons that do the "real work" of perception.

The New Model assigns a more creative role to sense organ functioning. It claims that sense organs actually create something quite distinctive in interaction with the extra-organismic physical world. Stop for a moment and ask yourself what happens in the eye, for example, before neurons become active. In the eye, the crystalline lens, the vitreous and aqueous humors, and the cornea produce something that is unique to this sensory system. First, the eye creates a phenomenon made solely out of light. It is a "pure" light phenomenon, a phenomenon to which other kinds of physical phenomena, such as sound waves, do not contribute. Moreover, only light of specific wave lengths--the appropriately termed "visible light" of the spectrum--contribute to this phenomenon. For example, in the human eye, infrared light is not part of the light phenomenon. Therefore, each sense organ abstracts a particular class of physical phenomena and, within that class, a specific range of phenomena, from the seamless web of physical phenomena taking place in the physical world. This is true of all sensory systems. A sense organ effectively makes all aspects of physical reality, but the ones for which it selects, irrelevant to the sensory system involved and hence to the organism. When you think about it, this, in itself, is a tremendous achievement. The sense organs create specifically organismic classes of physical phenomena. In effect, the sense organs create the "perceptual face" of physical phenomena for perceiving organisms. According to the New Model, the sense organs create non-neural physical phenomena which provide the organism with an essentially "perceptualized" form of physical reality. This is the first component of Proposition One.

The second component of Proposition One is the claim that sense organs produce essentially holistic phenomena. The sound event produced by a vibrating ear drum or the light phenomenon created by the eye, are unitary phenomena. They are "all of one piece", unanalyzed, undivided, unbroken. One holistic event occur in the ear and at the back of the eye. Although the Current Model does not specifically address the issue of the holistic character of the phenomena created by the sense organs, neither would it deny that, e.g., a holistic light event is projected on the surface of the retina. However, and this is where the New Model differs, neither does the Current Model assign any perceptual significance to the holistic character of the sense organ phenomena. The reason, for what the New Model judges as, a decisive oversight on the part of the Current Model is related, as we shall see, to the Current Model's neuro-centric bias.

The holistic phenomena created by sense organs are the very *first* achievements (i.e., results) of perceptual system functioning. All perceptual functioning starts with sense organ activity and, therefore, the first contribution to the percept are the holistic physical phenomena which the sense organs create for use by the organism. Recognition of this fact is the essential key to eliminating the binding problem, the issue to which we now turn.

Although the first two components of Proposition One may not seem that revolutionary when considered individually, taken together they effectively reverse the Current Model's explanatory framework that seeks to construct the percept's holism. The change is best appreciated by comparing the two models in terms of their respective explanatory points of departure. The Current Model, you will recall from Chapter One, begins its explanation of perceptual functioning with the activity of receptor neurons that, it claims, detect isolated features of the stimulus. The Current Model, therefore, must explain how perceptual systems eventually assemble fragmented feature information into a complete neural representation of the external stimulus. This in a nutshell is the binding problem. The New Model, however, claims that the first product of perceptual system functioning is the creation of holistic phenomena. Only after holistic phenomena are created by the sense organs do receptor neurons become analytically active in relation to the sense organ phenomena. Therefore, in the Current Model, an analytical process is the first component of perceptual system functioning to contribute to the percept, while the New Model maintains that the first perceptually relevant contribution of perceptual system functioning is the creation of holistic phenomena by the sense organs.

In the Current Model partial phenomena, isolated features, come first and then wholes are constructed. This way of thinking about systems is the one that we are most accustomed to, as mentioned in the Introduction. Perceptual experience reveals a world of objects, all of which possess certain features, e.g., a ball that is red, a sound that is loud, or a taste that is sweet. Reflection on the nature of the percept convinces perceivers that objects are built out of their features and parts. So it is natural, too, for perceptual theorists to bring this same mind set to bear on their work with perceptual systems. When the first level of neural functioning was discovered to be an analytical process, it was natural for researchers to conclude that perceptual systems build whole objects out of discrete features. After all, this is how things appear to exist from the perceiver's point of view, and the lack of a widely accepted conceptual alternative to the model of building holistic phenomena out of parts meant that researchers had absolutely no theoretical incentive to search for a process that predated analytical receptor functioning and that might be a more primitive, and perhaps holistic, first result of perceptual system functioning. Add to this the neuro-centric bias of the Current Model, and it is easy to understand why the Current Model is conceptually biased in a way that requires neural analysis first.

Several factors motivate the New Model to adopt the position that the holistic sense organ phenomena are the first perceptually relevant contributions of perceptual system functioning. One is its rejection of neuro-centrism, just discussed. From the perspective of the New Model, the binding problem basically grows out of the Current Model's neuro-centrism regarding perceptual system functioning, which forces it to rely exclusively on neural functioning to explain the all of the properties of the percept. Binding together isolated elements into a whole becomes a problem for the Current Model because it starts modelling the perceptual process with receptor neuron functioning, which is an isolating or analytic process. If the New Model were to start modelling the perceptual process with receptor activity, it too would be saddled with the binding problem, because somehow the analyzed data must be integrated in order to explain the holistic nature of the percept. In the Current Model, the holism of the sense organ phenomenon is solely the condition of the *external cause* of perceptual system activity; and since only neural functioning contributes to the percept, the holistic character of the sense organ event is essentially unavailable to the perceptual system and must be re-created neurally in some fashion.

The New Model, as mentioned in Chapter One, differs from the Current Model and other related proposals for solving the binding problem (e.g., Hardcastle 1994,) with its claim that there is *no neural solution* to the binding problem. Yet, the percept is holistic and if neural functioning cannot explain its holism, some aspect of perceptual functioning must. Thanks to its rejection of neuro-centrism, the New Model is free to consider other aspects of perceptual functioning to explain perceptual holism. Therefore, in the New Model of perception, perceptually relevant holism is said to be a non-neural achievement. Specifically, it is the first contribution to the percept made by perceptual system activity. Perceptual holism is established by the sense organs which create holistic phenomena within perceptual systems.

Therefore, the holistic event that is thought to be the *final* achievement of neural functioning in the Current Model, is the *first* component of perceptual functioning in the New Model. And, rather than being a neural achievement, as the Current Model claims, perceptual holism is a non-neural achievement in the New Model. This is the explanatory inversion mentioned above and its significance should be readily apparent. For the New Model of perception holism is not a problem, it is that which is created first and which is presupposed by all levels of neural functioning that follow it. There is no binding problem when theorists adopt a non-neuro-centric view of perceptual system functioning.

The view that holism is a non-neural achievement of perceptual system functioning, and not a neural one, is an important conceptual reversal that helps to explain why neuroscientists have not found a solution to the binding problem within the nervous system, despite concerted efforts to do so. The reason that they haven't found the neural solution to the binding problem, the New Model suggests, is because perceptual holism is not an achievement of the nervous system. Perceptual system researchers have been looking in the wrong place for the source of perceptual holism and have been asking neurons to achieve something that they cannot and do not achieve.

The third component of the New Model's proposal, implicit in its claim that the holistic sense organ phenomena are the first contribution to the percept, is its claim that the holistic phenomena created by sense organs are perceptually available. Again, the New Model's rejection of neuro-centrism is essential for understanding the perceptual availability of the holistic sense organ phenomena. According to the Current Model, the sense organ phenomena are perception-external in the sense that they do not directly contribute to the percept. Only when "transduced" by neurons, is the sense organ phenomenon made perceptually available. According to the Current Model, therefore, only that which is "filtered through neurons" contributes to the percept experienced by the organism. This is the real significance of neuro-centrism. The New Model does not demand that contributions to the percept be "neurofied" first and then transformed into the percept at a later stage of functioning. According to the New Model, elements of the percept are contributed by various aspects of perceptual functioning, not just by neurons. Once the holistic phenomena are created by the sense organs, they are essentially perceptual phenomena. Perceptual phenomena are perceivables. They occur within the perceptual system and are available to the organism to contribute to the percept; just as the results of neural functioning, occurring within the perceptual system, are available to the organism and contribute to the percept. Thus, the New Model proposes to view the status of the holistic phenomena created by the sense organs and the results of neural activity as equivalent in the sense that they are both internal results of perceptual functioning. This equality of status means that the holistic phenomena are equally available to contribute to perception because the privileged position of neural activity is rejected by the New Model.

In effect, by rejecting neuro-centrism, the New Model adopts a more distributed view of perceptual functioning than does the Current Model. Perception is ill-conceived as occurring solely in the brain, at the ultimate stage of neural processing. The percept is built out of aspects of organismic functioning that go on throughout the body right down to the sense organs. Which, of course, rather upsets the Current Model's computational view of perception as an information shuttling process in which all perceptually relevant information is held by neurons and must be passed into the brain where perception is supposed to occur.

This leads directly to the fourth component of Proposition One, the claim that

4. The sense organ phenomenon is the **phenomenal fabric of perception**.

If the sense organ phenomenon directly contributes to the percept, we want to know exactly what is made available? In the eye, the sense organ creates a phenomenon out of visible light; in the ear, an audible sound is created; and so on. The sense organs create *phenomenal*, i.e., perceptible, events within the perceptual system. This ought to have interested perceptual theorists enormously, I believe, and yet the creation of perceptible events by the sense organs has been passed over time and again. Theorists and researchers whose thinking is bound by neuro-centrism failed to note the relevance of the fact that, e.g., the visible light phenomenon created by and within the eye, is of the same nature as that which is visually perceived. That is to say, visible light is the sort of "stuff" of which the visual percept is made. In the terminology of the New Model, the eyes and other sense organs create the "phenomenal fabric" of the percept within perceptual systems.

When this insight is taken together with the third component of Proposition One (the directly availability of the sense organ phenomena) a revolution is achieved in perceptual theory. For what the sense organs make directly available to the perceiving organism is nothing less that the phenomenal nature of the percept. Organisms with visual systems perceive light phenomena because that is what their eyes produce with the visual system and, therefore, make available to them. Or, mammals perceive sound because sound is produced by the vibrating ear drum within their auditory systems.

This relates in an interesting way to the impression that perceivers all seem to share that perception takes place in the sense organ rather than in the brain. The Current Model implies that this impression is wrong, an epiphenomenon perhaps, because the percept is produced by neurons in the head. The New Model suggests that the impression that we see with our eyes or hear with our ears is quite accurate. Its claim that sense organs create and directly contribute the phenomenal fabric of the percept, lends credence to the impression that perception ocurs in the sense organ. The New Model's distributed view of perceptual functioning can accommodate this impression. The implications for the popular notion that "folk psychology" (Churchland 1986) will one day be replaced completely by a science of neural functioning are clear. Folk psychology refers to the kinds of explanations that we build upon our ordinary experiences. The psychological impression that we see with our eyes and not in the brain would be one aspect of folk psychology. Those who advocate the replacement of folk psychological explanations of perception and other cognitive events, propose that someday the naive and primitive information gleaned from ordinary perceptual experience will be replaced by purely neuroscientific accounts. Yet the New Model suggests, at least in some respects, that folk psychological accounts may be closer to the truth than their neuro-centric detractors suppose. Neurons are only part of the perceptual process, something that the eliminative materialists who advocate the replacement of folk psychological explanations with neurophyiological explanations do not recognize. And, if the New Model is right, perceptual experience does reveal at least one important fact about perceptual functioning: that, for example, seeing does happen in the eyes, because that is where the light is!

The fourth component of Proposition One also happens to be one of the proposition's most important because it solves, what I consider to be, the most baffling of riddles concerning perceptual system functioning: why perceivers do not perceive neural activity? The binding problem is but a minor problem when compared with this issue, because even if an internal neural representation of the complete object or scene or event would have been discovered in the brain, the Current Model would still have had to explain how that neural event is transformed into the sort of thing that is perceived by the organism. At some point, given the representational assumptions of the Current Model, all neural representations have to be transformed from purely physiological events into percepts.

How does this happen? What solution have advocates of the Current Model proposed? In point of fact, they haven't any solution to date. Thousands upon thousands of articles and books appear every year, full of talk about how neurons encode or represent this or that, but none of them explain how the perceptual system decodes the neural event into the kinds of phenomena that are perceived. It seems that current researchers and theorists are so involved in the details of neural encoding that they fail to take a larger view of their investigative model and ask themselves whether there is any viable, biologically sound account of how neural activity transforms into the percept. However, this will not do. The Current Model must explain this process. Any perceptual theory that asserts that neural activity is entirely responsible for the properties of the percept must address this issue eventually.

The change from neural reality to perceived reality is more than the difficult problem that it is acknowledge to be. Given the nature of the percept, it is not only hard to imagine how neurons could cause such phenomena, it is impossible. There is no neural solution to this problem. It is very important to get a deep sense of the difficulty involved here. There just couldn't be two more different kinds of things than the physiological functioning of neurons and the content of ordinary perceptual experience. Neurons and neural activity do not resemble perceived objects: they are not sounds, they are not tastes, colors, or textures, they do not have edges, and so on. Just how could neural activity transform into the such phenomena? How does one get a colored surface, say, out of neural activity? There is no conceivable way that this could happen. It would be difficult to explain how trees turn into birds, too, but this is not because trees actually turn into birds, but precisely because they do not do so.

Clearly, the Current Model's assumptions must be wrong. Perceptual systems regularly produce percepts whose character the Current Model is unable to explain in terms of neural activity. This is where the last component of Proposition One make its contribution to perceptual theory. It asserts that perceivers do not perceive a light phenomenon because neurons create representations of light for the purposes of eventual transformation within the brain from a physiological event into the kind of things that perceivers experience. The required transformations never take place. Perceivers perceive light phenomena because light phenomena are created by the sense organs. *The sense organs create the phenomenal fabric of the percept, not neurons.*

It seems marvelously simple and actually is. Theorists need not continue to knock their heads against the old neuronal wall any longer. It isn't that researchers have failed to come up with the right experiments to solve the problem of neural transmutation, it is simply that no such transmutation occurs. The neural system is not required to transmute neural activity into the phenomenal nature of perception. Instead, neurons "work on" the phenomenal fabric created by sense organs. They are not required to represent it either. The reason, of course, is that the phenomenal fabric is directly available to perception, and therefore, there is no need to introduce representational mechanisms to internalize or copy it. The New Model replaces neural representations with the "original", the phenomenal fabric of perception itself. There is no need to represent when the real stuff is available.

An important caveat must be mentioned in this connection to avoid misunderstanding. The claim that the phenomenal fabric of the percept is created by sense organs does not mean that the percept is merely its phenomenal fabric. The percept is not to be identified with its phenomenal fabric. In the ear, for example, a undifferentiated tonal event takes place thanks to the eardrum, and in the eye an undifferentiated light event occurs. Pereivers, however, do not perceive undifferentiated tonal or light events, they perceive the sound of a bird or see a colored object. A visible but undifferentiated light phenomenon is not colored, nor is it a perceived object. Light, however, is the stuff out of which all visual percepts are made. Light is the medium of vision, it is its "phenomenal fabric". What is visually perceived is built out of this phenomenal fabric, but more than this phenomenal fabric is required to produce the percept with its features and objects. According to the New Model, as we shall see, perceivers perceive the way in which the phenomenal fabric is "used" by different aspects of their own perceptual functioning. They perceive a light phenomenon that is transformed into objects and features by forms of perceptual use. For this to occur, other aspects of organismic functioning, including the first level of neural functioning to which we now turn our attention, are required.

PROPOSITION TWO

Level One receptor neurons function to "shatter", with their selective response abilities, the holistic phenomenal fabric created by the sense organ . Then, Level One post-receptor neural activity creates features by way of contrasted forms of "neural use".

Level One neural functioning must be completely redefined by the New Model. According to the Current Model, Level One neural functioning serves three functions: (1) stimulus internalization, (2) stimulus representation, and (3) the construction of feature complexes. These three functions, respectively, are reassigned, eliminated and completely redefined by the New Model. Stimulus internalization is reassigned to the sense organs. Internalization is not a process of neurofication, it is the creation of the perceptualized face of physical phenomena by the sense organs. Stimulus representations are eliminated by the New Model, which argues the the phenomenal fabric of the percept is directly available and is created by the sense organs. Feature compilation is not something that perceptual systems do, according to the New Model. Level One neurons generate features, but they do not copy them or put them together, as we shall see.

Level One neurons are divided into two classes that exhibit two modes of functioning. One form of functioning is the *selective functioning of receptor neurons*. Receptor neurons function "analytically" with respect to the holistic sense organ phenomenon, in that they are selectively sensitive to very specific aspects of the phenomenal fabric and because they function in isolation from one another. Receptor neurons react selectively to stimuli, i.e., they are stimulus specific in terms of their response characteristics. Each receptor neuron responds maximally (i.e., with a burst of intense electrical activity) to a specific type of stimulus. This was discussed in Chapter One. Also, Receptor neurons do not interact with other receptor neurons. The functioning of each receptor neuron occurs independently of the activity of other receptor neurons. These neurons function alone because they share no connections. Receptor neurons are isolated and hence analytic players in the perceptual process.

The second class and mode of functioning characteristic of Level One neurons is exhibited by *post-receptor neurons* in Level One. Post-receptor neurons engage in different forms of *contrast functioning*. Contrast functioning is a form of functioning involving opponency, and is the result of the unique interactive arrangement of connectivity that exists among post-receptor neurons. A simple example of contrast functioning is provided by the activity of the so-called ganglion post-receptor neuron in the visual system. The gangion's bursting activity is inhibited (stopped or slowed) by input that it receives from one type of receptor neuron, and excited (activated or sped up) by input from another type of receptor neuron. The ganglion neuron receives input from two different classes of receptor neurons that are sensitive to the same local region of the retina, a region called the "receptive field" of the ganglion neuron because this is the area of the retinal surface where light events trigger receptor neurons which then cause the ganglion's activity. The input from two classes of receptors can be organized in various ways at the ganglion. For example, the ganglion neuron may have what is called an on-center off-surround receptive field. This means that when the ganglion receives input from receptor neurons sensitive to the central area of its receptive field, the ganglion becomes active. However, if receptor neurons sensitive to the outer region of its receptive field (the surround) should become active, they will inhibit the activity of the ganglion neuron. This is one very simple form of contrast activity. The activity of the ganglion neuron, therefore, effectively contrasts receptor neural activity related to the center of its receptive field with the activity of receptor neurons sensitive to the area surrounding the center by virtue of the fact that input from receptors sensitive to the central area turn it on, and receptors sensitive to the outer regions turn it off.

All post-receptor neurons contrast one form of input with another by responding in different ways to each input, although not all contrast is achieved by the on-center mechanism. The input may be from different locations in the receptive field, as in the example just cited, or it may involve receptors responsive to different kinds of triggering stimuli, or it may involve input from different post-receptor neurons rather than receptor neuron, and in many cases contrast functioning involves whole networks of post-receptor neurons rather than individual neurons. I refer to it as contrast functioning because that is what the neural system is doing. The perceptual system has developed a means by which previously unrelated forms of neural functioning at the receptor level enter into contrast by way of the functioning of a post-receptor neurons and neural networks.

To summarize, the data indicate that Level One neural activity involves two distinct classes of neurons which exhibit two different modes of functioning.

Level One Neural Activity

1. The analytical activity of receptor neurons
2. The contrast activity of post-receptor neurons

Receptor neurons *"analyze"* the holistic phenomenal fabric occurring within the sense organs by way of the selective response, and post-receptor neurons *create contrasts* using imput from reeptor neurons and other post-receptors. The New Model develops a new conceptual framework for understanding Level One functioning in terms of these data concerning the nature of Level One neural functioning.

The "Shattering" Effects of Level One Receptor Neuron Activity

What does receptor selectivity achieve? In the Current Model, receptors are said to be feature detectors. This is not how the New Model interprets receptor activity. In the New Model, selectivity of response serves perception only as a method of isolation. According to the New Model, the *selectivity of response exhibited by receptor neurons is the means by which the perceptual system "shatters" the holistic event created by sense organs.* After this, and only after this, can the perceptual system create features. Features are created by post-receptors, not internalized or copied by receptor neurons. Schematically, the Level One neural accomplishments look like this. In the New Model, the perceptual process precedes from

<u>NEW MODEL</u>

(1) wholes -------> (2) shattering process -------> (3) feature creation

While in the Current Model, the entire view of perception processing is in reverse order:

<u>CURRENT MODEL</u>

(1) detection of proto-features -----> (2) feature combination -----> (3) wholes

Central to the New Model's recharacterization of Level One neural activity is its recognition of certain the logical relationships that hold among features and wholes or objects. From experience we know that every perceived object or event, regardless of the sensory system involved always has features or parts. There is no perceived object in the absence of features. This is easy to verify for oneself. A red circle, for example, is a visual object with a particular shape and color, both of which are features. Wholes are dependent upon their features. As discussed at the beginning of this chapter, perceptual features actually "form the object", i.e., define it as an object. What is not generally appreciated, however, is the fact that features are themselves dependent phenomena. They depend upon other features. Features are essentially *interdependent phenomena.* Every feature is what it is by virtue of its not being some other feature. The feature red, for example, is only red by virtue of the fact that it is not the feature green or blue, etc. Nothing is a feature in virtue of its own intrinsic properties. Therefore, features cannot be had in isolation, they can only be had thanks to a process of contrast with the set of other features in terms of which they are defined. Features require a contrast process. As discussed earlier, light opponency mechanisms are required for the visual perception of colors.

Even more basic, however, is the fact that the process of contrast is impossible in the absence of *functionally distinct phenomena.* That is to say, there must be individuated or distinct items to compare, before contrast can occur. This means that isolated phenomena must exist as such before contrast can occur; or, alternatively, a process of isolation or distinction must take place to effectively isolate phenomena which, then, can be contrast with one another.

To summarize: all perceived wholes depend on features, all features emerge in a process of contrast, and the contrast process itself depends upon the prior existence of isolated or distinct items that either pre-exist as isolated or are distinguished by a process of isolation. The New Model respects these logical relationships, the Current Model does not.

When applied to perceptual system functioning these logical relationships dictate that features cannot exist prior to post-receptor contrast functioning, because features emerge on the basis of contrast. It follows, therefore, that receptor neurons do not detect features as the Current Model claims. Receptor neurons are active prior to post-receptor contrast functioning. But if receptor neurons are not feature detectors, what do receptor neurons accomplish?

When the notion of feature detection is abandoned in connection with receptor level neural activity, we are left with the data which tell us about the receptor's exclusivity of response to stimuli and its functional isolation vis-a-vis the functioning of other receptor neurons (i.e., the fact that each receptor neuron functions on its own, without input from other receptor neurons). All agree that receptor activity is correctly characterized as a sharply-tuned, isolated, and reactive neural process. While it might not seem like much, in comparison with the razzle-dazzle of representationalism, these data indicate a marvelous evolutionary achievement. What we have comp upon is nothing less than an astounding biological achievement, but to appreciate it we need to think about perception a bit differently than we have in the past.

Proposition Two proposes that receptor neurons are responsible for the "complexity" of the percept. A better way of putting it is that whatever perceivers perceive is always broken up or articulated in some way. Percepts are not identical with the undifferentiated, unarticulated sense organ phenomena, as mentioned earlier. The New Model contends that all perceptual features are ultimately grounded in receptor level functioning. Receptor neurons constitute the organism's ability to use the holistic sense organ event in a plurality of distinct ways. Receptor neurons create organism-relative complexity out of the holistic event created at the level of sense organ functioning. Each receptor class constitutes a different form of using the holistic sense organ event. Each receptor is sensitive to a narrowly defined stimulus. They shatter the holistic sense organ event by reacting selectively to it and by operating as isolated players. This means that each distinct form of receptor use effectively "breaks up" the holistic sense organ phenomenon to which it reacts. Receptor neurons shatter the holistic event occurring in the sense organ and they do so on a relatively small scale. This is the unique contribution of receptor neurons.

Shattering is by no means a trivial accomplishment. Remember that there are no breaks in pre-perceptual physical reality. As I have said, physical reality is seamless, it is unbroken. The articulations of the world perceived aren't out there in the physical world. It is absolutely essential that this be recognized, otherwise one misses the remarkable achievement of Level One receptor functioning. *Receptor neurons shatter a universe that never was and never will be broken up in the way in which the world that we perceive is shattered.* The physical world is not shattered, it remains seamless; but, perceptual system functioning is shattered at the stage of receptor functioning in the perceptual system.

The distinction between the seamless physical world and a shattered form of organismic functioning is quite important. Perceived reality, as we have seen, does not resemble physical reality. Its objects and features are perceptual products. Receptor level shattering explains why and how it is that perceived reality is articulated into features when physical reality is seamless. Perceivers do not perceive the seamless web of connectivity that is the distinguishing feature of the physical world. They perceive shattered wholes, and this happens, according to the New Model, because perceptual system functioning includes the shattering activity of receptor neurons. Perceivers perceive articulated phenomena because their perceptual systems function as they do in interaction with the rest of the physical universe. Perceivers perceive an articulated world, because they perceptually articulate the holistic sense organ phenomena. Perceiving organisms are embedded in the seamless web of physical reality, but they have evolved a form of physiological functioning that provides them with a shattered version of physical reality. Traditional perceptual theories have seriously underestimated receptor functioning. They failed to recognize receptor functioning for the amazing organismic achievement that it is, and they failed to appreciate the incredible novelty that receptor functioning introduces by virtue of its shattering form of use. There is nothing like it in the rest of the natural world. The New Model asserts that the perceptual relevance of receptors is their form of functioning: they are the way in which the system creates isolated phenomena for its own use. Their functioning has nothing whatsoever to do with any form of representation.

Level One Post-Receptor Contrast Functioning

Post-receptor functioning is the second type of neural functioning within Level One. Post-receptor activity includes the activity of single neurons and of neural networks. The perceptual relevance of Level One post-receptor activity is also reflected in the way in which these neurons and neural networks behave. One basic physiological innovation of post-receptor functioning is that post-receptor neurons interact with other neurons. Neuron-neuron interaction alone, however, cannot explain feature functioning. According to the New Model, interaction among neurons is necessary, but not sufficient. Feature functioning requires a special form of interaction among neurons, viz., contrast functioning.

The activity of the ganglion neuron in the visual system mentioned earlier is one simple example of how post-receptor functioning creates a relationship of contrast between two classes of photoreceptor neural activity--one of which inhibits, and another that excites, the activity of the post-receptor ganglion neuron. The ganglion's activity creates a "this-as-opposed-to-that" relationship between the two kinds of input that it receives. This is contrast functioning. As discussed above, the ganglion's activity creates a contrast relationship between two classes of independently functioning receptor neurons with different selectivities of response to the holistic phenomenal fabric created by the sense organ. Contrast is a process in which two or more phenomena are played off against one another in a process of organismic functioning.

Post-receptor neurons perform contrasts, whether as individual neurons (as in the example just mentioned) or as networks of post-receptor neurons. Since contrasts form the basis for features, the New Model defines post-receptor activity as feature functioning. It claims that perceptual features are generated by post-receptor activity. Contrast functioning is a creative event and it should be recognized as such. Contrast functioning is something that organisms do. The physical reality of the holistic sense organ phenomenon to which receptor neurons react "just is". It is contrast functioning that "relates what is", and only when that which "just is" is involved in contrast relations can features exist. Therefore, organisms that exhibit post-receptor neural activity are feature generators.

It may seem as if the New Model doesn't differ from the Current Model on the issue of features, since both models claim that post-receptor activity is a form of feature functioning. However, the two models significantly differ in the following respects: (1) with respect to the extent of feature functioning in Level One, (2) with respect to that which post-receptor neurons are said to contrast, and finally, (3) because only the New Model explains features with the concept of "use" rather than with the concept of representation. Let us consider each point in turn.

Whereas the Current Model claims that feature functioning goes on *throughout Level One*, at the post-receptor stage as well as at the receptor stage, the New Model claims that receptor neurons and post-receptor neurons/networks serve *two different roles*, only one of which is feature functioning. Specifically, the New Model distinguishes the feature functioning of post-receptors from the pre-feature shattering activity of receptor neurons. Contrary to the claims of the Current Model, post-receptors do not simply carry on with the process of feature functioning begun at the receptor level in the New Model; rather, post-receptors inaugurate feature functioning within the perceptual system. The reason that feature functioning does not occur at the receptor stage is because, before receptor neurons perform their shattering function vis-a-vis the sense organ event, there is nothing to contrast. Receptors create the individuated elements that are contrast by post-receptor neurons.

The term "feature functioning" is incommensurate in the two models of perception, as well. Post-receptor neurons contrast quite different types of phenomena in the Current and the New Models. In the Current Model, post-receptor neurons are said to contrast *features*. For example, it is said that "red cones" and "green cones" (types of retinal photoreceptor neurons that take their name from the features that they are said to represent) pass information on to post-receptor ganglion neurons that are said to be "color contrast neurons". Color contrast neurons, as the name implies, contrast the color features coded for by receptor neurons. This is consistent with the Current Model's representational view of neural functioning. Clearly, the New Model cannot claim that post-receptor neurons contrast features encoded by receptor neurons. It cannot because it claims that features are first generated by contrast functioning. Therefore, there are no features at the receptor level to pass on to post-receptors. The New Model is forced to redefine post-receptor functioning in terms other than the contrast of features, especially at the earliest levels of post-receptor functioning where post-receptors contrast receptor input.

This is the point at which the New Model becomes a very different brand of perceptual theory. It must propose a totally new way of conceptualizing neural activity, a nonrepresentational alternative to the representation-based conceptual framework that dominates current thinking about neural activity. How does post-receptor functioning create features? The answer is found by introducing a use-based conceptual framework.

The Concept of "Neural Use"

The issue of the creation of perceived features is the most important question faced by any nonrepresentational theory of perceptual functioning, and without a doubt the most difficult problem to solve. Although critics of the Current Model are easy to find, they have never, to my way of thinking, tackled this problem head on. If the New Model cannot explain how post-receptor neural functioning creates features, it cannot succeed.

To explain how features are generated by perceptual systems the New Model introduces a use-based account of neural functioning. Specifically, the New Model proposes that post-receptor neurons and neural networks contrast forms of "**neural use**". Physiologically speaking, the only thing to which post-receptor neurons have access are forms of neural use, be it a receptor's isolated use of the sense organ event or that of other forms of post-receptor use, since post-receptors also interact with one another. Therefore, the New Model claims that *features result when forms of neural use are contrast within the perceptual system*.

The concept of "neural use" is central to the New Model. Unfortunately, this concept does not seem to be as intuitively accessible to most people as is the concept of representation. We use things all the time, but knowing how to use something is not the same thing as understanding the concept of use. The concept of use is difficult to understand, it turns out, because perceptual experience actually obscures the true nature of use and its remarkable achievements. Perceptual experience reveals only the "results" of use, i.e., the objects and features that perceivers perceive, rather than the process of use that produces the results. Therefore, the concept of use actually requires a bit of reflection to understand clearly. In order to understand the concept of use a philosophical investigation is required, not just a scientific one. Let's begin, then, with a bit of "biophilosophy".

The New Model proposes to view neural activity as a way of doing something with something else, rather than as a representational or copy process. Therefore, it views receptor activity as a way of using the sense organ event. Applied to receptor functioning, this means that receptors differ, not because of their representational content, but in virtue of the fact that they use different aspects of the holistic sense organ event. Different receptor classes are functional classes, classes composed of narrowly defined forms of receptor use. Receptor neurons are discretized forms of perceptual system action in relation to the sense organ phenomenon.

Post-receptor activity is also a way of doing something. Post-receptor neurons, at the earliest stages of the post-receptor hierarchy, make use of different receptor uses of the sense organ event when they function. It is the New Model's position that, at the stage of Level One in which receptors connect (synapse) with post-receptor neurons, post-receptor neurons contrast the ways in which receptor neurons use the sense organ event. Extending this beyond the receptor-post-receptor level of the hierarchy, the New Model claims that different forms of post-receptor use are contrased in a hierarchy of complex stages of neural interaction within Level One. Features, therefore, result from a web of contrast relations among forms of neural use. The concept of representation is replaced in the New Model with the concept of use.

The most important thing to realize about forms of use is that they are *inherently creative*, and that the creativity of use principally affects the nature of that which is used. The distinctive character or nature of that which is used is created by the using of it. In the case of neural forms of use in perceptual systems, the New Model claims that the distinctively perceptual nature of that which is used is created by neural use.

For example, consider the issue of stimulus specificity. Both perceptual models agreethat receptor neurons are sharply-tuned players in perceptual systems. The Current Model, however, interprets response specificity as a function of stimulus specificity. That is, specificity is a property of the external stimulus itself, and receptors simply react to and encode the inherent specificity of stimulus features. Receptor neurons copy specificity from the external world. The concept of use reverses the origin of stimulus specificity. Stimulus specificity cannot be copied from the seamless physical world, according to the New Model, rather it is the product of receptor use. The New Model claims that stimulus specificity is "inherited" from the ways in which receptor neurons use the sense organ event. The sharply-tuned nature of receptor use is responsible for stimulus specificity. Each receptor, as it were, *lends* its own specificity to that which it uses in the phenomenal fabric created by the sense organ. In this way, the sense organ event *acquires specificity* within the perceptual system from the specificity of use into which it is incorporated at the receptor stage of Level One. The use-based interpretation of receptor activity empasizes that neural use has a profound effect on what is used.

In the past, theorists have not understood the "creative" aspect of receptor activity. Real creativity goes on at the receptor level, despite the fact that receptor neurons function reactively to the sense organ event. In the past, I too, considered the reactivity of receptor neurons as a form of "passivity", i.e., as the absence of creativity. Reaction, to me, meant that nothing uniquely perceptual occurred at the receptor stage of functioning. I now believe that I was wrong about this. I failed to realize that every receptor's reaction, albeit passively triggered, is a form of use. While receptor reactivity is not be a form of use that is internally initiated by the organism, it is still a form of use. I now believe that receptor use, like all forms of use, has a constructive nature: receptor use determines the nature of the stimulus.

Before elaborating further upon the creative nature of neural use, it is important to understand what neural use is *not.* The Current Model views neurons in two ways. It views them

1. as *physiological* entities, and
2. as *representational* entities.

The New Model rejects the representational view of neurons, but not that neurons are physiological entities with physiological properties. Does this mean, then, that the New Model propose to explain the neural contribution to perception solely in terms of the physiological properties of neurons? Wouldn't this condemn the New Model to failure? After all, wasn't it precisely the inability of purely physiological properties to explain what is perceived, that prompted theorists to adopt the representational theory of neural functioning in the first place? The physiological properties of neurons do not explain the kinds of things that we perceive, as I have explained elsewhere. This would prove problematic for the New Model if it weren't for its introduction of a new definition of neural reality. The Current Model's two options for viewing neurons do not exhaust the possibilities. The innovation of the New Model is its view of neurons in terms of neural use. The New Model, therefore, introduces a different two-fold characterization of neurons. Neurons are viewed

(1) as *physiological entities*, and
(2) as *forms of doing* something.

The New Model, therefore, draws a distinction between what neurons *are* and what neurons *do*. The physiological properties of neurons are not the same as their functional properties. Put in different terms, what something does, e.g., teaching, is not the same as what something is, e.g., flesh and bones.

According to the New Model, the functional aspect of neural activity is the true perceptual reality of neural functioning. Of course, functional descriptions of phenomena are not my invention. Other kinds of theories, e.g., theories of mind, have introduced functional definitions of phenomena. What is unique, however, is the way in which the New Model defines and incorporates the functionality of neurons within perceptual theory in terms of the constructive nature of neural use. This brings us full circle back to the issue of the creative nature of use.

Use is a process characteristic of organismic life forms. The most important feature of use is that it is creative. Just doing something with something, as simple as that may seem, achieves something truly remarkable. I've already mentioned one example of the constructive nature of neural use in terms of the effect that receptor usage has upon that to which these neurons react. Receptor neurons create isolated phenomena (phenomenal specficity) out of a holistic field that is itself unarticulated. The generation of isolated phenomena by receptor neurons is one constructive result of neural use that reveals something quite important about the nature of use. *Use makes what is used into something that directly derives its nature or character from the way in which it is used*.

Consider a non-neural case of use. Something used to extract termites out of a hole becomes, by virtue of the form of use into which it is encorporated, a termite probe. Probes and other tools are things that are *used in certain ways* (Heidegger 1962). They are are what they are as tools in virtue of the use to which they are put. Toolhood is not a physical characteristic, it is a use-based characteristic. For example, when archaeologists sift through an ancient site and find bits of stone, they cannot say that they have found tools unless they also have evidence that these stones were used as tools, e.g., evidence of tool making, products of tool use. It is the form of use that makes stones into tools.

"Use makes it so". Use endows what is used with a distinctive nature. Linguistic meaning provides another good example of use-dependence. Words have the meanings that they do, not because of any inherent property possessed by the sounds or by the arrangement of letters, or even because of what a speaker has "in mind" (i.e., what is mentally represented in the thought of the speaker). Meaning is not a property of a sound or a mark, nor is it some kind of mental representation. Words have the meanings that they do because they *are used as they are by a linguistic community*. Linguistic meaning is a matter of linguistic use.

Use-relativity applies to all kinds of objects. Objects, too, are forms of use. For example, pieces of wood or plastic or metal are not themselves tables. Tables are made out of such materials, but those materials are not tables. Nor does being a table mean that an object possesses certain physical characteristics that all tables possess and in virtue of which they are tables (Dreyfus 1979). There is no set of defining characteristics that are possessed by *all* tables. Some tables have legs, but not all tables do: a rock can be a table, or a blanket on the ground. Not all tables are manufactured, or have a hard surface, or are of a certain height off the ground, or are made of the same materials, etc. Think as hard as you can about this problem, but you will never come up with a list of physical properties that uniquely apply to *every* table. There will always be an exception to whatever definition you settle upon. A table is that which is used as a table: its height off the ground depends on how it is used (some are low because people kneel on the ground, others are higher to accommodate chairs or high stools). The lesson is clear: *use is the deciding factor in determing what counts as a table.* Tables are functionally defined entities, they are use-dependent.

In Western philosophy, we have the philosopher Ludwig Wittgenstein (1889-1951) to thank for this theoretical insight into the use-relative nature of the things (Wittgenstein 1953). He termed the use-relative nature of a thing its "conventional nature". He taught that linguistic meaning, rules, and objects are what the are because we use them, talk about them, apply them, and manipulate them as we do. When something is used in a certain way, it takes a character or nature from that form of use. There is nothing more to it. We may think that objects get their character or meaning from how we think about them. Wittgenstein also disproved this hypothesis, showing instead that how we think about things is as use-dependent as anything else. No "objective" or "subjective", use-independent criteria can explain what use achieves. Use is the bottom line. If the respective forms of use were to cease, the meanings of words, the significance of rules, and the very character of objects could not exist.

This use-relativity relates in an interesting way to what was said earlier about the nature of the pre-perceptual physical world. I said that the physical world does not contain the "originals" of the objects that perceivers perceive, and therefore, that the perceived cannot be copied from the physical world. Where, then, does the perceptual nature of things come from? The concept of use explains the transition from the merely physical to the perceptual and it does so without representations. Although a table appears as something from its own side, i.e., as something perceivers simply discover or come upon, and that possesses in and of itself the characteristic of being a table, the concept of use indicates that this impression is not accurate. A table is the product of use--of my use and the use of other beings like me. It acquires its nature as a table, from our use of it. Tables would not exist in a world without beings who use things as humans do, who are physically built as we are, who have certain customs associated with eating, and so on. Therefore, the Current Model's claim that perceptual systems merely copy such objects and their features from the external world is refuted by the recognition of the use-dependent nature of features and objects. Neurons cannot copy what is generated by perceptual forms of use. What the representational theory of perception wants neurons to copy and then internalize from the external physical world, is, according to the New Model, what perceptual use of the physical world by neurons creates. In other words, the use-based theory of perception does not require representations, because *neural use creates what neurons were thought to copy*. This change is absolutely required in order that the New Model be successful, since this model rejects the perceptualized account of physical reality and, therefore, cannot employ representational mechanisms.

I mean to extend the concept of use beyond the social and specifically human phenomena to which theorists have previously applied the concept. The concept is also relevant to perceptual system functioning. What neurons use will be influenced by that use in much the same way that sounds, marks, or tables inherit their nature from a form of usage. Let's apply this use-based interpretation to Level One neural activity in the visual system. Here the concept of use explains how contrast functioning creates features when prior to contrast activity no features exist. As I said earlier, photoreceptor usage isolates and individualizes forms of light that do not exist as individuated items in the physical universe. In terms of the concept of use, individuated or individuated forms of light are created in dependence on different kinds of receptor usage of the sense organ phenomenon, thanks to the fact that a given receptor reacts to a certain type of light frequency. Then at the post-receptor stage, a new form of neural use is introduced, contrast usage. Post-receptor contrast usage generates features in a way that is analogous to the way in which the meaning of a word such as "good-bye" is generated. "Good-bye" is a set of physical marks or sounds that are *used* in a particular context, viz., to end a conversation or to express good wishes, and whose usage contrasts with the use of different sounds and marks in different contexts. The generation of word meaning, therefore, is based on contrast usage of sounds and marks. Analogously, certain frequencies of light are used by way of contrast by post-receptor neurons and in this way "contextualized" as color features. Individuated receptor usage of light events provide the raw material for subsequent contrast functioning by post-receptors which create features, just as distinct sound events form the basis for linguistic use which creates meanings. (Of course, in the case of linguistic meaning the whole process presupposes perceptual functioning in the sense that the raw material for linguistic use is perceived. This is not true in the case of perceptual systems, in which the raw material is pre-perceptual rather than perceptual.) Just as only sounds used in a linguistic way have meaning, so too, only light frequencies used in a color way, i.e., by way of contrast with light of different frequencies, obtain the status of colors. Red is a form of light use defined by contrast with other forms of light use by the visual system. Red is a form of light isolated by certain receptor neurons that is not--because of contrast usage--the form of light isolated by the so-called green receptors. Red and green are "different", i.e., they take on their distinctive nature thanks to the fact that different receptors react to each frequency of light in the sense organ and thanks to the fact that post-receptors contrast the two frequencies in a this-as-opposed-to-that relationship. The frequencies of light associated with red and green get their unique color character from being contrast with one another.

The contrast dependency of visual color features was established by Edwin Land, the pioneer of color photography, in experiments conducted in 1957. Land showed that the color of light is not a property of its wavelengths. On the contrary, color is generated by a system like the visual system which contrasts or compares different light wavelengths to generate color. Therefore, the contrast dependency of features is not the invention of the New Model, and it accords with independent scientific investigations of features such as visual color and with that which is known about the nature of post-receptor functioning.

It would seem, therefore, that all of the aspects of the sense organ event of light isolated by receptor neurons that are individuated and then brought into direct contrast with one another create a complex "context of use" that constitutes the organism's color field of vision. Each light frequency gets its unique character in virtue of the nature of the forms of receptor light use with which it is contrast. Pigeons, whose visual system makes use of ultra-violet and infrared frequencies of light in addition to those frequencies which humans perceive, should therefore be expected to see wholly different color phenomena than do human perceivers (Varela, Thompson & Rosch 1991) because their visual systems contrast different sorts of light frequencies with the result that each frequency takes on a different quality than our own. In much the same way, sounds that are involved in relationships of contrast use with one another create the context of language and constitute the realm of linguistic meaning. The reality of perceptual features like red is that they are the results of specific forms of use of some substrate. The relativity of use is ineliminable and is what makes features. Use by way of contrast is essential for word meaning and for perceptual features.

There is an important point of difference between perceptual features and linguistic meanings, however, that derserves mention because it serves to point up an important feature of bodily functioning. When it comes to perceptual features, it is the body itself that is involved in the creation of features. Not, as in the case of language, a society of individual speakers, but the body itself. The body can create perceptual features because it has the ability to contrast various forms of its own functioning (use). Meanings and features differ, therefore, in that perceptual features result from a form of "**bodily convention**" or bodily form of use, while meanings are created by a "social conventions" shared by a linguistic community of speakers.

As far as I know, no one has viewed the body as an integrated set of conventions before. I'm not sure why this is. Philosophers and others have known about the nature of conventions and the concept of use for a long time, and these concepts have been applied in a wide variety of theoretical disciplines, but never in the biological sciences to my knowledge. Instead, the body is generally viewed as a kind of machine, a kind of blind mechanism, and although the body machine is thought to be quite complex, it is generally agreed that whatever the body machine does it does in a mechanical way. As long as the body is viewed in this way, the concept of use is ignored.

This is not the way in which the New Model views the body. The body is correctly viewed, according to the New Model, when it is realized that the body is fraught with conventions. Bodies are articulated sets of conventions. To have a body is to possess certain conventions of organismic use. Perceptual functioning is one form of bodily convention; or more accurately, perception is one cluster of bodily conventions. There are other bodily conventions such as movement. The perceptual cluster of conventions is unique to perceiving organisms. Bodily conventions, like perception, come with embodiment, they *are* embodiment of a certain kind.

The bodily conventions unique to each organism are its "**structure of behavior**" (Merleau-Ponty 1942). When I refer to perception as a bodily convention, as a particular structure of behavior, this should not be taken as a form of behaviorism. Perception is not a stimulus-triggered behavioral response, or an observed causal relation between a stimulus and a response, as a behaviorist would claim. That an organism with a perceptual convention will perceive is not a learned response to a stimulus, it is a class of interactive uses involving aspects of the organism's own functioning. Perception is a structure of behavior in the sense of being complex set of different uses that determines the kinds of reactions an organism can exhibit in the ever-changing circumstances in which it finds itself. Reactive responses are determined by the forms of use in which an organism engages, not the other way around. Use predates and shapes reactivity. As Merleau-Ponty (1942) emphasizes, reflex activity has a style depending upon which organism is involved. Reflex activity is not just any physical action that can be produced given the physics of the system, rather it is a style of activity that is part of the structure of that organism's own behavior. For example, humans exhibit a patelar reflex (knee jerk) because their structure of behavior involves walking rather than slinking like a snake.

Perception as a set of conventions, to use another phrase coined by Wittgenstein, is "**a form of life**". A form of life is a way of living in the world. It is a style of interaction and of functioning. Perception is one such style. Perception is a form of life that is shared by many different kinds of organisms in our world. Organisms that engage in the same or a very similar form of bodily convention, share a common "structure of behavior". For example, humans share a common form of perceptual functioning, a "perceptual style", that is a set of identical perceptual uses or structures that shape what they perceive. This is the human perceptual style. Not all perceivers, however, share the human perceptual structure of behavior. As the philosopher Thomas Nagel (1979) pointed out, bats are a good example of perceivers that have a perceptual style that is in many ways incommensurate with our own. Bats are perceivers, but with a very different perceptual convention or set of conventions than our own. Their sonic perceptual style is quite different than anything that we posses. We can only imagine, not engage in the perceptual conventions that constitute bat perception; therefore, Nagel contends, we cannot know what it is like to *be* a bat. Or, as I would put it, bats differ from us with respect to the set of perceptual conventions that they possess. Which amounts to saying, if you accept my definition of bodies as webs of conventions or forms of use, that bats and people have *different bodies*, specifically, different perceptual bodies.

"Neural use", "bodily conventions", and "structures of behavior": these are powerful concepts for redefining perceptual functioning. They force us to view the body dynamically. They also force us to view the products of such functioning, e.g., perceived features, in terms of the perceptual dynamic of use that gave rise to them and that determines their nature. This produces a radical shift in how we view organisms and their perceived worlds.

What Neurons Pass On to Other Neurons

What exactly do neurons pass on to other neurons? According to the Current Model, neurons pass on their representational content, that which they encode and which must eventually be decoded to become perceptually available. The New Model claims, instead, that **neurons pass on their form of use**. In so doing, neurons achieve what the representational theory tried unsuccessfully to explain with representations.

The New Model identifies features as the product of neural use, which means that features are only available to the system if the system as a whole has access to the *ways in which post-receptor neurons use the receptor usage of the holistic fabric of the sense organ event*.

This follows because use is the determining factor. Neurons must pass their forms of use to other neurons because this is what creates features. In the Current model, features were copied; in the New Model, forms of use are created which create features. In the Current Model, the post-receptor hierarchy is a representational hierarchy; in the New Model, the hierarchy is viewed as a hierarchy of forms of use.

Thus, by passing on forms of use, neurons are able to define and refine the nature of what is used by contrasting and compounding forms of use alone. Passing on a form of use is passing on the determining factor that endows that which is used with its characteristic, use-dependent nature. We pass on table use to our children, not a list of defining features that are possessed by all tables; receptor neurons pass on their use of the sense organ, not a copy of something in the sense organ that predates their functioning. According to the New Model, organisms that have access to their own forms of use and that are able to use them relative to one another are perfect systems for generating features. Indeed, the New Model asserts that features cannot exist except for organisms that function as perceiving organisms do. Such organisms provide the necessary conditions for feature generation in their interaction with the physical universe.

This means that features are not derived from features in the New Model, as they were in the Current Model. Instead, features have their origin in a featureless physical substrate. Features originate as a form of perceptual system use because they are dependent upon a form of contrast. The origin of features is the physical substrate of the holistic sense organ event and receptor use of that substrate. Both are featureless. When these two featureless bases are used by way of contrast by post-receptor neurons, features are created.

The New Model ultimately views perception as a form of **organismic self-use**. Indeed, this could well serve as a motto for the new approach to perception. The organism makes use of its own functioning at all levels of perceptual functioning by passing on forms of use rather than representations. Perceiving organisms create sense organ phenomena, break them up, and then use their shattered uses of the physical substrate by way of contrast with one another. This is Level One neural functioning. It is a truly marvelous form of organization and of optimizing system dynamics.

We get an interesting new perspective on perceptual functioning with the New Model, that sets it apart from the Current Model in which the question of access occupied center stage. According to previous perceptual theorists, a main problem for perceiving organisms is to gain access to the external situation and to correctly copy what what exists outside. This is not the problem for perceptual systems, according to the New Model. For one thing, the New Model views the organism as embedded in the seamless web of the physical universe, so there is never a problem of access in this respect because the organism cannot get unconnected to the whole in which it is embedded. But more important is the New Model's claim that perception is a process of self-use, which means that *what is perceived is built out of the fabric of organismic functioning itself.* This interpretation eliminates the problem of access in two ways. First, perceiving organisms are never isolated from the rest of the physical universe. They cannot get outside of the seamless web. Therefore, access to the "rest of physical reality" is never a problem for organisms. Accessibility is the fundamental condition of physical reality, including the physical organism. Secondly, perceiving organisms always have access to their own functioning. Perceiving organisms can count on their own functioning, in a way that is impossible regarding the state of the extra-organismic environment. Therefore, it makes sense for organisms to utilize their own functioning as the basis for their behavior, especially in view of the fact that it is their own functioning that endows what they use with its distinctive nature. Obviously, there are great evolutionary advantages to this way of functioning. Personally, I've always found unplausible the "problem solving" view of perception, in which organisms are viewed as systems that have to discover unknown and essentially alien external variables in order to perceive. It just doesn't make biological sense. If we view perceptual functioning as the New Model does, the problem solving interpretation of perception is unnecessary.

Given this change of perspective, it should come as no surprise to us that organisms suffer most when aspects of their own functioning deteriorate, but are able to tolerate a high degree of variability in the physical environment. This is what one would expect if organismic behaviors, like perception, depend on the organism's ability to use aspects of its own dynamic functioning. Ultimately, the organism's interactive flexibility with the environment depends on the organism's ability to successfully use its own dynamic activity at different levels. This does not mean that environmental degredation and change are irrelvant to organismic functioning. They are not. Rather, the point is to put the emphasis back on the determining organismic variables and to recognize the essentially organismic nature of perception.

Finally, if one accepts that contrasted forms of neural use of the sense organ event create features, one cannot be a perceptual realist regarding the nature of the physical world. Although perceivers perceptually experience features as properties of external objects, features are forms of perceptual use. Therefore, perceptual realism, the view that what a perceiver perceives exists in the pre-perceptual, external world, is ruled out by the New Model's definition of features. Perceptual realism is based on what perceivers perceive, i.e., on what is perceptually experienced. It does not accord with the nature of the physical world, according to the New Model, and does not recognize that features, like the rest of the percept, are the products of perceptual functioning.

The Functions of Level One Neural Activity

The data indicate that post-receptor neural processes in Level One are hierarchically arranged, and that different hierarchical levels of post-receptor functioning correlate with features that differ in scale. This hierarchical process is what the Current Model interprets as a progressively process of feature composition. Level One must be a compositional process, so the reasoning goes, because the perceptual system must reconstruct the external situation that receptor level functioning shatters. The New Model eliminates the binding process; therefore, in the New Model, the progressive composition of larger and more complete features of the whole loses it meaning. This means that the New Model must reinterpret the overall function of Level One neural activity.

All Level One neural activity relates to features in one way or another. Although the New Model does not interpret receptor activity itself as a form of feature functioning, it still maintains that receptor activity is related to feature functioning in that it provides its foundation by creating elements that can be contrast. Post-receptor activity, on the other hand, decisively correlates with perceived features. Moreover, post-receptor activity correlates with perceived features that differ in scale, from the contrast functioning responsible for simple features like colors to more complex features like edges or direction of movement. The difference between the Current Model and the New Model comes down to a difference in how the two models of perception interpret the finding that post-receptor activity correlates with perceived features that differ in scale.

The Current Model claims that the data indicate that post-receptors are part of a process that constructs whole objects from their smallest feature components. The New Model argues that post-receptor functioning should be viewed in terms of disassembly, rather than in terms of assembly or binding. In part, the New Model bases its claim on its recognition of the fact that features are always aspects or parts of wholes. No matter how big the feature is, it remains a part of a whole. Hence, post-receptor activity, which correlates with features, is concerned with creating parts, according to the New Model. The New Model puts the emphasis on partial phenomena in accordance with the data. Therefore, it claims that Level One neural activity does not build up a whole, it breaks up the holistic phenomenal fabric created by the sense organ. This all that Level One neural activity does. Binding, assembly, construction are not involved. The difference between the two perceptual models on the issue of Level One functioning are starkly portrayed here. The Current Model has it that perceptual systems construct the very holism that the New Model claims that Level One neurons deconstruct. The problem of perception, according to the Current Model, is reconstruction. The problem of perception, according to the New Model, is *deconstruction*.

Why does it seem to us that Level One is building up something, when, as the New Model suggests, it is actually breaking up something? The answer is that it depends entirely on the conceptual framework that one brings to bear on the process. If one thinks reductionistically (trying to account for wholes in terms of their parts), based on the evidence that receptor neural activity correlates with highly discretized phenomena, then one is led to adopt a perceptual model that is contructivist in nature. In addition, if one's basic conceptual framework is representational in nature, constructivist tendencies are further encouraged because the whole goal is to reproduce the kinds of holistic objects and events one locates in the external world. And finally, if perceptual functioning is neuro-centrically conceived and receptor functioning is believed to be its foundation, then contructivism is inevitable given the fact that receptor neurons discretize the sense organ event but perceivers perceive objects not disperate features.

The New Model suggests that the hierarchical process of post-receptor activity will be constructivistically interpreted unless these conceptual biases are rooted out. One way to facilitate this is to seriously consider the negative data. There is no evidence that perceptual systems construct complete percepts (this is the negative finding), but we know that receptor neurons shatter the holistic sense organ phenomenon and that post-receptor neurons are responsible for creating the partial phenomena of the percept, viz., features. If we then take the lack of data to support the binding hypothesis as proof that the binding process does not occur, along with the data on the shattering properties of receptor and post-receptor functioning vis-a-vis the holistic sense organ phenomenon, we can conclude that Level One neural functioning is a deconstructive process through and through because all the evidence points to the fact that it is concerned with partial phenomena. Therefore, according to the New Model, what the Current Model interprets as a process of progressive construction of a whole object is interpreted as a process of progressive articulation or disassembly of the holistic sense organ phenomenon at larger and larger scales. It is one thing to progressively articulate a whole at larger and larger scales, as the New Model suggests, and entirely another to build up a whole out of progressively larger scale features. The two processes are easily confused depending upon which interpretive conceptual framework one applies to the data, but they are two distinct kinds of processes.

Progressive deconstruction of the holistic phenomenal fabric in the sense organ is the underlying significance of Level One's hierarchical architecture. It is progressive because in perceptual systems large scale feature articulation builds on finer scale feature articulation at the post-receptor level. The process of deconstruction begins with receptor shattering that is carried out at a relatively fine scale. When post-receptor neurons contrast receptor level use of the sense organ event, progressively larger and larger scale *feature deconstruction* is accomplished. So, for example, a red square is not built up out of its features, such as the color red, edges, corners and surface, rather a red square is broken out of the undifferentiated sense organ event by a progressive process that first defines the most simple elements and then deconstructs larger scale shattering on this basis. I imagine the process as somewhat similar to searching for an object hidden in one of those puzzle drawings in which it is "hidden" in a noisy background; suddenly, I see an eyeball, then a face, and finally a dog. In this example, I have not put together a dog out of features, so much as I have progressively articulated an unarticlated situation at progressively larger scales. The difference here is, perhaps, subtle, but it is important. Progressive levels of post-receptor functioning are like shock waves of articulation spreading from the smallest of scales to envelope the entire phenomenal fabric of the sense organ phenomenon. The process is a bit like the cracks that generate from the point of impact when a ball hits a pane of glass: an undifferentiated field of glass is shattered by a process that begins at a small scale and deconstructs outward. In the same way the entire process of Level One functioning is deconstructive of the original undifferentiation, it is not reconstructive in any sense of the term.

In conclusion, Level One neural activity is concerned exclusively with the holistic, undifferential phenomenal fabric created by sense organs, and its sole function is deconstructive. Deconstructive functioning with respect to the undifferentiated phenomenal fabric is the hallmark of Level One functionping. The problem for perceiving organisms is not how to put what it sees together. Holism is not a problem in a seamless universe, therefore, it is not a problem either for organisms that are part of the universal holism and whose very functioning depends upon this holism. Perception is an articulative form of organismic functioning. The problem of perception is to break up what is unified, to break up the undifferentiated and holistic sense organ event into features and objects. This is the unique achievement of Level One neural functioning in perceiving organisms. The two perceptual models stand on opposite ends of the spectrum on these issues. When this is understood, one has gone a long way towards understanding the New Model of perception. The New Model revolutionizes our view of Level One neural functioning, and as you will see, the revolution continues with a new view of Level Two neural functioning as well.

CHAPTER FOUR

Redefining Level Two Neural Activity:

The "Articulative Action" of the Nervous System

The genesis of the whole by composition of the parts is fictitious. It arbitrarily breaks the chain of reciprocal determinations (Merleau-Ponty 1942).

The New Model is forced to redefine the function of Level Two neural activity because it eliminates the binding problem. Without the postulated binding process it makes no sense to define Level Two neural functioning as the process whereby isolated features are bound together to form complete internal correlates of perceived objects. The New Model proposes the following concerning Level Two neural functioning. The New Model claims that perceived objects are not a neural achievement. The New Model completely separates the issue of Level Two neural functioning from the issue of object perception. Neurons and neural functioning are not responsible for the perception of objects.

Instead, according to the New Model, Level Two neural functioning occupies an intermediary ground relative to two other aspects of perceptual functioning that are identified by the New Model. It claims that Level Two functioning is sandwiched between Level One functioning (sense organ functioning and the neural activity of receptors and post-receptors in the service of features) and a form of non-neural functioning, yet to be discussed (see Chapter Five), that is responsible for the perception of objects (see Table 4.1).

Locating Level Two Within Perceptual Functioning as a Whole

Sense Organ and Level One Activity	**Level Two Neural Activity**	**Non-Neural Activity**
non-neural sense organ event two forms of neural activity: (1) receptor activity (2) post-receptor activity	neural mass action	whole organism use of the results of Level Two functioning

[Table 4.1]

The New Model proposes that the articulative process that began in Level One continues in Level Two. Articulation, rather than integration, is the basic contribution of Level Two functioning. However, the process of articulation taking place at Level Two is quite distinctive. Level Two neural activity (1) consists of a different form of neural activity than that which is characteristic of Level One, and (2) it articulates a completely different phenomenon than does Level One neural activity. Level One neurons act as isolated individuals or as members of neural networks and articulate the sense organ phenomenon. Level Two neural activity, on the other hand, involves the cooperative activity of enormous populations of neurons, and articulates the functioning of the organism itself, rather than the sense organ phenomenon. Therefore, the New Model predicts that Level Two neural functioning should correlate with organismic variables, rather than with perceived variables, such as features and objects. This in a nutshell is the New Model's interpretation of Level Two activity.

Articulation vs Construction

The defining feature of the perceptual form of life, according to the New Model, is that it is fundamentally articulative in nature. *All* neural functioning is a form of articulation. The articulative paradigm, however, is not limited in the New Model to interpreting neural functioning. Non-neural organismic functioning in the service of perception is also articulative. For example, sense organ functioning is a form of non-neural articulation. The sense organ articulates a single phenomenal fabric, e.g., light, from the complex web of seamless physical processes that are the physical reality of the universe. This is a form of non-neural articulative use by organisms. Thus, articulation or articulative use is the key concept for understanding *all* aspects of organismic functioning in the service of perception, according to the New Model.

The term "articulation", introduced at the end of the last chapter, happens to have two diametrically opposed meanings, only one of which is relevant to the New Model. As far as the New Model is concerned articulation means to divide up a holistic phenomenon, thereby creating parts where there were none before the articulative process began. 'To create parts where there were none before': this concept sets the New Model's use of the term articulation apart from the meaning of terms such as "to decompose" or "to analyze". These terms take for granted that whatever is analyzed or decomposed *already possesses distinct parts*. This is an assumption that is not allowed for by the New Model's definition of the nature of physical reality as a seamless web, to which the notion of parts is alien. The New Model claims that articulative perceptual functioning literally creates parts. Perceptual articulation, therefore, starts with a seamless whole and breaks it up.

One aspect perceptual articulation, as we have seen, is the shattering use of the sense organ phenomenaon by receptor neurons. Receptor functioning is one way in which neurons articulate, but it is not the only way. There are differences that the term articulation, when applied generally to all aspects of neural functioning, tends to mask. Receptor shattering is a unique form of articulation in one respect: whereas Level One receptor neurons function in isolation from one another, other forms of articulative neural functioning are not isolated in this sense. Post-receptor neurons operate in relation to one another, never in isolation. Contrast functioning cannot occur when neurons function as isolated players. To "shatter" and to "articulate", therefore, are roughly equivalent in that they both refer to a decompositional rather than construtive process, but differ in that they refer to two different modes of neural functioning, one that depends upon isolative functioning and one that requires interactive functioning.

There is another, perhaps more common meaning of the term articulation that is just the opposite of articulation as the creation of parts, viz., articulation as the jointing together or unification of parts. This is not the sense in which the term is used in the New Model. The reason should be obvious: in order to bind parts together, parts must already exist. The New Model denies that the parts relevant to perception, e.g., isolated physical phenomena or features, predate the activity of neurons, which activity is said to be the means by which these parts come into being. Perceptual complexity arises on the basis of articulative use. Holism is the universal given, it is the primal or original state of everything that exists. Escape from this pervasive holism is the ultimate achievement of perceptual functioning.

Articulation is understood as a process whereby parts are created in scientific fields other than that of neuroscience, e.g., in the field of developmental biology. The development of a complex organism from a single cell immediately raises the question as to how such complexity is generated. Morphogenesis, the study of how embryonic structures (organs) form or develop, is considered the most important outstanding issue in developmental biology today. However, the "parts" referred to in connection with perceptual system functioning are not anatomical structures, as they are in developmental biology. Rather, in the case of perceptual system functioning, articulation primarily creates different organismic forms of use, partial forms of functioning, or unique forms of bodily conventions to use the language of Chapter Three. In short, the parts referred to by the New Model, are not things, they are *forms of use*. Thus, I urge the reader to adopt a dynamic perspective on perceptual articulation, rather than a static, structural or anatomical perspective.

It is instructive to constrast the New Model's articulative characterization of neural functioning with the view of nerve activity formulated by Sir Charles Sherrington in his seminal book, *The Integrative Action of the Nervous System* (1906). Sherrington writes:

In the multicellular animal, especially for those higher reactions which constitute its behaviour as a social unit in the natural economy, it is nervous reaction which *par excellence* integrates it, welds it together from its components, and constitutes ... from a mere collection of organs an animal individual. This integrative action in virtue of which the nervous system unifies from separate organs an animal possessing solidarity, an individual, is the problem before us in these lectures.

Sherrington paints a constructivist picture of nerve functioning. Sherrington effectively takes partial functioning for granted. Sherrington conceives of organismic functioning as the solution to the integrative problem that he poses.

Neural constructivism is the dominant view regarding nervous system functioning, as I have already indicated. Organismic functioning is completely interpreted in terms of integration. Given the prevalence of this intellectual habit, it is quite difficult to think about nervous system functioning in terms other than that of integration, yet I suggest that we do just that.

Constructivism not only influences the way in which neurons are viewed, it influences the way in which the whole organism is viewed. Thus, the organism is conceived of in terms of its partial functioning, as a collection of parts which serve individual functions and that are welded together by nervous system functioning to produce the global behavior of the organism. Each part is defined in terms of its mutual exteriority to other parts, a form of reductionism that has been criticized on many fronts, e.g., Goldstein (1934), Merleau-Ponty (1942), Rose (1987; 1992). From neural activity within neural systems, such as the visual system, on up to interaction among neural subsystems and beyond, the entire organismic problematic is ordinarily conceived of in constructivist terms. Even the traditional mind / body problem is but the final stage in the constructivist picture of organismic functioning. For example, Sherrington's ultimate goal--to discover the final integration which unites the "two great, and in some respects counterpart, systems of the organism", the physical body and the psychical facts of mind or experience--is clearly a constructivist goal (Sherrington 1947). The Sherringtonian project is to put the organism together from its smallest neural components to its most sublime aspects of mind and body.

It is arguable, however, that the integrative model of organismic functioning takes far too much for granted. Once again , I believe, that the culprit is perceptual experience itself. The integrative model is based on an observational viewpoint on the organism. The problem of integration starts when an outside observer perceives independent subsystems, nerves, organs, and so forth. From the observers point of view the organism is a collection of parts. Sherrington's integrative approach is based on his perceptual observation of the organism. Others have criticized the external nature of the observer-relative view of the organism and how it distorts the nature of organismic functioning (e.g., Merleau-Ponty 1942). I wish to make a different point in the present context, namely, that the observational view of the organism is perception-based. Sherrington formulates a theory of organismic functioning in terms of the *perceived* organism.

In this connection, recall what was said at the beginning of Chapter Three about the unique character of perceived reality. What is perceived, i.e., the perceived world, is endowed with features and parts which rightly understood are the products or results of perceptual functioning. Physical reality is different, it is a seamless web in which the question of integration of "parts" cannot be posed in any meaningful way. Everything already is integrated in the physical world. Integration is the basic condition of seamless physical reality. Integration is not a problem, it is a fact about physical reality. Applied to the physical organism, the implications of this characterization of physical reality are clear. The physical organism is of one fabric with the rest of physical reality. Its physical reality is seamless. Therefore, it follows that the organism's physical reality is not the same as that of its perceived reality, as the observational viewpoint assumes. It also implies that perception-based descriptions of the organism can mislead perceptual theorists because such descriptions take the shattering effects of perceptual functioning as a fact about the organism's own physical reality, when in truth, the parts that observers perceive are results of their own perceptual functioning and, therefore, facts about their perception of the organism's physical reality. Thus, it would seem that observation-based descriptions of the organism actually create the problem of integration for theorists. In a world without perceivers, the integration problem does not exist because independent parts do not exist. Sherrington's integrative problem is fundamentally a perceptual problem, not an organismic, physical one. The insight that integration is a perception-based problem further undermines the view of neural functioning in constructivist terms.

To summarize, two changes are required by the New Model. First, as just mentioned, the New Model describes perceptual functioning starting from a non-perceptualized description of the organism and its world, which means that integration is inescapable. Second, the New Model requires theorists to adopt an "internal perspective" on organismic functioning: beginning with the phsyical reality of the organism which shares the seamless nature of all physical reality, ask youself how such a system generates percepts with their features and independent objects. Think about the problem from the inside out, in other words, rather than from the point of view of an outside observer. This is one perspective change that makes all the difference in the world.

What Counts as Level Two Neural Activity?

A perceptual model that introduces a second level of neural functioning must address two issues. One issue is to identify the type of neural activity that qualifies as Level Two functioning. The second issue concerns the contribution made by Level Two activity to perception. The New Model differs from the Current Model on both issues.

Concerning the first issue, consider what the Current Model has to say about Level Two neural activity. In Chapter One it was explained that neuroscientists no longer subscribe to the "pontifical cell" view of Level Two neural activity proposed by Barlow, which equates Level Two activity with the activity of single neurons. Nor are contemporary neuroscientists inclined to accept the view that the activity of small, local neural networks acting on their own is Level Two activity. Today researchers tend to identify Level Two activity with the activity of quite large neural networks, such as those described by the Synchronization Model. Synchronization theorists identify Level Two neural activity with the activity of neural "supernetworks". Is Level Two neural activity correctly characterized in this manner? Is Level Two neural activity supernetwork activity?

In order to decide whether or not supernetwork activity represents a distinct, second level of neural functioning, it is important to examine the type of neural activity that is synchronized? In other words, we want to know how the neurons in supernetworks behave? Is there something about the nature of neural functioning in supernetworks that qualifies supernetwork activity as a distinctive form of neural functioning within perceptual systems? A second level of neural activity ought to reflect a distinctive form of neural functioning, otherwise, why refer to a Level Two at all? For answers, we must return once again to the data.

The data indicate that neurons in supernetworks exhibit synchronized rhythmic bursts of activity when the neurons are active in relation to the same stimulus, e.g., the same orientation of a moving bar of light (Gray & Singer 1987) or orientations that are nearly the same within a small range of variability. Stimulation of the visual system with a single light bar oriented in a particular direction, for example, showed that synchronizing links exist among cells and small cell groups triggered by a similar orientation. "Similar orientation" is defined as a narrow range of variablity in perceived stimulus orientation. Desynchronizing connections, on the other hand, are thought to exist between neurons that have widely divergent orientation preferences.

This tell us something important about neural functioning within supernetworks. First, the data indicate that the neurons that make up supernetworks function like receptor neurons and post-receptor neurons in the sense that their activity *correlates with specific stimuli*, in this case specific orientations of a bar of light. Synchronizing and desynchronizing links are thought to exist among neurons selective for specific stimuli. The neurons in supernetworks are, therefore, narrowly tuned and stimulus specific, just like Level One neurons. Stimulus specific functioning, therefore, takes place at both levels of neural functioning, according to the Synchronization Model. This means that no neural innovation is introduced at Level Two with respect to the activity of the individual neurons involved. The activity of individual supernetwork neurons essentially consists of the same kind of stimulus specific neural activity as that which is exhibited by Level One neurons. This is one point.

Admittedly, however, the activity of neurons involved in neural networks is different than the activity of non-network, stimulus sensitive neurons, such as receptor neurons. All neurons that are members of neural networks are linked by *mutual excitatory connections* that primarily serve to facilitate network activity. These bi-directional excitatory connections allow the activity of one or more neurons in the network to trigger the activity of all of the members of the network so that they become simultaneously active, because the whole network is linked up with excitatory connections. Mutual excitation, however, is not involved when neurons, e.g., receptors, act as individuals rather than as network members, despite the fact that both receptor activity and neural network activity correlate with features. So, neurons in networks do exhibit a distinctive form of interaction.

However, and this is the second point, the property of mutual excitation occurring between neurons in neural networks cannot be used to distinguish Level Two neural activity from Level One neural activity. This is because network activity is also characteristic of Level One at the post-receptor stage. The Current Model itself claims that neural network activity is a feature of Level One functioning, although it maintains that the networks involved are small local networks rather than the supernetworks under discussion here. However, insofar as all networks rely on the same underlying mutual excitatory mechanisms, such mechanisms cannot be used to distinguish Level One neural activity from Level Two activity. The issue of scale is irrelevant here. Network dynamics are the same no matter how large or small the network or how widely distributed its members.

A third and final point concerns the question of whether or not supernetwork activity is functionally distinct from the contrast functioning characteristic of Level One. This question relates to the hypothesis concerning synchronizing links that are thought to be characteristic of supernetworks. The Synchronization Model proposes that supernetwork neurons have synchronizing links that allow member neurons, not only to excite one another into activity as all network neurons do, but specifically to *burst simultaneously* with one another. Neurons that share desynchronizing links cannot burst synchronously. It is not clear whether synchronizing links are present in all neural networks, however, the synchronizing / desynchronizing relations between supernetwork neurons actually provides further evidence for the view that supernetwork activity resembles Level One neural activity. Why? The reason is that synchronization and desynchronization are essentially *contrast mechanisms.* Whatever is synchronized is contrast with that which is desynchronized. This suggests that Level One activity--specifically the activity of Level One post-receptor neurons--and the activity of supernetworks is once again similar because they both are forms of contrast functioning, albeit on different scales. As a form of contrast functioning, moreover, supernetwork activity cannot be equated with the internal correlate of complete objects, as the Synchronization Model suggests. Contrast functioning is feature functioning in both the New Model and the Current Model; therefore, if as it appears, synchronization / desynchronization is a form of contrast functioning, this means that supernetwork activity, no matter how widely distributed across the cortex, is still a form of feature functioning. The only real difference between contrast functioning involving single neurons or small networks and that of supernetworks is one of scale: with larger groups of neurons articulating larger scale features, but once again scale does not transform a feature into a perceived object.

Therefore, supernetwork activity is actually equivalent to Level One neural activity, since both involve stimulus specific neural activity, neural network activity, and both are forms of contrast functioning and hence feature functioning. It seems clear that, far from being a distinctive second level of neural activity, *supernetwork activity is but another aspect of Level One neural activity*. If this is right, and I believe that the data support this hypothesis, then Level

One neural activity includes three classes of neural activity, rather than the two identified by the Current Model. Level One neural activity includes the activity of

(1) receptor neurons functioning in isolation from one another, and

(2) individual neurons and small neural networks at the post-receptor stage, and

(3) the activity of supernetworks distributed across large areas of the cortex.

Level One is a level of functioning, therefore, that includes receptors, post-receptors and neural networks, both small and large. Given this interpretation of the data, it would seem that synchronization theorists have discovered yet another aspect Level One neural activity, not, as they believe, a form of Level Two neural functioning.

Level One neural activity, therefore, does not just occur at the periphery of the nervous system, it takes place throughout the brain. Just because a neural process takes place within the cortex, does not make it a Level Two neural process. The Level One/Level Two distinction is not a distinction between what takes place outside the cortex and what takes place within the cortex. We cannot differentiate Level One from Level Two neural activity in terms of its anatomical location within the brain. For, while it is true that the only type of neural activity that takes place in the sense organs is Level One neural activity, both Level One and Level Two processes take place in the cortex. According to the New Model, the important thing to consider when differentiating Level One from Level Two neural activity is not its spatial arrangement or location, but rather the neural dynamics involved and the form of neural use facilitated by that dynamics.

According to the New Model, Level One neural activity is entirely concerned with the holistic sense organ event, in that its function is to break this holistic event up and to articulate distinct features by way of contrast usage of it. Level One neural dynamics either provide the basis for contrast functioning (receptor shattering) or are themselves forms of contrast functioning vis-a-vis the sense organ phenomenon. Level One neural processes display different forms of connectivity among participant neurons, forms of connectivity that are specially suited to shattering and to contrast functioning. Level One neural activity, finally, involves the activity of single neurons and of neural networks both large and small. Therefore, Level One is rather more broadly defined by the New Model than it is by the Current Model: any neural process that shares the four basic features of Level One neural activity just outlined, is a form of Level One functioning. I conclude, therefore, that if there is a distinct, second level of neural activity, one that makes a qualititatively new contribution to perceptual system functioning beyond that of receptor shattering and feature functioning, it is not the synchronized bursting of neural networks. Level Two, if there is one, must consist of a form of neural activity that we have not yet discussed.

Level Two Activity: Self-Organizing Neural Masses

PROPOSITION THREE

Level Two neural activity is the dynamic of globally distributed, neural mass activity exhibited by an entire system of neurons. The aim of Level Two functioning is twofold: (1) to create systemic neural behavior, and (2) to articulate the whole organism into distinct subsystems of use.

There is a form of neural activity, not discussed in the previous chapters, for which an interesting body of evidence is accumulating. This form of neural activity takes place at an extremely global level of neural functioning, much more global than that of neural supernetworks. It is referred to as "neural mass action" (Freeman 1975). Neural mass action is behavior collectively generated by tens of thousands of interconnected neurons. This is not a form of activity capable of being exhibited by individual neurons or neural networks. It is true system behavior, like that of a wave in the ocean. Just as there are innumerable water molecules involved in a wave, there are tens of thousands of neurons involved in neural mass action in the brain. A wave is the global activity of a complex system acting as a whole that emerges only when innumerable water molecules function as a system to create a coherent form of system behavior. A wave is a system phenomenon. In a similar way, neural mass action is a system phenomenon whose properties and effects are irreducible to the properties and effects capable of being produced or possessed by its component neurons. Therefore, when you think about neural mass activity you must think of it as a true system event, a form of dynamic activity on the part of a system whole.

Why should perceptual theorists be interested in neural mass action? As far as the New Model is concerned, neural mass action is of interest first because it is a neural candidate for Level Two activity. Of course, it might be argued that there is no need to posit a second level of neural functioning in the New Model. After all, the New Model claims that neural activity is not responsible for the perception of objects and that perceptual features are created by Level One neural activity. There doesn't seem to be anything left for a second level of neural functioning to achieve in the New Model. At least, this would appear to be the case from the viewpoint of the Current Model, which associates all neural functioning within perceptual systems with the production of that which is perceived by the organism.

The New Model of perception, however, does not restrict the contributions of neural functioning within perceptual systems to feature and object formation. According to the New Model, Level Two neural functioning provides the basis for subsequent forms of perceptual use that are responsible for the objectivity of the percept, but does not contribute directly to the percept itself (see Chapter Five). Level Two's distinctive contribution to perception is much more basic than objects and features.

In this connection it is essential to note the systemic nature of perception. Perception is not just the activity of feature creation or object production, it is an event that is unique to a particular system of functioning. Each perceptual event is what it is, at least in part, because it is an event created by a particular system, e.g., the visual system. The New Model argues that the *systemic nature of perception* requires an explanation, too. It requires that something like neural mass action must occur in the brain. It is not enough that individual neurons or neural networks become active in the service of perception, because their activity does not constitute system behavior. The systemic nature of perceptual functioning demands explanation and is the fundamental motivation for the New Model to postulate a distinct, second level of neural functioning. The systemic nature of perception is not explained by any version of the Current Model to date.

The existence of system activity would be difficult to understand given the ways in which different versions of the Current Model characterize neural functioning within perceptual systems. Indeed, based on what the Current Model says about neural functioning, it seems doubtful whether system behavior plays a role in perception at all. Neither Barlow's Neuron Doctrine nor any of the various network models address the issue of systemwide neural behavior. Even the Synchronization Model does not discuss systemic behavior; rather, it highlights the activity of the relative handful of neurons that take part in a neural network. There may be hundreds or even several thousands of neurons involved in a given supernetwork, but this is a very small number indeed when one considers how many neurons are in any region of the brain. Network activity is not systemwide activity, nor is it activity on the part of most or the majority of neurons within an anatomically defined region of the brain. Network activity in the olfactory bulb, for example, involves perhaps 1-5% of bulbar neurons (Skarda & Freeman 1987), hardly the whole system. A neural system consists of hundreds and hundreds of thousands of neurons, not just the few thousand that may partake in neural supernetwork activity.

This raises an important question. How is a system, such as a perceptual system, defined? Generally speaking, perceptual systems are defined in anatomical terms as structures. Does simple location within the brain define a neural event as a visual or auditory event? From one perspective it is legitimate to identify a neural system with a particular anatomical structure. The structural description of neural systems is an observer-based definition of neural systems. However, the New Model claims that observer-based descriptions distort the true nature of perceptual system functioning. It is true that the neurons involved in visual perception occupy certain anatomical areas of the brain, but the question is what constitutes a neural system in terms of brain functioning itself, i.e., from the internal and dynamic point of view?

The internal perspective on brain function adopted by the New Model emphasizes a dynamic perspective on neural functioning. It requires that neural systems be defined from the perspective of neural functioning itself, rather than in the terms in which an outside observer would use. Thus, the New Model conceives of neural systems dynamically, as forms of activity, rather than morphogenically, as structures. This immediately raises the issue of *system generation*. What is the neural basis of perceptual *system* activity, if not the activity of single neurons or neural networks? How is a visual or other sensory system event created?

It is the view of the New Model that a neural system is a system when it *behaves as a system*, i.e., as a unitary neural process of some sort. By this definition, perceptual systems are forms of activity, namely, global or systemwide activity. Systemwide neural activity is responsible for the systemic nature of perception. The implication of this, foreign though it is to the anatomically-based definition of a neural system, is that *one essential task of neural functioning in the service of perception is to create a system*. Systems are forms of cooperative activity, their contribution to perception is not their physical reality as an anatomical structure. This interpretation propels us headlong into the topic of neural mass action, because if perception is a system event, we want to know what type of activity is involved.

It is in this connection, that one of the most important and exciting discoveries of the past decades is the finding that whole populations of neurons generate forms of systemic behavior that is unlike the activity of individual neural components and of neural networks. The discovery was Walter Freeman's (1975). It turns out that neural mass action is an excellent candidate for systemic behavior in the nervous system.

Freeman's data on neural mass action come from living animals trained (using classical conditioning) to respond to certain stimuli and not to respond to other stimuli. Freeman and his colleagues first recorded the neural activity of neural masses in the olfactory perceptual system (e.g., Freeman & Schneider 1982), and later on in the visual cortex (Freeman & van Dijk 1987; Freeman 1991). Freeman recorded neural activity involving tens of thousands of neurons by using electroencephalogram (EEG) recordings, with the recording devices implanted on the surface of the brain itself. The EEG is a recording technique that detects the averaged activity of tens of thousands of neurons, and is frequently displayed or plotted as an oscillating waveform (see Fig. 4.1). An EEG recording does not detect the activity of individual neurons beneath the recording device (i.e., electrodes), instead it records an average of all of the activity taking place beneath it in the neural tissue. This means that EEG recordings are an excellent way to tap into the system level of neural functioning by a neural mass.

Neural mass action, by the way, refers to something quite specific. It is not random neural activity on the part of thousands of neurons. Neural mass action is "coherent" behavior, i.e., behavior that exhibits a definite form or structure. Coherent behavior occurs when an orchestra plays a symphony and all of the instrumentalists take part in the creation of one piece of music; it is not like the cacophony created by instrumentalists randomly playing different pieces of music. Like a symphony, neural mass action exhibits a unified, temporally unfolding (dynamic) structure. Freeman's EEG recordings of perceptual system neural activity demonstrate that patterned neural mass activity takes place in perceptual systems, rather than random or completely unorganized neural activity. Freeman discovered that "spatially extended patterned neural mass activity", i.e., a coherent pattern of neural activity taking place across an entire region of the brain, is generated by a mass of neurons within a few tenths of a second after receptor input arrives from the sense organ. Freeman further found that identifiable patterns of neural mass activity formed when he presented different odorants to animals under reinforcement. Animals taught to respond in a particular way to a specific odorant (e.g., by licking), exhibited unique coherent patterns of neural activity in connection with the presentation of an odorant.

Thus, Freeman's data are significant, first, because they demonstrate that perceptual system neurons do, in fact, *behave as a system*, generating cooperative neural behavior that involves masses of neurons acting in concert with one another. Freeman' s data, therefore, introduced a new neural player on the field of perceptual functioning: systemic neural behavior rather than neurons working in isolation or as part of a neural network, whether small or large. In terms of brain functioning, systems are dynamic global neural events.

The New Model builds on Freeman's findings by proposing that neural mass activity is true Level Two neural activity in perceptual systems. Support for this claim is based on evidence from Freeman's model of the neural substrate that indicates that neural mass action is a unique form of neural activity involving neural mechanisms that are not utilized in the formation and activity of neural networks and other Level One neural processes. To understand this it is necessary to understand how cooperative activity involving thousands of neurons is generated.

Freeman (1991) explains the neural dynamics responsible for mass action as follows. In the brain, whole *populations of neurons* are interconnected by excitatory and inhibitory connections, forming of pairs of excitatory and inhibitory neural populations (Fig. 4.2). Negative feedback takes place between excitatory and inhibitory populations of neurons. Negative feedback is an interactive process that unfolds in several stages. First, the excitatory population becomes active and its activity excites the inhibitory population into activity. Then the inhibitory population's activity is fed back onto the excitatory population, thus inhibiting the activity of the excitatory population. This is negative feedback. When the excitatory population is inhibited, however, the excitatory population's input to the inhibitory population decreases, causing the inhibitory population to become less active, which allows for a new burst of activity on the part of the excitatory population whose activity is no longer being inhibited. Then, the whole process repeats itself again and again. The result is a pattern of "on-off" activity (Fig. 4.3) that is referred to as "oscillatory behavior". The neural mass oscillates between a highly active state and a much less active state. The oscillatory behavior of the neural mass is reflected in the EEG recording in terms of the EEG wave's recurring "peaks and valleys" over time.

Negative feedback is critical for neural mass activtiy. Systemwide neural behavior requires more than uni-directional neural links, or feedforward connections, such as those that connect receptor neurons with post-receptor neurons. Neural mass action also requires more than the mutual *excitatory* feedback connections that exist between the members of a neural network. Neural mass activity requires negative feedback. Herein lies the essential distinction between neural mass activity and the neural network activity that is discussed by synchronization theorists and the activity taking place in neural masses. Here also is the feature that distinguishes Level Two from Level One neural activity, according to the New Model.

Neural networks involve different neural mechanisms than does neural mass activity. Neural networks are formed by (a) activity involving pairs of individual neurons, that become (b) active at the same time, and (c) that are connected by mutually excitatory connections that are strengthened (i.e., their interactive ability is enhanced) by undergoing physiological changes at the synapse. Thus, if neuron A and neuron B become active at the same time, and if the activity of each neuron excites the other into activity, then the two neurons will develop strengthened connections with one another, such that the excitation of one neuron will automatically bring the other into action. Note that neural networks require feedback, but that the form of feedback is mutually *excitatory* (i.e., "positive").

Neural mass activity is different in two very important respects. Neural mass activity relies primarily on (1) negative feedback relations, and (2) negative feedback occurs between whole populations of neurons. Neural mass activity, therefore, requires negative rather than positive feedback, and the feedback relations involve tens of thousands of neurons rather than individual neurons. Neural masses are not just "super supernetworks" because they involve different neural mechanisms. Therefore, neural mass activity ought not to be equated with Level One neural activity that was discussed in Chapter Three. Neural mass activity is truly a second, distinctive form of neural functioning that takes place in perceptual systems.

It is significant that negative feedback occurs throughout the brain. It occurs within and among perceptual subsystem components, e.g., in the olfactory system among the olfactory bulb, anterior olfactory nucleus and prepyriform cortex. Negative feedback also occurs among anatomically distinct neural systems, e.g., between a sensory system and the motor system. Negative feedback creates inherent instability in the brain leading to the emergence of the characteristic oscillatory behavior recorded in EEGs. This means that systemwide activity is both possible and pervasive throughout the brain because negative feedback is a ubiquitous feature of neural functioning. Therefore, Level Two neural dynamics occur in every brain region, not only within perceptual systems.

Neural mass action is the kind of activity required by the New Model as a candidate for Level Two neural functioning.

It remains for us to determine what exactly neural mass action achieves. Is neural mass activity yet another form of feature functioning? It isn't and here is why. When an entire neural mass, a mass that involves *every neuron in the region* in population activity, engages in collective neural activity, contrast functioning is ruled out. This is because the entire neural mass is involved as a system whole in creating a spatially distributed cooperative pattern of neural activity. There is nothing held out that can enter into contrast with its systemwide behavior. This is telling. There is nothing to contrast because the entire neural mass creates a *single form of globally distributed activity*. Contrast, you will recall, requires distinct phenomena that can be brought into relation with one another. Neural mass action rules this out since the mass is, by definition, the whole system. Therefore, contrast functioning is ruled out at the level of neural mass activity, and where contrast functioning does not occur, features cannot be created. Thus it seems fair to conclude that neural mass action does not represent a further form of Level One feature functioning.

Is neural mass action the neural representation of the perceived object? The New Model denies this, too, and there are convincing data in this regard; but to understand them requires further consideration of Freeman's findings. As I said earlier, Freeman and his colleagues found that odor specific patterns of neural mass action form in response to the presentation of odorants presented to his trained animals, however, the correlation between the stimuli and the patterns of neural activity was not as one would expect based on the hypothesis that such activity is the representational correlate of the stimulus. If cooperative neural mass activity were the correlate of that which is perceived, one would expect that when the same stimulus is presented to an animal, the same pattern of neural activity would be recorded in the brain. After all, the neural correlate is supposed to be the stimulus's "stand in" within the brain and if the pattern changed but the stimulus remained the same how would the organism perceive the *same stimulus* based on a neural event? The stimulus is only known through its neural proxy according to the Current Model.

In the case of olfactory perception, Freeman found that the correlation between the stimulus and the resulting pattern of neural mass activity was anything but the tight fit predicted by the Current Model's representational theory. There are several relevant findings in this connection. First, when the same odorant was presented to different animals trained to give the same response to that odorant, different odor-related patterns were recorded from each animal. The implication of these findings was that the patterns actually correlated with each animal, rather than being unique to a particular odorant. Moreover, the patterned activity that resulted from the presentation of the same odorant to the same animal was never twice the same, even when neither the odorant nor the stimulus-response contingency changed. Freeman did find that the patterns possessed a kind of "family resemblance", but they did not exhibit the invariance of the stimulus presented. This is not what one would expect if the pattern were a representative of the odor and the odor didn't vary. How can an animal experience the same odor on the basis of changing patterns, if its sole access to the invariant stimulus is through its patterned neural activity? Additionally, when animals trained to respond to odorants were taught to respond to a new odorant, or when the response contingency for a previously learned odorant was changed (e.g., from licking to not licking), all of the previously recorded patterns associated with particular odorants changed (see Fig. 4.4). Introduction of a new stimulus, therefore, changed all of the patterns associated with previous stimuli. This clearly indicates that the patterns are not stimulus correlates, because if they were, one would not predict changes in patterns associated with previously learned odorants. Therefore, it seems clear that whatever neural mass action contributes to perception it is not a representation of the stimulus or its inner correlate.

What does Level Two neural mass activity correlate with if not with features or the internal correlate of the stimulus? The New Model proposes that neural mass action correlates with *forms of perceptual use* on the part of the perceiving organism and that its chief contribution is the creation of system behavior throughout the brain.

The key to understanding the New Model on this point is to think about neural mass action in terms of the functioning of the organism itself, rather than in relation to the external stimulus. Ask yourself what changes when an animal learns a new odorant? In Freeman's experiments the external physical stimulus did not change. The only factor that could change was something about the animal itself. To say that the animal changes, however, is still pretty vague. Therefore, we can translate this into the terminology of the New Model by saying that, when an animal learns to recognize a new odorant, what changes is the complex system of uses that is perceptual functioning in the perceptual system at that moment. According to the New Model each neural mass activity pattern correlates with a distinctive form of organismic use. When an animal learns a new odorant, it acquires a new form of use of the results of its own sense organ functioning and subsequent post-receptor activity. The acquisition of each new form of use leads to changes in the entire system of related uses within the sensory system under consideration. The New Model identifies Freeman's pattern with this changing system of uses.

Forms of use, as defined by the New Model, exhibit several features that are especially relevant to the New Model's claim that patterned neural mass action correlates with forms of use. One of these, already touched upon in Chapter Three, is that forms of use arise *within a context of related uses.* Forms of use are context dependent phenomena in that each form of use acquires its distinctive character in relation to other forms of use to which it is related by the system. For example, in the case of post-receptor functioning each form of receptor use acquires its distinctive feature character from the fact that it is involved in contrast relations at the post-receptor stage with other forms of receptor use. All this should be familiar to the reader already, but now consider a further characteristic of use. Context dependency implies a two way relationship between a form of use and the context of related uses. As just mentioned, the context of use defines each form of use, but each form of use also defines the context as a whole. Whenever new forms of use are introduced, the whole context changes. This means that all of the previous forms of use will change whenever a new form of use is acquired.

As an example of this, consider again pigeons whose visual systems respond to infrared and ultraviolet light as well as to light of the visible spectrum that humans perceive. Pigeon visual systems cannot produce the same color features that are produced by the human visual system. Why not? Because in the pigeon visual system, the larger context of related forms of light use that define color features is different. It involves light forms that are not part of the visible spectrum for human beings. This means that all of the forms of light that human perceptual systems also make use of are differently defined in the pigeon visual system. The introduction of different light frequencies changes the entire context and with it the nature of color vision: pigeons and human beings both have visual systems that interact selectively with light from the visible spectrum, but because the pigeon visual system interacts with light of other frequencies, pigeons do not perceive the human color features of red and green.

The influence of the context upon forms of use is significant because it explains Freeman's observation that introduction of a new odorant leads to changes in all of the patterns associated with previously learned odorants. The reason that all of the previous patterns change is that introduction of a new form of use redefines the entire context of uses. A form of use cannot remain the same when the context of use is redefined by the introduction of a new form of neural use. The context changes leading to changes in individual patterns of neural use, and introduction of a new form of use changes the context. This is the way things ought to unfold if neural mass action patterns are correlated with forms of use rather than with stimulus events. Patterns of neural mass activity change because they correlate with forms of use that are co-defined and cannot occur except in relation with one another.

The context dependency of use also explains why Freeman finds a family resemblance between successive recordings of neural mass activity associated with the same odorant, but not strict identity. A change of any sort in the context of use which ultimately involves the entire organism and all of its inter-related forms of functioning must effect each form of use to some extent. We know this to be true in terms of non-biological forms of use as well. Consider the following. Bicycle riding is a form of use. Admittedly, it is not a neural form of use, but still it is a good example for demonstrating a point that pertains to all forms of use, including neural forms of use. As a form of use, bicycle riding is a difficult thing to pin down in terms of a strict definition of essential components. Bicycle riding essentially amounts to something different depending on the context. Riding a bicycle is one set of movements, body postures, and balances and counterbalances when going up a hill, but something a bit different when riding it down a hill, on a flat road, with training wheels, over a curb, or along a mountain path. In each instance bicycle riding differs in that it requires different postures and involves different muscle groups on the part of the rider, etc. My point being that there is no one form of activity that is bicycle riding in each and every case. Much the same thing can be said about forms of neural use. As the context in which neural mass activity emerges undergoes changes, the patterned activity too will change. At every succeeding moment changes occur in the environment and/or in the perceiving organism. Nothing remains exactly the same, even in the laboratory. At best, the most that can be said is that succeeding moments are similar. This similarity is reflected in Freeman's recordings. Use of receptor interaction with odorant A is similar under the highly rarified conditions of the experimental setup when no new odorants are introduced, but never identical, because all along the larger context of organismic use is changing, e.g., animal is undergoing internal changes, different groups of receptors and post-receptors are being activated, and so on. Perceiving odorant A, therefore, is a lot like riding a bicycle: it cannot remain the same over time because the context within which it occurs always changes. Therefore, it would not do a perceiver any good to create only one pattern of neural mass activity for each stimulus, because this would lock the organism into a present that can never exactly repeat itself. Just as it would not do a child any good to learn but one style of riding a bicycle. Thus, the use-based interpretation of patterns of neural mass action explains several of Freeman's findings, and lends further credence to the New Model's interpretation of neural mass activity in terms of use.

Thus far, I have focused on the patterned nature of neural mass action. Global activity patterns are shaped in terms of Level One neural activity, specifically by neural network activity that is generated following receptor input is received by post-receptor neurons. This happens, according to Freeman, because network activity biases the neural mass to adopt a Level One relative form of activity at the moment when neural mass activity emerges. Freeman's hypothesis is that input into the system increases the general level of neural activity within a neural mass. This pushes neural mass activity as a whole away from its rest state, i.e., its activity state before receiving receptor input. When neural mass activity has been pushed sufficiently far away from its rest state, neural network activity induces the whole neural mass to adopt a new, network-relative form of global activity. Depending on the neural network that is active at the moment, the same neural mass can exhibit many different forms of patterned activity. Thus, neural mass activity always reflects the nature of Level One neural functioning in terms of the specific pattern of mass activity that is generated. This is what one would expect given the context dependence of neural mass activity. If the initial conditions differ, the resulting mass activity will also differ. Indeed, it could be said that neural mass activity cannot help but reflect its Level One neural context. It must, because of the seamless nature of physiological reality. However, is the patterned nature of Level Two neural activity *Level Two's* contribution to perception? The pattern of activity that Level Two neural functioning adopts is determined by Level One functioning, which implies that the patterns directly express forms of feature functioning. Re-expression of feature functioning, however, is not an original achievement for a second level of neural functioning. Why the need for neural mass action?

The New Model proposes that the true contribution of Level Two neural activity proper can only be understood by perceptual theorists who turn their attention away from the patterned nature of neural mass action. Perceptual theorists who focus exclusively on the patterned nature of neural mass action, tend to miss something equally important, viz., the fact that *systemic behavior* is generated at all by perceptual systems. I contend that the systemic nature of Level Two neural activity is its primary contribution to perceptual functioning. You see, neural mass action requires consensus, and consensus requires global cooperation. Global neural cooperativity plays no role in Level One, but it does in Level Two. This should make us pause. Why does perception require cooperative neural functioning in addition to contrast functioning and the shattering activity of Level One in general? What does the cooperative systemic nature of the functioning contribute?

As I see it, the piece of data that is most instructive for determining the actual contribution made by global activity in the service of perception is Freeman's finding that behaviorally relevant neural mass action does not take place if connections between the neural mass and the rest of the brain are severed. In other words, were it not for feedback from the rest of the brain, the kind of neural mass action that Freeman investigates would be impossible. Freeman proved this by cutting the connections between the olfactory system and the rest of the brain and observing the resulting absence of behaviorally relevant oscillatory behavior in the olfactory bulb, olfactory nucleus, and prepyriform cortex. That is, oscillatory behavior still occurred in the olfactory system, but its flexibility with behavior was lost. Freeman's discovery provides an important clue as to the unique contribution of global activity.

Why does systemwide neural mass activity within a perceptual system depend upon neural activity taking place outside the perceptual system in question? Freeman's data, and his resulting model, suggest an answer. The data indicate that Level Two neural mass action occurring in one area of the brain requires neural mass partners in other areas of the brain. The partnership of correlated functioning at the neural mass level is twofold and completely interdependent. First, neural mass action within the perceptual system requires feedback from other areas of the brain which push the activity taking place at the neural mass level within the perceptual system away from its rest state. Level One input alone is not enough to create the state of instability required for the neural mass to generate globally distributed system activity. Freeman also found that the results of neural mass activity taking place within the perceptual system are passed on to the rest of the brain. Extrapolating on this finding, we can say that the results of Level Two neural activity taking place in the rest of the brain must also be fed into the perceptual system. Thus, Level Two neural functioning within the perceptual system requires Level Two neural partners throughout the brain.

This brings us to the heart of the New Model's claim regarding the contributions of Level Two neural functioning. If Level Two neural activity within a perceptual system requires Level Two partners, this means that global forms of neural functioning are interdependent phenomena. They require one another to exist at all. Thus, neural systems, which the New Model defines as forms of systemic behavior, can only exist by way of difference in relation to other systems. This means that system activity must be related throughout the brain and must occur in more than one place simultaneously. Systems are continuously co-created and co-defined within the brain by way of interaction. This is an ongoing process, requiring constant and probably fairly complex feedback relations that create the conditions for systemwide behavior to emerge. When systemic behavior emerges in a perceptual system it must be fed out of the perceptual system to the rest of the brain thus providing the basis for the emergence of system behavior elsewhere that eventually provides the basis for further global mass action to occur within the perceptual system. In this way the interactive complexity of organismic functioning is created as a system of systems. Without it, organismic behavior as we know it would be impossible.

Based on Freeman's findings, then, the New Model proposes that the ultimate achievement of Level Two neural mass activity proper is that it creates distinct systems of neural activity in the brain. Thus the primary aim of Level Two neural mass action is to articulate organismic functioning itself. Neural mass action is the means by which unified and distinct systems of neural use are articulated by the organism. The primary function of Level Two activity is, therefore, to carve up organismic functioning itself. Remember, in this connection, the methodological reversal which underlies the New Model which puts holistic phenomena before partial phenomena. According to the New Model, the physical reality of the organism is holistic. Articualtion of the holistic physical substrate is accomplished by forms of organismic functioning. Therefore, one task of the nervous system is to dynamically carve up the physical holism of the organism. One aspect of this is the generation of neural systems or subsystems. The nervous system itself must create systemic neural behavior. This is the unique contribution of Level Two neural mass activity, according to the New Model, which generates unique perceptual systems of use.

Therefore, when thinking about Level Two neural mass action perceptual theorists ought to direct their attention "inwards" towards the organism itself, rather than "outwards" toward the stimulus. Level One neural functioning contributes to what is perceived by the organism by generating features from receptor reactivity to the sense organ phenomenon. Level Two neural functioning, however, creates a system within which feature functioning occurs. Mass activity does not itself contribute properties to the percept like features. Rather, Level Two neural mass activity creates *a perceptual even*t, e.g., a visual event as opposed to an olfactory one. Thanks to Level Two neural activity organisms embody systems of use, rather than just the local neural interaction responsible for feature functioning. Level Two neural activity also forms the *basis* for a further form of use by the whole organism which explains object perception (see Chapter Five). But Level Two activity itself does not explain the perception of objects, it explains the generation of uniquely perceptual system events.

This brings me to a final property of neural mass action not yet discussed in this chapter. Neural mass action is a *self-organized* dynamic event. Self-organization refers to a form of global dynamics. Specifically, it is a dynamic property of complex, spatially distributed systems composed of millions of similar component elements among which dense feedback relations occur. Waves are self-organizing phenomena. So, too, are weather patterns, dripping faucets, and embryonic development. *Self*-organization means that a complex substrate of inter-related elements itself generates a form of coherent collective activity. The collective's form of activity is not imposed on it from elsewhere, rather it is spontaneously generated by the collective itself under certain conditions.

One example of self-organized behavior can be observed by adding cold cream slowly to a cup of hot coffee. At first, the cream sinks to the botton. Then, if the liquid is not disturbed, a characteristic pattern of system behavior will gradually begin to emerge. The liquid will gradually partition itself into roughly octagonal convection cells in order to conduct heat. The cells are oriented vertically from the bottom to the surface of the liguid. At the surface, one will see a cross section of the cells. Hot liquid rises within the convection cells up from the bottom, cools at the top, and then falls down the outside of the cell back down to the bottom of the cup. This is a self-organizing system in action. The system has organized itself into a distinct pattern of dynamic activity which can be observed.

The coherent patterns of neural mass activity are also self-organized. Systemic behavior is generated by a massive collection of neurons sharing dense feedback connections. Coherent system activity in the brain, therefore, is something that the brain itself generates. Much has been made of the fact that neural activity is self-organized in recent years, and rightly so. A vast literature on the subject has developed. Researchers have made some important discoveries based on their understanding of the self-organized nature of neural dynamics. New interpretive models have been developed and new forms of data analysis have been made available based on the mathematics of self-organizing systems. As it pertains to the New Model, however, I would like to make a single observation: Level Two activity, as defined by the New Model, cannot be anything but self-organized. If self-organization were an impossibility in this universe, and if organisms did not have nervous systems built out of millions of highly similar components that were densely interconnected with one another, organismic systems could not occur and organismic life as we know it would not exist. Level Two activity articulates the organism into distinct systems of organismic use. Organismic articulation cannot be borrowed from elsewhere. How could it be? Organismic functioning is unique in the physical world. It cannot be copied from the nonorganismic environment, because that environment does not share the organizational dynamics of living organisms. Therefore, organismic articulation into systems must be self-generated by the organism. Which, in turn, means that the organism must possess a form of dynamics that will allow it to create something essentially novel in the physical universe. This is why self-organization is a must for organisms.

Freeman once wrote that "with each breath the rabbit draws it creates a new world view" (Freeman 1983). He is right in two respects. With each breath the rabbit articulates its sense organ event into a complex of features that are not found in physical world before the rabbit enters the picture. But the rabbit does more than this. At the same time rabbit dynamics also continually articulate the rabbit itself into a complex system of systems. Perceptual functioning, therefore, simultaneously creates the features perceived and the perceiver as a system of subsystems. Perceptual functioning is much more remarkable than perceptual theorists have imagined.

CHAPTER FIVE

Perceived Objects and the Nature of Consciousness

Without consciousness the mind-body problem would be much less interesting. With consciousness it seems hopeless (Nagel 1979).

The sense organs create the holistic, phenomenal fabric of the percept. Then, Level One neural activity articulates the holistic sense organ event generating contrast defined features. Level Two neural activity articulates the perceiving organism itself into a system of subsystems, creating perceptual systems proper. But the holistic phenomenal fabric of the percept, features, and the articulation of a perceptual system event do not yet explain the perception of objects. Objects, as the word implies, enjoy an objective status.

Whence the objectivity of that which is perceived? The objectivity of the percept, its "otherness", is surely the most fundamental characteristic of that which is perceived. Therefore, problem of objectivity is a pivotal issue for perceptual theory although it is generally ignored by perceptual theorists. Seldom is mention even made of the fact that what is perceived is perceived as "other" than the perceiver. The Current Model, for example, does not explain how the neural representation achieves objective status. Apparently, the pecept's objectivity is understood by the Current Model to be a property of the original stimulus, just as features are thought to be properties of the stimulus, and therefore can be copied or internalized by neurons.

Of course, the New Model rejects this interpretation. Perception does not copy the percept, it creates it. As for the percept's objectivity, that too must be generated by the perceiver. The seamless character of the physical universe rules out the separateness that the Current Model would have neurons copy. The otherness of objects is lacking entirely in physical reality viewed as seamless or essentially holistic, i.e., without any inherently existent breaks whatsoever. Where there are no breaks, there can be no other. Physical reality is of one piece. Therefore, the New Model must explain the objectivity of the percept in terms of perceptual functioning.

The objectivity problem, however, is but one half of a more general issue that needs to be addressed by perceptual theorists. Its mirror half is the problem of subjectivity. The otherness of perceived objects assumes a non-other, a self. Objects are objects for subjects. There is a simple rule involved here: subjectivity and objectivity occur together or not all.

Historically, perceptual theorists with a scientific learning have regarded the problem of subjectivity an anathema to avoid at all costs. They have been seriously misguided in this respect. To be sure, subjectivity is a difficult issue, however, it is not an issue that those interested in explaining how perceptual functioning generates the percept can dismiss. Those who wish to banish the issue of subjectivity fail to recognize that problem of subjectivity is not an isolated problem that can be handed over to philosophers to deal with while the scientific explanation of perceptual functioning proceeds on course. Objectivity is the flipside of the subjectivity problem. Objectivity and subjectivity are twinned issues. Without subjectivity there is no objectivity, and without objectivity one cannot explain the percept. Hence, perceptual researchers cannot continue to ignore the problem of subjectivity. If they do, the objectivity of the perceived will be incomprehensible. This is why the objectivity of the percept today remains just as much a mystery as does the issue of subjectivity. Wishing to avoid the issue of subjectivity, those interested in explaining perceptual functioning are also forced to avoid the issue of objectivity which carries with it an ineliminable reference to a perceiving subject.

The subjectivity-objectivity problem is basically the problem of consciousness. Therefore, the problem of consciousness is a central issue for perceptual theory. There can be no scientific explanation of the objectivity of the percept unless the problem of consciousness is tackled head on. Therefore, it is imperative for perceptual theorists and researchers alike that an operational definition of consciousness be formulated. Although in recent years there has been much talk about the need to develop such a working definition, to my knowledge no definition has yet been proposed. There is even a general reluctance to tackle the issue had on, as if it were a hopeless task. It is a difficult issue, but surely not an impossible one. It is, however, an issue that requires a fresh look.

What is Consciousness?

Traditionally, consciousness has been considered in terms of the mind / body problem. The mind / body problem is a debate which pits dualism against materialism. Is the mind or consciousness something nonphysical and irreducible to the physical (this is dualism) or is it material in the sense of being some sort of physical event taking place inside the brain or body of the organism (this is materialism)? Philosophers of mind, who study the mind / body problem, have gone back and forth on this issue for centuries. The essentials of the debate, in its present form, can be summarized in a few words. From the viewpoint of the experiencing subject, perceptual experience is clearly something quite different than material phenomena like neurons. Neurons are physiological entities that are publically available for examination, they can be placed under a microscope, they take up space in the skull, etc. Perceptual consciousness is not like neurons because, to quote again the philosopher Thomas Nagel, it is something that it is "like to be" rather than something that is physically available to be measured and examined by others. Consciousness is thought to be essentially subjective.

Dualists, past and present, argue that the subjectivity of consciousness is irreducible to bodily states. It is something over and above the neuronal machinery. Some dualists claim that consciousness is a nonphysical or nonmaterial entity or phenomenon, while others claim that consciousness is an experiential property that "emerges" from the material substrate like the physical property of the wetness of water arises from the atomic substrate of hydrogen and oxygen molecules. Materialists, on the other hand, argue that all claims for an irreducible, nonphysical consciousness are fundamentally unscientific. They argue that there is no scientific evidence to support dualistic claims for a nonmaterial unknown. Materialists argue that consciousness must be some sort of physical phenomenon, one as yet undiscovered but in principle accessible to science. Materialist philosophers place great hope in scientific progress in matters of consciousness, even while scientists themselves prefer to ignore the issue entirely while they pursue what they take to be "genuine" scientific research goals.

To date the philosophical tradition has not succeeded in producing a generally agreed upon definition of consciousness. Dualists do not agree even among themselves (there are many varieties of dualism from the substance dualism of Descartes and Leibniz to property dualism and emergentism), and certainly dualists have not won over their materialist opponents. Exactly the same situation plagues materialism. Recently, however, a new trend is emerging in philosophy of mind that favors a nondualistic and nonmaterialistic new approach to issue of consciousness. Many philosophers of mind now agree that a fresh line of thinking about the issue of consciousness is required. The question is how to start.

To begin with it is clear that, whatever the relation between consciousness and the body, there has always been an enormous amount of confusion surrounding the use of the term consciousness. Four prevalent usages can be distinguished in the philosophical and psychological literature as well as in common parlance:

- consciousness is the subject
- consciousness is a mental state
- consciousness is a bodily sensation
- consciousness is a faculty of the subject

In many, if not most, articles and books on the subject of consciousness, the reader would be hard pressed to determine what the author means by the term consciousness. This is because the term is identified with more than one of the four meanings. However, these four uses are not equivalent, they are contradictory. The first usage of the term equates consciousness with the self; the second, defines consciousness as a cognitive relation bridging the gap between the self and its object; the third, equates consciousness with a state of the physical body; while the fourth, equates consciousness with a power or ability possessed by the self. Clearly, consciousness cannot be simultaneously the subject, a mental relation between the subject and its objects, a state of the physical body, and a subjective ability. Only one of these definitions can be the right one, that is, if any of the four definitions is actually a correct definition.

However, it turns out that each of the four definitions of consciousness is problematic in and of itself. First, defining consciousness as the self isn't informative unless the term "self" is defined. The self, however, is an unknown quantity as a quick look at its dictionary definition quickly reveals. The term self is defined variously as the individuality or essence of a thing, not only of living organisms but of inanimate objects as well (objects to which consciousness is never ascribed); the self is defined as "person", a term that surely is more nearly synonymous with the term self than explanatory of it; and the self is even defined as the object of introspective consciousness, making consciousness, if identified with the self, the object of consciousness. Far from clarifying what is meant by consciousness, therefore, defining it as the self further confuses the issue. Add to this the fact the self is considered a unitary phenomenon, whereas consciousness is generally viewed as being in constant flux, always changing like the stream with which it is often identified, and it becomes even less appealing to identify the self with consciousness. The problems besetting the identification of consciousness with the self also impact on the fourth definition of consciousness as a faculty of the self. Without a viable definition of the self, all ascriptions to it of properties or faculties are in serious jeopardy.

Viewing consciousness as a bodily sensation is also unsatisfactory because this definition unacceptably narrows the scope of the phenomena to which the term consciousness is ordinarily applied. Perceptual states are forms of consciousness just as surely as are, e.g., sensations of pain, but the identification of the term consciousness with sensations rules out perceptual states as forms of consciousness because they are not bodily sensations. Moreover, defining consciousness as a bodily sensation just recasts the issue of consciousness as the sensation problem, and there is a long philosophical history of failure to agree on what is meant by "sensation" as well. Finally, as discussed shortly, the second definition of consciousness as the cognitive bridge that delivers objects to a subject, is also unacceptible in terms of the articulative conceptual framework of the New Model. Therefore, the New Model does not define consciousness in any of these four ways. It develops a new definition of consciousness upon which to base its account of perceptual objectivity.

The New Model's definition of consciousness is developed in reaction to two related ways of thinking about consciousness. The first is the widely accepted view that consciousness has an unique structure. This structure is referred to as the "intentional" structure of consciousness, and as been investigated by philosophers in great detail, notably by the German phenomenologist Edmund Husserl and his school. According to intentional theory, consciousness is a form of mental directedness toward an object. When one perceives a house, for example, one is mentally directed toward and hence put into relation with a perceived house. The intentional structure of consciousness expresses the dominant view that the subjective and objective are separated from one another and that the function of consciousness is to connect or relate the two. A second, related way of thinking about consciousness comes up in the context of the mind/body problem. Dualists and materialists are eager to eliminate the "gap" between the subjective realm of consciousness and the objective realm of physical reality. The whole attempt to eliminate the gap started in philosophy of mind with the view that the subjective and the objective are isolated realms. However, as materialists argue, if the two phenomena are completely isolated, basic facts about organismic functioning cannot be explained. For example, how does a subjective intention to take a drink of water lead, as it seems to do, to the physical movements of the subject's arm and hand toward a glass of water? In order to reintegrate subjectivity and objectivity, materialialists propose that what appears as irreducibly subjective is just a special form of objectivity, i.e., neural activity. They essentially seek to reduce two isolated realms to one all-inclusive physical realm, which they view as inherently objective. The problem of subjectivity is the problem of getting rid of the unavoidable and yet problematic difference between the subjective and the objective that stares theorists in the face whenever they think about these issues. Together, these two lines of thinking about consciousness share a common feature: they both conceive of consciousness in terms of gap elimination: intentional theorists tell us that the function of consciousness is to bridge the gap by relating the subject to its intentional objects, and dualists and materialists have created the fundamental mystery of consciousness in terms of the mind/body gap that must be eliminated in order to understand behavior.

These two approaches to the issue of consciousness are rejected by the New Model. From the perspective of the New Model, traditional approaches to the issue of consciousness reflect a conceptual framework that should be very familiar to the reader who has followed the development of the New Model to this point, viz., constructivism. Just a scientists have taken a contructivisitic approach to neural functioning, intentional theorists and philosophers of mind have viewed consciousness in constructivistic terms, i.e., in terms of gap bridging or elimination. Constructivistic thinking about neural functioning created the intractable binding problem in neuroscience, and the

New Model suggests that constructivistic thinking also creates problems when formulating a theory of consciousness.

According to the New Model, both forms of constructivism are conceptual dead ends when it comes to defining consciousness. Intentional theories of consciousness that define, e.g., perceptual consciousness as the means by which subjects get into relation with perceived objects, are plausible only if one also assumes first that the subjective is something that exists in its own right. If the subjective could exist on its own, independent of objectivity, it might be legitimate to view consciousness as a cognitive bridge between the subjective and the objective. However, the assumed independence of subjects runs dead against the fact that the subjective and objective are codependent phenomena. The subjective is what it is precisely because it is not objective, and vice versa; much like the color red is what it is by virtue of not being green. However, since the subjective and objective are always necessarily related, creating a bridge to relate the two makes no sense. Consciousness as a bridge is meaningless when the constant relatedness of subject and object is recognized, and the constructivist reading of consciousness loses its much if not all of its original appeal. So argues the New Model.

The second expression of constructivist thinking about consciousness is the philosophical search to find some way to eliminate the gap between the subjective and the objective. At least 300 years of serious constructivist thinking about this gap has occupied philosophers since the time of Descartes. However, there are some serious conceptual difficulties with the project that have passed unnoticed. The subjective, as I have said, is related to the objective, but their relationship is a special form of relationship. The two are related by way of *difference*. In other words, subjective and objective are involved in a contrast relationship. Contrast is essential for the existence of both. But now consider this in terms of the materialistic project of gap elimination. The gap is the difference between the two phenomena. If the gap which differentiates the two phenomena by way of contrast were eliminated, if the subjective were reduced to some objective phenomena, this would amount to the elimination of both the subjective and the objective. This is because the two terms are codefined by way of contrast and the gap of difference is a requirement for the existence of both; the gap cannot be eliminated without eliminating at the same time both of the terms which the gap makes possible. Materialism cannot be right.

Based on these insights, the New Model, which rejects constructivistic thinking about neural functioning in favor of an articulative conceptual framework, adopts an articulative approach to the issue of consciousness as well. According to the New Model, articulation does not stop with neural functioning, it extends across the board to all aspects of perceptual functioning including those responsible for object perception. The operational definition of consciousness proposed by the New Model is that consciousness itself is the gap: *consciousness is the articulative moment of differentiation between what is used as subjective and what is used as objective by the whole organism*.

The change of perspective on the issue of consciousness is quite simple really, but it immediately introduces some thoroughly intriguing possibilities for perceptual theory. For one thing, the new definition of consciousness implies that consciousness is not the subjective. Consciousness cannot be subjective, according to the New Model, because it is the condition for the subjective. Each subjective moment reveals its dependence on consciousness as defined by the New Model. Objectivity is equally rooted in consciousness. Both the subjectivity of the experience and its objective correlate require the moment of differentiation which is the gap that the New Model identifies with consciousness. The subjective and the objective are rooted in consciousness, consciousness is not rooted in either the subjective or the objective. One cannot reduce consciousness to the terms to which it gives rise, be they subjective or objective. The philosophical tradition in general has been misled by the assumption that objectivity is a fact about physical reality. This causes real problems, as I have already emphasized. However, one problem not yet discussed is the mystery that this view of objectivity makes of the subjective. If objectivity is an inherent property of the physical realm, then subjectivity cannot but become a mystery because it is the polar opposite of the objective. However, if both subjectivity and objectivity are rooted in consciousness, which is neither, then objectivity is not an inherent property of the physical realm any more than subjectivity isn't a property of the physical realm. Both have their origins in consciousness as the gap.

Thus, consciousness is the gap structure, the moment of differentiation which gives rise to the subjective and the objective. Having said this, however, more is required. The gap itself requires further explanation. What is meant by saying that consciousness is a "moment of differentiation"?

The Final Aspect of Perceptual Articulation

The New Model's definition of the gap that is consciousness is based on the concept of use. Use, you will remember, is a context dependent process that creates or lends to that which is used its specific nature, e.g., as a color, which is a use-based property rather than a physical property of light. The final proposition of the New Model summarizes the New Model's proposals in this regard.

PROPOSITION FOUR

The objectivity of the percept can only be explained in terms of consciousness. Consciousness is an articulative form of use, engaged in by the whole organism, that contrasts the two results of Level Two articulative neural functioning to create the subjective and the objective.

Consciousness is a form of contrast usage of the two results of Level Two articulative neural functioning. This does not mean that consciousness is a form of Level Two neural functioning. Consciousness is not a form of neural functioning. Consciousness is a form of whole organism use of the products of neural functioning. According to the New Model, consciousness is a form of *contrast usage of* the two results of Level Two neural functioning. The two results of Level Two neural functioning are: (1) Level Two neural mass action creates neural systems as forms of dynamic activity in the brain, and (2) Level Two neural mass action articulates the whole organism into a global system of inter-related subsystems. Proposition Four says that these two results of Level Two functioning provide the bases which are employed by the form of use that is consciousness. It is important to note the difference between a *form of use* (in this case consciousness), and the *bases which are used* (the results of Level Two functioning). If the bases are conflated with the organism's use of them, it is impossible to avoid the materialist position of identifying consciousness with a neural event or some other physical event occurring in the brain. The New Model is not a form of materialism because it explains what materialists identify as a material entity in terms of a form of doing something with something else, viz., the basis of use.

With the distinction between the bases of use and forms of use in hand, there are two basic issues that must be understood in connection with the problem of object perception, according to the New Model. It is necessary to define the basis and the form of use that is objectivity and the basis and the form of use that is subjectivity. In summary, here is what the New Model proposes:

(1) The basis of perceived objectivity, that which is used by the whole organism as objective, is the result of global mass action which produces the system activity which is a perceptual event.

(2) The basis of subjectivity, that which is used by the whole organism as subjective, is the result of Level Two articulation which creates the articulated global system that is the organismic whole.

The New Model proposes to explain the origins of object perception in terms of these two facets of perceptual functioning.

"Perceived Objects"

The basis of the form of use that generates perceptual objectivity, according to the New Model, is perceptual system activity in the form of global mass action, a Level Two neural contribution. There are a couple of things that need to be considered in this connection. One concerns the characteristics of system activity that allow it to serve as a basis of object perception, and the other concerns the form of use that creates the objective nature of the percept. I will consider each topic in turn.

Two aspects of global mass action are relevant to its role as the basis which is used to produce perceptual objectivity. One aspect is the *patterned* nature of global mass action, and the other is its *systemic* character. In connection with the first aspect, you may recall that in Chapter Four I set aside the issue of the patterned nature of neural mass activity. There I said that the patterned nature of neural mass activity is not relevant to Level Two's own contribution to perceptual functioning. I proposed that the specific *Level Two* contribution to perception concerned the global or systemwide nature of the behavior generated, not its patterned nature. However, the patterned nature of Level Two neural mass activity is relevant when it comes to Level Two's role as the basis of the form of use that creates perceptual objectivity.

Freeman's model reveals that Level Two neural mass action is shaped by Level One neural functioning. This is because Level One neural network activity biases subsequent global mass activity to adopt a particular Level One relative form of mass activity. This means that global mass activity is always shaped by forms of neural use in Level One. Therefore, the cumulative effects of all forms of Level One use of the sense organ event by receptors and post-receptors is conveyed by the pattern of neural mass action. Thus, the patterned nature of Level Two global mass activity conveys the articulative achievements of Level One functioning. But, why does a perceptual system need to convey or reconfigure Level One feature functioning in the form of Level Two neural mass activity? The New Model proposes that the reconfiguration in the form of neural mass action is required to provide the basis for the form of whole organism use that creates the objectivity of the percept. This brings us back to the systemic nature of global mass action. Systemic activity is required for the generation of objectivity.

The reason that Level Two system creation is so important for perceptual functioning is that, while perceived objects clearly depend upon the complete articulation of the sense organ phenomenon by receptors and post-receptor neurons and neural networks, Level One feature generation is an extremely complex affair. Thousands of distinct feature generation processes occur in parallel and sequentially. Feature functioning is a complicated business involving many segregated processes. Therefore, the New Model suggests, that patterned Level Two neural mass action is essential for object perception because it creates a single entity or process that conveys all of the results of Level One feature articulation of the sense organ phenomenon. In other words, when neural mass action takes place and produces output as a system, it constitutes a new basis of use that is made available for subsequent levels of perceptual functioning. With the creation of this new basis of use, the perceiving organism for the first time also has a perceptual system event proper with which to work. The New Model proposes that this perceptual event, which conveys the complete set of use-based articulations of the sense organ event into features, forms the basis of the form of use that creates the objectivity of the articulated sense organ event.

I hasten to add that Level Two neural mass action does not bind features together. The unity of the articulated features is established by the sense organ phenomenon. Level Two neural mass action is not a solution to the feature binding problem, as was stressed in Chapter Three, although it might appear that this what is going on given the New Model's interpretation of the systemic expression by Level Two neural mass activity of Level One feature functioning. The unification that occurs at the level of neural mass action is not a form of feature binding, it is the way that the perceptual system creates a new basis of use. The Level Two event does not bind features, it simply re-expresses feature functioning as a unitary basis for subsequent perceptual use by the whole organism.

Which bring us to the form of use that creates perceptual objectivity. According to the New Model, *perceptual objectivity is created by a form of use wherein the organism as a whole takes up the Level Two perceptual system event as "other" or "out there"*. That is, the perceptual objectivity of the holistic phenomenal fabric and related Level One feature use of it is generated by the whole organism which uses Level Two's systemic expression of all Level One forms of articulative use of the phenomenal fabric as objective or other.

So, for example, in the olfactory system which Freeman investigates, the results of global mass activity are made available to the whole organismic system by being passed out of the olfactory system. This activity has a pattern that conveys the whole set of Level One uses of the sense organ phenomenon. Once produced, the whole organism has available to it the phenomenal fabric of the sense organ phenomenon in the nose plus the complete set of feature articulations in relation to that phenomenon. The organism then uses the perceptual system event as something objective or other. This is the basis of olfactory objectivity according to the New Model.

It is important to understand that what is used as other by the whole perceiving organism is not neural activity as a neurophysiological process. Neurophysiological properties cannot explain the properties of the percept, as I have said elsewhere. What is used as other are the results of forms of use. Neural activity's perceptual role must always be viewed in terms of its function as a form of use. In the example of olfactory perception, just mentioned, the whole organism takes up the feature articulations of the sense organ phenomenon that result from forms of Level One neural use. These articulations are made available as a unit in the form of the system event produced by Level Two neural functioning. The perceiving organism uses its feature articulations of the sense organ event as something distinct from it, as objective.

The plausibility of the New Model's account of perceptual objectivity, of course, depends upon its recognition of the power of use to determine the character of that which is used. According to the New Model, objectivity or otherness is not a property of physical reality. Physical reality is not objective in its own right. There is no extra-organismic source of objectivity. Physical reality's seamless nature doesn't have any breaks; and yet, it is precisely breaks or gaps that are required in order for there to be objectivity. Gaps are organismic creations, they are created by organismic forms of use. Proposition Four proposes one way in which to explain the separability that is required by the perception of objects that cannot be copied from the physical world. It proposes that objectivity is created by a form of organismic functioning that uses the results of perceptual system functioning itself as "out there", as facts about something else. What is used as other inherits its character of otherness from this form of use, according to the New Model. This is the use-dependent origin and the organismic basis of object perception.

The reader will no doubt appreciate that this account of objectivity represents a real departure from the way in which the tradition has dealt with objectivity in the context of perceptual theory. Objectivity is generated by the way in which perceiving organisms use aspects of their own perceptual functioning. The New Model's account of perceptual objectivity also does not accord with the impression that perceivers have about the nature of objects. Perceivers experience objects as external, as inherently separate entities or processes, but the New Model proposes that the objectivity of the percept is the product of a form of use, viz., use of the results of patterned perceptual system activity. It seems counterintuitive, and it is. As I have repeatedly emphasized, perceptual experience obscures its own origins. The percept does not display the forms of articulative use that are responsible for its objective status.

"Subjectivity"

Use of something as an object requires a form of subjective use. The objective is defined by way of contrast with the subjective. How is the subjectivity of perceptual experience generated? The New Model claims that the basis for the form of use that creates perceptual subjectivity is the result of Level Two's articulation of the organism itself.

As explained in Chapter Four, the generation of Level Two neural mass activity also contributes to the articulation of the organismic whole. This is the flipside of system activity, the second aspect of Level Two processes. Chapter Four emphasized that the organism must achieve its own articulation into a complex whole. Level Two processes create the organism as a complex system of subsystems. Sherrington emphasized that animals possess "solidarity". His statement underscores the complex nature of the perceiving creatures he studied. Perceiving organisms are not amorphous, they are articulated wholes.

The New Model suggests that Level Two neural activity which articulates (rather than integrates) the organism, forms the basis for the subjective form of use. The subjective aspect of perception, therefore, depends upon Level Two neural functioning, just as the objectivity of the percept does. The difference is that, in the case of subjectivity, a different aspect of Level Two functioning comes into play. The aspect of consciousness that is subject-use is based on the global occurrence of mutually articulative neural mass action occurring throughout the brain. When this articulated organismic reality is generated, it is available for use. The organism has its articulated wholeness available to it thanks to Level Two functioning. When the organism takes up the results of the Level Two articulation of its own reality, it does so, the New Model suggests, by using aspects of its articulated wholeness as subjective, rather than as objective.

Here again, the New Model contends that use makes it so. What is used as subjective is subjective. While engaging in various behaviors, the New Model suggests that the organism consistently uses aspects of its own articulative functioning as subjective. Subjectivity, therefore, is a use-based reality. It is not a neural state or something that physiologists can locate in the body. Like objectivity, subjectivity is a form of whole organism use of its own lower level forms of use. When the organism behaves as a whole, its behavior, which is a concatenation of levels of use, creates subjectivity. Both subjectivity and objectivity are generated by the most global aspect of perceptual functioning: the functioning of the whole organism as perceiver.

Therefore, subjectivity does not require the ability to engage in the kind of reflective mentation of which humans are capable. Perception is not a self-reflective process. Indeed, as the term "self-reflection" implies, subjectivity is presupposed by the reflection on it. Still, one might wonder how the subjectivity of perception could amount to "nothing more than" a form of use. There is a tendency to feel robbed of something more concrete by use-based accounts. We thought we had something tangible or solid in hand when thinking about subjectivity as some physical or mental thing, and in its place the New Model puts a form of use of bases that are not themselves subjective.

And yet the New Model proposes that subjectivity can be a form of use and something remarkable as well. We are so biased in our thinking by perceptual experience, that always presents us with individuated phenomena and their properties, that we have no conceptual space for the very process that generates tangibility and its subjective counterpart in the first place. Why insist that perceptual functioning share the nature of what is perceived? Perception is the source of tangibility and subjectivity. And by all accounts, forms of use are powerful processes. Uses create what the representations of the Current Model could only copy. Perception as a concatenation of forms of use is a truly amazing phenomenon, one that our fascination with the machines that we have created to imitate cognitive processes like perception cannot touch.

"Consciousness"

Consciousness is the gap between what is used as objective and what is used as subjective. Gaps are interesting phenomena because they create difference or separation. Consciousness as the gap, therefore, must be a process of contrast between the two forms of use just discussed. Interestingly, the two bases of use created by Level Two functioning are always correlated in terms of organismic functioning. As we have seen, there is no articulated organismic whole in the absence of system activity, and no perceptual system activity without the articulated organismic whole into other systems in relation to which individual system activity is generated through feedback. This means that the two forms of use that are contrast by the gap that is consciousness are constantly correlated by organismic functioning.

Consciousness is the articulative process in which these two correlated forms of use are contrast or played off against one another. This is the subject-object gap in which perceivers live. This form of contrast or dichotomization becomes the nature of reality for perceiving organisms. Consciousness is the final form of perceptual articulation that behaviorally tears the organism perceptually apart from the seamless fabric of physical reality in which it exists and sets it up as the realm of subjectivity in opposition to objectivity. Now the organism becomes a perceiver, a self or individual proper. And it does so thanks to a unique form of whole organism use of aspects of its own functioning. This is what I meant in Chapter Three, when I said that the perceptual form of life is really a form of organismic self-use.

At the same time that it creates subjective reality for the organism, consciousness creates an "environment" for the first time: that which the organism uses as "out there", as something in which it functions as an individual, as something that it is surrounded by. The environment, too, is use-based. How could it not be use-based? The seamless physical reality of the world is not an environment. In the seamless web of physical reality there is no separate reality that the "rest of" physical reality can surround. Therefore, environments are not physical realities, they are organismic, perceptual realities. Only perceivers have environments, because only perceivers have the forms of use required to create an environment out of seamless physicality.

In conclusion, then, only a theory of consciousness can explain the objectivity of the percept. Without a theory of consciousness, no theory of perception can be complete. The use-based definition of consciouness proposed by the New Model is one way in which to explain the nature of consciousness. Moreover, it is an account that does not identify consciousness with a mysterious nonphysical entity or with a physical one. It is neither dualistic or materialistic.

It is not dualist, because it does not define consciousness as an nonphysical event. It is an articulated gap between two forms of use of Level Two functioning. The New Model is not materialist either, because it does not identify consciousness with some neural process going on in the brain, as contemporary materialists are want to do. A gapped form of whole organism use of its own dynamics is not a physiological entity. Therefore, the New Model puts consciousness in the world, but as a form of use which is related to but not reducible to the reality of its physical bases. The essential thing is to explain how the whole organism perceives something other than itself, something out there in its--the whole organism's--environment. Such an explanation requires a delicate conceptual balance, based on the notion of use, between the extremes of dualism and materialism.

CONCLUSION

The Perceptual Form of Life

The great common achievement of all organisms that perceive is their ability to deconstruct the seamless web of physical reality in which they are emeshed as physical systems by articulating aspects of their functioning for their own use. The truly remarkable nature of this achievement cannot be stressed enough. Traditional interpretations of perceptual functioning miss it entirely, and end with a derivative notion of perceptual reality as a representation of an independently existing articulated physical situation that resembles what perceivers perceive. Any other interpretation of perceptual functioning, especially one that assigns a creative role to perception, is considered anti-realistic. Realism is supposed to adhere to the nature of the world as it really is in itself, but realism is actually a perception-based view of the nature of the physical world in which perceiving organisms find themselves. Realism presupposes perceptual activity which articulates the objective independently existing reality of objects and events that realists would have perceptual systems copy out of the seamless web of reality. Nonperceiving organisms cannot be realists. Realism is not a viable viewpoint on which to base a perceptual theory.

Does the creativity of perceptual functioning mean, however, that perceivers are trapped forever in their own subjective phantasy that hides from them the nature of physical reality? No, of course not. First, nothing exists in isolation in the seamlessness of the only reality that exists. Second, the fear of subjectivism misses the whole point of the use-based definition of subjectivity. For the New Model, subjectivism is an illusionary problem as it traditionally has been understood in science and philosophy. Subjectivity is not an independently existent state of affairs. Nothing can be "purely subjective" in the sense of being cut off from what is objective, as if the two conditions formed independent, isolated realms of existence. There is only one reality, the physical reality that I have described as seamless. In itself, physical reality isn't objective any more than the perceiving organism's own physiological functioning is subjective in itself. Objectivity is a form of use, just as subjectivity is a form of use; and what is more, the two forms of use can only be had by a system that contrasts the two forms of use in terms of its own functioning. The dualism of subjectivity and objectivity is the product of use and are not realms inside of which organisms can be trapped or outside of which they can exist.

Consciousness, too, is a form of contrast usage, it is not the condition of matter or of something nonmaterial. Consciousness is a style of living that is engaged in by some, but not all, organisms. It includes perceptual forms of life and, in the case of human beings, mental cognition. Consciousness requires that the organism is able to articulate itself and its products of use in the ways outlined in Chapters Three through Five. Consciousness, therefore, requires a certain degree of physiological complexity that can support the concatenation of forms of use that are required to produce objectivity and subjectivity in relation to one another. Therefore, not all organisms, e.g., bacteria, are perceivers, according to the New Model.

There are many additional ramifications of the New Model of perception. In closing, I want to mention only one: the implications for each of us as perceivers. When we think about ourselves in terms of the Current Model of perception, the tendency is to view ourselves as marvelouly complicated machines. Our attention focuses primarily on our own *complexity* as a system: the billions of neurons in our brains, the infinite possibilities for connectivity and change at the neural level, and so on. If we think about ourselves, instead, in terms of the New Model, the focus changes. We are confronted with the marvelous articulative creativity of perceptual functioning, the fact that by engaging in forms of use perceiving organisms create themselves as individual perceivers and their objective environment at the same time. It is not our complexity that stands out from this perspective, it is our *creativity* that is striking. From this perspective our physical complexity as a system is entirely in the service of the creativity of use which we embody as perceivers.

Perception is truly a style of living, a style of engagement in the seamless web of physical reality. Each of us individually embodies this form of life. In the end, the purpose of this book has been to show its readers the marvelous nature of this organismic achievement. We and other perceivers are the great miracles of the universe. In the end, perceivers are that in the face of which we ought to stand in awe.

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For further questions or comments Christine Skarda can be reached via email at: raykreisel@yahoo.com